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Dept. of Applied Physics & Astronomy— University of Sharjah
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Inside this issue:

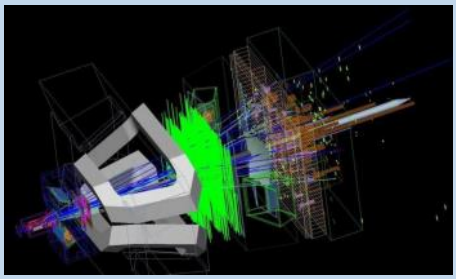
Is this the trailer for the upcoming LHC blockbuster?

In light of the latest analysis on the decay of beauty mesons, the dawn of a 'new physics', may be approaching. An important contribution to the analysis has been made by physicists from the Institute of Nuclear Physics of the Polish Academy of Sciences (IFJ PAN).

There are some indications that physicists working at the LHC accelerator at the European Organization for Nuclear Research (CERN) near Geneva are on the verge of of physics beyond the current theory describing the structure of matter. It emerges from the latest analysis of data collected by the LHCb experiment in 2011 and 2012. Physicists from the Institute of Nuclear Physics of the Polish Academy of Sciences (IFJ PAN) in Kraków, Poland, have made an important contribution to the analysis.

"To put it in terms of the cinema, where we once only had a few leaked scenes from an much-anticipated blockbuster, the LHC has finally treated fans to the first real trailer," says Prof. Mariusz Witek (IFJ PAN).

The Standard Model, a theoretical framework formulated in the 1970s, describes the structure of matter on the scale of elementary particles. Particles we now considered ...Read More...



*R. Aaij et al. Angular analysis of the B 0 → K *0 μ + μ − decay using 3 fb−1 of integrated luminosity, Journal of High Energy Physics (2016). DOI: 10.1007/JHEP02(2016)104 This is a computer simulation of rare decay of Bs meson to J/psi and phi mesons in LHCb detector at CERN. Credit: CERN*

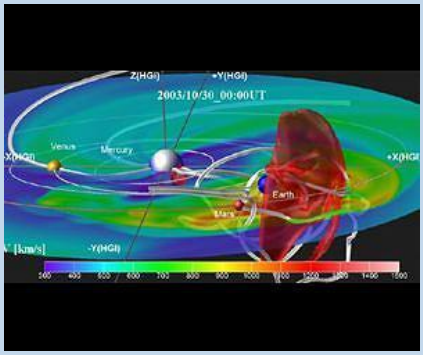
Coronal mass ejection simulations to boost space weather forecasting

Coronal mass ejections (CMEs) are massive expulsions of magnetic flux into space from the solar corona, the ionized atmosphere surrounding the sun. Magnetic storms arising from CMEs pose radiation hazards that can damage satellites and that can negatively impact communications systems and electricity on Earth. Accurate predictions of such events are invaluable in space weather forecasting.

A new and robust simulation code for CME events was developed based on the realistic description of the mechanisms behind CME generation and their propagation through space.

An article recently published in Space Weather presents their results from the method, which was successfully validated using observational data from a series of CME events reaching the Earth's position around Halloween of 2003.

"Our model is able to simulate complex 'flux ropes', taking into account the mechanisms behind CME generation derived from real-time solar observations. With this model ...Read More..



A coronal mass ejection event showing a representation of the flux rope anchored at the sun and the propagation of the magnetic flux rope through space toward Earth. The white shaded lines indicate the magnetic field lines. Red shade indicates high speed stream in the front of the CME. Image courtesy Nagoya University.

Solar cells as light as a soap bubble

The MIT team has achieved the thinnest and lightest complete solar cells ever made, they say. To demonstrate just how thin and lightweight the cells are, the researchers draped a working cell on top of a soap bubble, without popping the bubble. Image courtesy Joel Jean and Anna Osherov. For a larger version of this image please go here.

Imagine solar cells so thin, flexible, and lightweight that they could be placed on almost any material or surface, including your hat, shirt, or smartphone, or even on a sheet of paper or a helium balloon.

Researchers at MIT have now demonstrated just such a technology: the thinnest, lightest solar cells ever produced. Though it may take years to develop into a commercial product, the laboratory proof-of-concept shows a new approach to making solar cells that could help power the next generation of portable electronic devices.

The new process is described in a paper by MIT professor Vladimir Bulovi?, research scientist Annie Wang, and doctoral student Joel Jean, in the journal Organic Electronics.

Bulovi?, MIT's associate dean for innovation and the Fariborz Maseeh (1990) Professor of Emerging Technology, says the key to the new approach is to make the solar cell, the substrate that supports it, and a protective overcoating to shield it from the environment, all in one process. The substrate is made in place and never needs to be handled, cleaned, or removed from the vacuum during fabrication, thus ...Read More...

The MIT team has achieved the thinnest and lightest complete solar cells ever made, they say. To demonstrate just how thin and lightweight the cells are, the researchers draped a working cell on top of a soap bubble, without popping the bubble. Image courtesy Joel Jean and Anna Osherov.

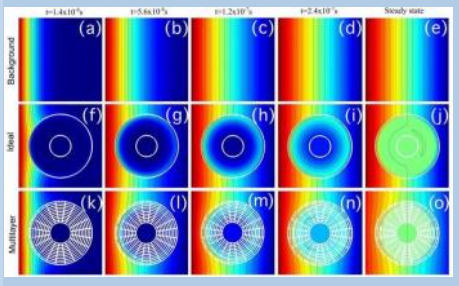
Metamaterial separation proposed for chemical, biomolecular uses

The unique properties of metamaterials have been used to cloak objects from light, and to hide them from vibration, pressure waves and heat. Now, a Georgia Institute of Technology researcher wants to add another use for metamaterials: creating a new directional separation technique that cloaks one compound while concentrating the other.

Though the idea must still be proven experimentally, the researchers believe that manipulating mass transfer using metamaterials could help reduce the energy required for certain chemical and biomolecular processes. The proposed technique would use specially-patterned polymeric materials to direct the flow of atoms by taking advantage of their specific physical properties.

A detailed explanation for how the technique could be used to separate a mixture of nitrogen and oxygen - by cloaking the nitrogen and concentrating the oxygen - was reported February 25 in the journal Scientific Reports. The research was supported by a seed grant from the American Chemical Society.

"We will control how the atoms cross the metamaterial, in which direction they will go," said Martin Maldovan, an assistant professor in Georgia Tech's School of Chemical & Biomolecular Engineering and School of Physics. "By designing the diffusivity of the metamaterials, we can make the atoms of one compound go one way, and the atoms of another compound go ...Read More...

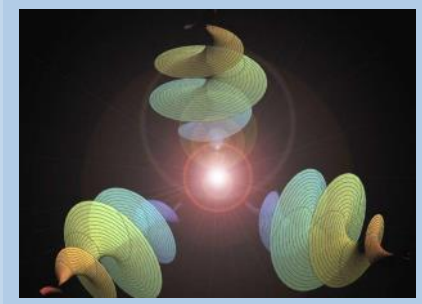


These are concentration profiles for cloaked compound A at different times and steady-state. (a-e) background, (f-j) anisotropic homogeneous cloak, (k-o) multilayer cloak. Credit: Martin Maldovan and Juan Manuel Restrepo-Flórez, Georgia Tech

Three 'twisted' photons in 3 dimensions

Researchers at the Institute of Quantum Optics and Quantum Information, the University of Vienna, and the Universitat Autonoma de Barcelona have achieved a new milestone in quantum physics: they were able to entangle three particles of light in a high-dimensional quantum property related to the 'twist' of their wavefront structure. The results from their experiment appear in the journal Nature Photonics.

Entanglement is a counterintuitive property of quantum physics that has long puzzled scientists and philosophers alike. Entangled quanta of light seem to exert an influence on each other, irrespective of how much distance is between them. Consider for example a metaphorical quantum ice dancer, who has the uncanny ability to pirouette both clockwise and counterclockwise simultaneously. A pair of entangled ice-dancers whirling away from each other would then have perfectly correlated directions of rotation: If the first dancer twirls clockwise then so does her partner, even if skating in ice rinks on two different continents. "The entangled photons in our experiment can be illustrated by not two, but three such ice dancers, dancing a perfectly synchronized quantum mechanical ballet," explains Mehul Malik, the first author of the paper. "Their dance is also a bit more complex, with two of the dancers performing yet another correlated movement in addition to pirouetting. This type of asymmetric quantum entanglement has been predicted before ..Read More..



Artist's depiction of the twisted-photon entangled state created in the Vienna experiment. Credit: Faculty of Physics, University of Vienna

Asteroid scientists explore new ways to save Earth

Scientists at Tomsk State University's Institute of Applied Mathematics and Mechanics have calculated how to blow up an asteroid with a diameter of 200 meters using nuclear power, while also making sure that dangerously irradiated fragments of the asteroid do not land on Earth.

"The method we suggest to destroy dangers from space makes sense to use when it is not possible to eliminate the object more gently, or it can be used to destroy objects that are constantly returning toward Earth," explained Tatiana Galushina, a researcher at the university's department of celestial mechanics and astrometry.

"Previous preventative measures proposed destroying the asteroid on its approach to our planet, but that could have catastrophic effects if a multitude of highly radioactive debris falls to Earth," Galushina said.

Because the majority of potentially dangerous objects that approach Earth from space do so several times, the scientists propose blowing up the asteroid at a point when it is traveling away from our planet.

They calculated that a nuclear device with energy equivalent to a million tons of TNT would obliterate the asteroid into particles of gas and liquid, with fragments no bigger than ten meters.

"Since the rocket blows the asteroid backward, practically all the fragments after the destruction fly forward. The orbit ...Read More...

File Image.

Celestial bodies born like cracking paint

A Duke theorist says there's a very good reason why objects in the universe come in a wide variety of sizes, from the largest stars to the smallest dust motes - and it has a lot to do with how paint cracks when it dries.

In a paper published March 1 in the Journal of Applied Physics, Adrian Bejan, the J.A. Jones Professor of Mechanical Engineering at Duke University, explains how the need to release internal tension shaped the universe as we see it. Though unknowably large and spread out, the very early universe can be thought of as a finite volume of suspended particles. And because every object in the universe exerts a gravitational force on every other object in the universe, this volume was in internal tension.

It was only a matter of time before particles began coming together to form larger objects. But why did they come together to form objects in such a wide variety of sizes, rather than in a uniform manner?

"We know from common experiences that things in volumetric tension crack, and they crack instantly everywhere," ...Read More...

The same principal of physics that makes paint and mud crack was at work in the formation of celestial bodies of many different sizes, says a Duke engineering professor. Image courtesy NASA.

Smoking Gun Uncovering Secret of Cosmic Bullets

LOFAR, the low-frequency array radio telescope, normally receives weak radio waves from the distant universe. But now and then an ultra-short, bright radio pulse is observed somewhere in between AM and FM radio frequencies. This radio blast would appear as a short cracking sound in your car radio. While usually ignored, this radio signal is actually the last SOS of an elementary particle entering the Earth atmosphere at almost the speed of light. The particles were fired off by a cosmic accelerator Millions of year ago.

An international team of astronomers including a number of scientists from the German Long Wavelength consortium (GLOW) have now unraveled the radio code of these intruders to determine their nature and constrain their origin.

Supernova explosions, dying stars, black holes. All these phenomena have been named as sources of cosmic ray particles. But until now nobody really knows the origin. Cosmic ray particles are elementary particles that travel through the universe with an energy that is a million times bigger than in the largest particle accelerator on earth.

With almost the speed of light, they collide like bullets with the atmosphere, before falling apart into a cascade of secondary particles. Their interaction with the Earth's magnetic field leads to an extremely short radio signal, no longer than one billionth of a second. Thousands of LOFAR antennas help to find the signal and measure it accurately. ...Read More...

Image of air showers, simulated with CORSIKA, mounted onto a photo of the central station ("superterp") of the LOFAR telescope network near Exloo/Netherlands. Image courtesy ASTRON/KIT/Radboud.

Dept. of Applied Physics & Astronomy

College of Sciences - University of Sharjah
POB 27272 - Sharjah
United Arab Emirates
Phone: 00-971-6-5050363
Email: physics@sharjah.ac.ae

Sharjah Center for Astronomy and Space Sciences
Sharjah
United Arab Emirates
Phone: 00-971-6-5166000
E-mail: planetarium@scass.ae

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What if extraterrestrial observers called, but nobody heard

As scientists step up their search for other life in the universe, two astrophysicists are proposing a way to make sure we don't miss the signal if extraterrestrial observers try to contact us first.

Rene Heller and Ralph Pudritz say the best chance for us finding a signal from beyond is to presume that extraterrestrial observers are using the same methods to search for us that we are using to search for life beyond Earth.

Here on Earth, space researchers are focusing most of their search efforts on planets and moons that are too far away to see directly. Instead, they study them by tracking their shadows as they pass in front of their own host stars.

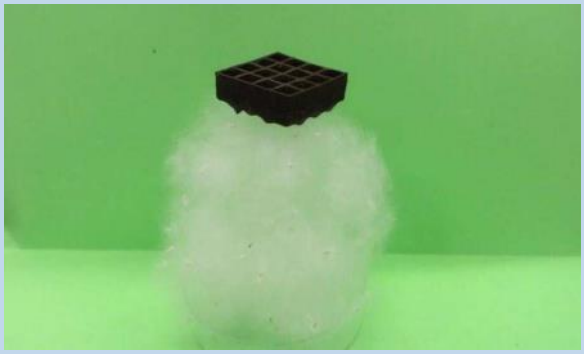
Measuring the dimming of starlight as a planet crosses the face of its star during orbit, scientists can collect a wealth of information, even without ever seeing those worlds directly...Read More...

File Image.

The secret to 3-D graphene? Just freeze it

Graphene is a wonder material saddled with great expectations. Discovered in 2004, it is 1 million times thinner than a human hair, 300 times stronger than steel and it's the best known conductor of heat and electricity. These qualities could, among other things, make computers faster, batteries more powerful and solar panels more efficient.

But the material is tough to manipulate beyond its two-dimensional form. Recently, scientists poured graphene oxide suspension, a gel-like form of the material, into freezing molds to create 3-D objects. The process works, but only with simple structures that have limited commercial applications. Another option is to use a 3-D printer. In this scenario, scientists typically mix graphene with a polymer or other thickening agent. This helps keep the structure from ...Read More...



3-D graphene created by an international research team led by Unversity at Buffalo engineers. Credit: University at Buffalo.

A proposed superconductivity theory receives exclusive experimental confirmation

Superconductivity - a quantum phenomenon in which metals below a certain temperature develop flow of current with no loss or resistance - is one of the most exciting problems in physics, which has resulted in investments worldwide of enormous brain power and resources since its discovery a little over a century ago. Many prominent theorists, Nobel laureates among them, have proposed theories for new classes of superconducting materials discovered several decades later, followed by teams of experimentalists working furiously to provide solid evidence for these theories. More than 100,000 research papers have been published on the new materials.

One such theory began with a proposal in 1989 by Chandra Varma while at Bell Laboratories, NJ, and now a distinguished professor of physics and astronomy at the University of California, Riverside. At UC Riverside, he further developed the theory and proposed experiments to confirm or refute it. That theory has now been experimentally proven to be a consistent theory by physicists in China and Korea.

The experimental results, published in Science Advances today (March 4), now allow for a clear discrimination of theories of high-temperature superconductivity, favoring one and ruling others out. The research paper is titled "Quantitative determination of pairing interactions for high-temperature superconductivity in cuprates."

"At the core of most models for the high-temperature superconductivity in cuprates lies the idea of the electron-electron pairing," said Lev P. Gor'kov, a theoretical physicist at Florida State ...Read More...