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Department of Applied Physics— University of Sharjah
Weekly Scientific News Compiled by Dr. Ilias Fernini

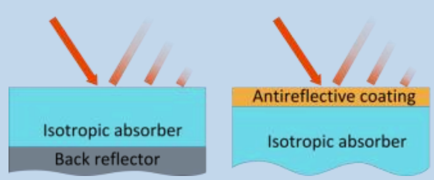
Inside this issue:

Scientists show a new way to absorb electromagnetic radiation

A team of authors from MIPT, Kansas State University, and the U.S. Naval Research Laboratory have demonstrated that it is possible to fully absorb electromagnetic radiation using an anisotropic crystal. The observations are of fundamental importance for electrodynamics and will provide researchers with an entirely new method of absorbing the energy of electromagnetic waves. The paper has been published in Physical Review B.

Effective absorption of the energy of electromagnetic radiation is the cornerstone of a wide range of practical applications. Electromagnetic energy harvesting in the visible spectrum is very important for photovoltaics – the conversion of solar energy into direct current electricity. Absorbing materials in the microwave range of frequencies have an application that is equally as important – they are able to reduce the radar visibility of an aircraft. Effective absorption of electromagnetic waves is also important for use in sensing, nanochemistry, and photodynamic therapy.

A classic example of an electromagnetic absorber that is familiar to many people is ordinary black paint. It looks black because a significant amount of the light that falls on it is absorbed in the layer of paint and does not reach the observer. However, black paint is a relatively poor absorber – a certain amount of energy from the incident light (typically a few percent) is still ...Read More...



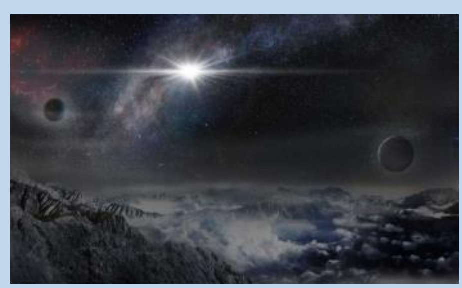
Left – an absorbing medium lying on a reflective substrate. Right – an absorbing medium with an anti-reflective coating applied on top. In both cases the interference of light results in the complete absorption of energy within the artificial structure. Credit: Image courtesy of the authors of the study

Machine learning helps discover the most luminous supernova in history

Machine-learning technology developed at Los Alamos National Laboratory played a key role in the discovery of supernova ASASSN-15lh, an exceptionally powerful explosion that was 570 billion times brighter than the Sun and more than twice as luminous as the previous record-holding supernova. This extraordinary event marking the death of a star was identified by the All Sky Automated Survey for SuperNovae (ASAS-SN) and is described in a new study published in Science.

"This is a golden age for studying changes in astronomical objects thanks to rapid growth in imaging and computing technology," said Przemek Wozniak, the principal investigator of the project that created the software system used to spot ASASSN-15lh. "ASAS-SN is a leader in wide-area searches for supernovae using small robotic telescopes that repeatedly observe the same areas of the sky looking for interesting changes."

ASASSN-15lh was first observed in June 2015 by twin ASAS-SN telescopes - just 14 centimeters in diameter - located in Cerro Tololo, Chile. While supernovae already rank among the ...Read More..



An artist's impression of the record-breakingly powerful, superluminous supernova ASASSN- 15lh as it would appear from an exoplanet located about 10,000 light years away in the host galaxy of the supernova. Credit: Wayne Rosing

Physicists offer theories to explain mysterious collision at Large Hadron Collider

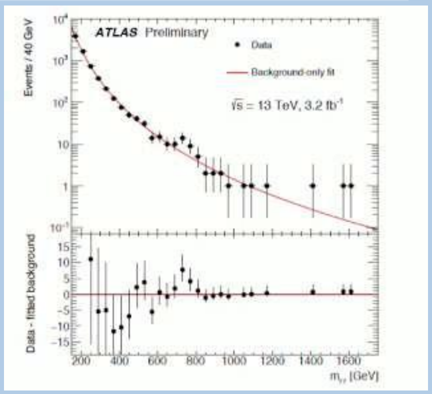
Physicists around the world were puzzled recently when an unusual bump appeared in the signal of the Large Hadron Collider, the world's largest and most powerful particle accelerator, causing them to wonder if it was a new particle previously unknown, or perhaps even two new particles. The collision cannot be explained by the Standard Model, the theoretical foundation of particle physics.

Adam Martin, assistant professor of physics at the University of Notre Dame, said he and other theoretical physicists had heard about the results before they were released on Dec. 15, and groups began brainstorming, via Skype and other ways, about what the bump could mean if confirmed—a long shot, but an intriguing one. He and some collaborators from Cincinnati and New York submitted a pre-peer-review paper that appeared on arXiv.org on Dec. 23.

This graph illustrates black dots that show events in experiment records compared along a red line that depicts the number expected through Standard Model processes. Two black dots don't fall in with the red line. Adam Martin says the bump at 750 is "the most exciting."

"It was so weird that people were forced to chuck their favorite theories and start from scratch," Martin says. "That's a fun area of particle physics. We're looking into the unknown. Is it one new particle? Is it two new particles?"

The paper considers four possible explanations for the data, including the possibility that it could indicate a heavier version of the ...Read More…



This graph illustrates black dots that show events in experiment records compared along a red line that depicts the number expected through Standard Model processes. Two black dots don't fall in with the red line. Adam Martin says the bump at 750 is "the most exciting." Credit: Adam Martin

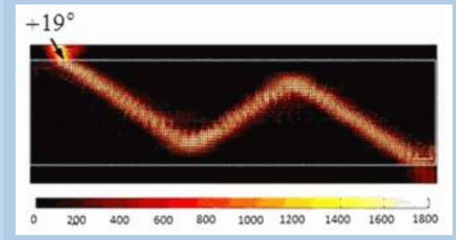
One-way light beam can be steered in different directions

Over the past few years, scientists have demonstrated the phenomenon of "one-way light," in which a light beam propagates in one direction only. The materials used to achieve this effect can be thought of as optical diodes, in analogy to the diodes used in electric circuits that allow an electric current to travel in one direction while prohibiting it from traveling in the opposite direction. One-way light could play an important role in integrated photonic circuits, which perform operations using beams of light instead of an electric current.

Researchers have previously shown that a few different materials, such as photonic crystals and metamaterials, can be used to realize one-way light. These materials typically have some kind of asymmetry that routes light differently depending on which direction the waves are traveling.

Building on this research, Qing-Bo Li, et al., from Nanjing University in China have theoretically shown that one-way light beams in photonic crystals can be bent into arbitrary trajectories by applying a gradient magnetic field. Their work is published in a recent issue of Applied Physics Letters.

Typically, light beams in a photonic crystal broaden as they propagate, which limits their applications. However, here the researchers showed that photonic crystals can be tuned so that the light self-collimates, staying highly focused. Applying a gradient magnetic field to the ...Read More...



A self-collimated one-way light beam can be steered inside a photonic crystal using gradient magnetic fields. Credit: Li, et al. ©2015 AIP Publishing

Gravitational wave rumors ripple through science world

Rumors are rippling through the science world that physicists may have detected gravitational waves, a key element of Einstein's theory which if confirmed would be one of the biggest discoveries of our time.

There has been no announcement, no peer review or publication of the findings—all typically important steps in the process of releasing reliable and verifiable scientific research.

Instead, a message on Twitter from an Arizona State University cosmologist, Lawrence Krauss, has sparked a firestorm of speculation and excitement.

Krauss does not work with the Advanced Laser Interferometer Gravitational Wave Observatory, or LIGO, which is searching for ripples in the fabric of space and time.

But he tweeted on Monday about the apparent shoring up of rumor he'd heard some months ago, that LIGO scientists were writing up a paper on gravitational waves they had discovered using US-based detectors.

"My earlier rumor about LIGO has been confirmed by independent sources. Stay tuned! Gravitational waves may have been discovered!! Exciting," Krauss tweeted. ...Read More...

Arizona State University cosmologist Lawrence Krauss (R), pictured on January 14, 2010, sparked a firestorm of speculation and excitement by tweeting that gravitational waves may have been discovered.

A Milky Way twin swept by an ultra-fast X-ray wind

ESA's XMM-Newton has found a wind of high-speed gas streaming from the centre of a bright spiral galaxy like our own that may be reducing its ability to produce new stars. It is not unusual to find hot winds blowing from the swirling discs of material around supermassive black holes at the centre of active galaxies.

If powerful enough, these winds can influence their surroundings in various ways. Their primary effect is to sweep away reservoirs of gas that might otherwise have formed stars, but it is also possible that they might trigger the collapse of some clouds to form stars. Such processes are thought to play a fundamental role in galaxies and black holes throughout the Universe's 13.8 billion years.

But they were thought to affect only the largest objects, such as massive elliptical galaxies formed through the dramatic collision and merging of two or more galaxies, which sometimes trigger the winds powerful enough to influence star formation. Now, for the first time, these winds have been seen in a more normal kind of active galaxy known as a Seyfert, which does not appear to have undergone any merging.

When observed in visible light, almost all Seyfert galaxies have a spiral shape similar to our own Milky Way. However, unlike the Milky Way, Seyferts have bright cores that shine across the entire electromagnetic spectrum, a sign that the supermassive black holes at their centres are not idle but are ...Read More...

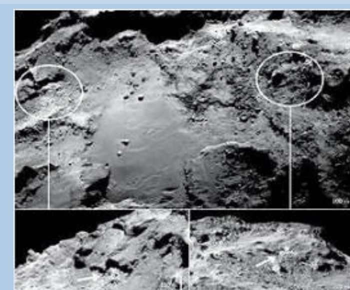
Artist's impression depicting a wind flowing from around a supermassive black hole at the centre of a bright spiral galaxy. Image courtesy ESA.

Exposed ice on Rosetta's comet confirmed as water

Observations made shortly after Rosetta's arrival at its target comet in 2014 have provided definitive confirmation of the presence of water ice. Although water vapour is the main gas seen flowing from comet 67P/Churyumov-Gerasimenko, the great majority of ice is believed to come from under the comet's crust, and very few examples of exposed water ice have been found on the surface.

However, a detailed analysis by Rosetta's VIRTIS infrared instrument reveals the composition of the comet's topmost layer: it is primarily coated in a dark, dry and organic-rich material but with a small amount of water ice mixed in. In the latest study, which focuses on scans between September and November 2014, the team confirms that two areas several tens of metres across in the Imhotep region that appear as bright patches in visible light, do indeed include a significant amount of water ice.

The ice is associated with cliff walls and debris falls, and was at an average temperature of about -120+ C at the time. In those regions, pure water ice was found to occupy ...Read More...



Two exposures of water ice identified by Rosetta's VIRTIS instrument in the Imhotep region of Comet 67P/Churyumov-Gerasimenko in September-November 2014. The main image was taken on 17 September 2014 from a distance of ..

New theory of secondary inflation expands options for dark matter excess

Standard cosmology - that is, the Big Bang Theory with its early period of exponential growth known as inflation - is the prevailing scientific model for our universe, in which the entirety of space and time ballooned out from a very hot, very dense point into a homogeneous and ever-expanding vastness. This theory accounts for many of the physical phenomena we observe. But what if that's not all there was to it?

A new theory from physicists at the U.S. Department of Energy's Brookhaven National Laboratory, Fermi National Accelerator Laboratory, and Stony Brook University, which will publish online on January 18 in Physical Review Letters, suggests a shorter secondary inflationary period that could account for the amount of dark matter estimated to exist throughout the cosmos.

"In general, a fundamental theory of nature can explain certain phenomena, but it may not always end up giving you the right amount of dark matter," said Hooman Davoudiasl, group leader in the High-Energy Theory Group at Brookhaven National Laboratory and an author on the paper. "If you come up with too little dark matter, you can suggest another source, but having too much is a problem."

Measuring the amount of dark matter in the universe is no easy task. It is dark after all, so it doesn't interact in any significant way with ordinary matter. Nonetheless, gravitational effects of dark matter give scientists a good idea of how much of it is out there. The best estimates indicate that it makes up about a quarter of the mass-energy ...Read More...

A new theory suggests a shorter secondary inflationary period that could account for the amount of dark matter estimated to exist throughout the cosmos. Image courtesy Brookhaven National Laboratory.

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UNIVERSITY OF SHARJAH

Sharjah Center for Astronomy and Space Sciences. I - The Astronomical Observatory.

The SCASS observatory is equipped with three main telescopes:

- 17" (450 mm) / f6.8 Corrected Dall-Kirkham reflector. It is suitable for deep sky observation and astrophotography.

- 180 mm / f7 triplet fluorite apochromatic refractor. It is mainly used for planetary observation and white light solar observation.

- 105 mm / f5.2 triplet ED apochromatic refractor. It is mainly used for Hα solar observations.

These three main instruments are mounted on a German equatorial mount. The whole telescopic system resides inside an observatory dome with dust proof sealing. Other instruments are also connected to the system like the SBIG STX16803 CCD camera and an Echelle Compact Spectrograph (BACHES). The system can be remotely controlled.

This system is unique in the quality of the lenses used and its high quality mirrors. It is connected to an electronic control network that posts the acquired data on the internet to enable users to use the telescope anywhere in the world. Academically, the observatory plays a significant role in teaching astronomy and astrophysics to university students who are rapidly increasing in numbers every semester.

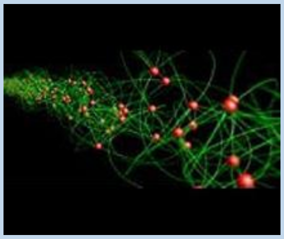
His Highness Dr. Sheikh Sultan Bin Mohammed Al Qasimi, Supreme Council Member and Ruler of Sharjah and President of the University of Sharjah, checking on the newly opened observatory with Prof. Hamid Al Naimiy, Chancellor of the University of Sharjah.

Counting Photons; How Low Can You Go

The process of detecting light-whether with our eyes, cameras or other devices-is at the heart of a wide range of civilian and military applications, including light or laser detection and ranging (LIDAR or LADAR), photography, astronomy, quantum information processing, medical imaging, microscopy and communications. But even the most advanced detectors of photons-the massless, ghostlike packets of energy that are the fundamental units of light-are imperfect, limiting their effectiveness.

Scientists suspect that the performance of light-based applications could improve by orders of magnitude if they could get beyond conventional photon detector designs-perhaps even to the point of being able to identify each and every photon relevant to a given application. But is it even possible, within the laws of quantum physics, to definitively detect and identify every relevant photon-and to be confident that each detection signal is true and accurate?

DARPA's Fundamental Limits of Photon Detection-or Detect-program aims to establish the first-principles limits of photon detector performance by developing new fully quantum models ...Read More...



Photons in the visible range fill at the minimum a cubic micron of space, which might seem to make them easy to distinguish and to count. The difficulty arises when light interacts with matter. A cubic micron of conventional photon-detection material has more than a trillion atoms, and the incoming light will interact with many of those atoms simultaneously.

New twists in the diffraction of intense laser light

A discovery by University of Strathclyde researchers could have a major impact on advancing smaller, cheaper, laser-driven particle accelerators - and their potential applications.

The research found that the diffraction of ultra-intense laser light passing through a thin foil could be used to control charged particle motion. This new observation in the fundamental physics of intense laser-plasma interactions could have a wide-reaching impact in medicine, industry and security.

The findings of the research, published in leading physics journal Nature Physics, has demonstrated that the interaction of the high intensity laser pulse with the foil target creates a localised region (termed a relativistic plasma aperture) at the peak of the laser intensity which is transparent to the laser light. Manipulating the diffraction of the light through the aperture enables control of the particle motion.

The research, a collaboration with the Central Laser Facility and Queen's University Belfast, is led by the University of Strathclyde's Professor Paul McKenna. He said: "The development of compact laser-driven particle accelerators and high-energy radiation sources relies on controlling the motion of plasma electrons displaced by the intense laser fields.

"Our discovery that diffraction via a self-induced plasma aperture not only controls this motion but also drives ...Read More...