INTERNATIONAL YEAR OF LIGHT 2015

100 Million Stars in the Andromeda galaxy.

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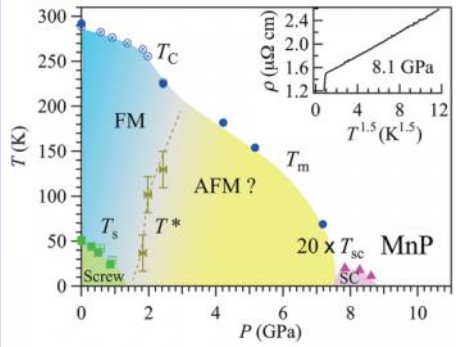
Weekly news from around the world compiled by Dr. Ilias Fernini

Inside this issue:

Researchers discover first manganese based superconductor

A combined team of researchers from the Institute of Physics in China and the University of Tokyo has found the first instance of a manganese based superconductor. In their paper published in the journal Physical Review Letters, the team describes the technique they used to discover the superconductor properties in the material which many had thought would not be possible due to its high degree of magnetism.

Until recently, the idea that a material such as manganese phosphide could have a superconducting state, was ruled out because conventional superconductors have a property where electrons formed couplets known as Cooper pairs—and magnetism disrupted them. But then it was found that using magnetism suppression techniques allowed researchers to discover superconductor states in some organic or even iron based materials where it wasn't driven by Cooper pairs. In this new effort, the researchers ...***Read More***...



Pressure-temperature phase diagram of the helical magnet MnP [8]. Although several different magnetic phases are indicated—helical (Screw), ferromagnetic (FM), and antiferromagnetic (AFM)—all are likely to be variants of the helical phase. Suppression of the magnetism by pressure gives rise to a superconducting phase, similar to what is observed in the related helical magnet CrAs [5, 6], as seen in the inset, where the resistivity versus temperature at a pressure of 8.1 GPa is plotted. Credit: Jin-Guang Cheng/ Beijing National Laboratory

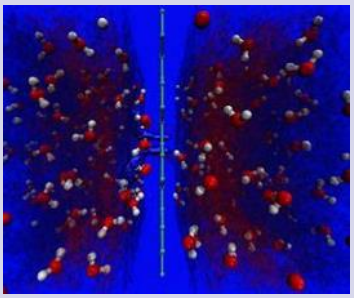
Graphene membrane could lead to better fuel cells, water filters

An atomically thin membrane with microscopically small holes may prove to be the basis for future hydrogen fuel cells, water filtering and desalination membranes, according to a group of 15 theorists and experimentalists, including three theoretical researchers from Penn State.

The team, led by Franz Geiger of Northwestern University, tested the possibility of using graphene, the robust single atomic layer carbon, as a separation membrane in water and found that naturally occurring defects, essentially a few missing carbon atoms, allowed hydrogen protons to cross the barrier at unprecedented speeds.

While many researchers strive to make graphene defect-free to exploit its superior electronic properties, Geiger's team found that graphene required the vacancies to create water channels through the membrane. Computer simulations carried out at Penn State and the University of Minnesota showed the protons were shuttled across the barrier via hydroxyl-terminated atomic defects, that is, by oxygen hydrogen groups linked at the defect.

The researchers published their results in the journal Nature Communications...***Read More***...



This is a figure showing the proton transfer channel across a quad-defect in graphene, as obtained from a ReaxFF molecular dynamics simulation. Image courtesy Murali Raju, Penn State.

Scientists invent new way to control light, critical for next gen of super fast computing

A device resembling a plastic honeycomb yet infinitely smaller than a bee's stinger can steer light beams around tighter curves than ever before possible, while keeping the integrity and intensity of the beam intact.

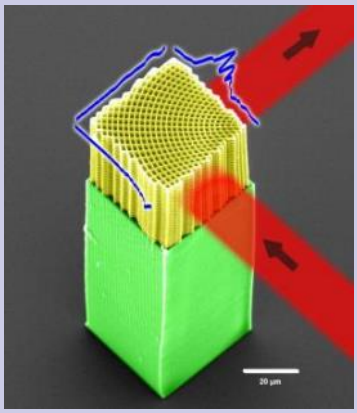
The work, conducted by researchers at the University of Texas El Paso (UTEP) and at the University of Central Florida (UCF) and published in the journal Optics Express, introduces a more effective way to transmit data rapidly on electronic circuit boards by using light.

Sending information on light beams, instead of electrical signals, allows data to be transmitted thousands of times more quickly. But controlling the light beams without losing their energy has been the challenge. Microchip and computer manufacturers however, are increasingly looking to light as the best way to overcome speed bottlenecks associated with today's electronics.

"Computer chips and circuit boards have metal wire connections within them that transport data signals," said Raymond Rumpf, professor of electrical and computer engineering at UTEP. "One of challenges when using light is figuring out a way to make tight bends so we can replace the metal wiring more effectively."

That's where UCF comes in.

"Direct laser writing has the potential to become a flexible means for manufacturing next-generation computer devices," said Stephen Kuebler, associate professor of ...***Read More***...



Honeycomb like lattice, which bends light. Credit: UCF

Explainer: What are fundamental particles?

It is often claimed that the Ancient Greeks were the first to identify objects that have no size, yet are able to build up the world around us through their interactions. And as we are able to observe the world in tinier and tinier detail through microscopes of increasing power, it is natural to wonder what these objects are made of.

We believe we have found some of these objects: subatomic particles, or fundamental particles, which having no size can have no substructure. We are now seeking to explain the properties of these particles and working to show how these can be used to explain the contents of the universe.

There are two types of fundamental particles: matter particles, some of which combine to produce the world about us, and force particles – one of which, the photon, is responsible for electromagnetic radiation. These are classified in the standard model of particle physics, which theorizes how the basic building blocks of matter interact, governed by fundamental forces. Matter particles are fermions while force particles are bosons.

Matter particles: quarks and leptons

Matter particles are split into two groups : quarks and leptons— there are six of these, each with a corresponding partner.

Leptons are divided into three pairs. Each pair has an elementary particle with a charge and one with no charge – one that is much lighter and extremely difficult to detect. The lightest of these pairs is the electron and electron-neutrino...***Read More***...

The epoch of the leptons existed for nine seconds after the Big Bang. Credit: Big Bang by Shutterstock

The physics of clouds

In 1941, Russian physicist Andrey Kolmogorov developed a theory of turbulence that has served as the basic foundation for our understanding of this important naturally occurring phenomenon.

Turbulence occurs when fluid flow is characterized by chaotic physical changes. Kolmogorov's theory has been interpreted to imply that transitions from one state of turbulence to another must be a smooth evolution because very intense fluctuations that are part of the process itself would smooth out anything sharp.

Now, however, a new experiment conducted by physicists at UC Santa Barbara disproves this interpretation of Kolmogorov's theory. Their results appear this week in the journal Physical Review Letters.

"In our paper we offer experimental evidence that these transitions are indeed sharp," said Guenter Ahlers, a professor in UCSB's Department of Physics. "We have been enlightened by these data and they have shown us that the interpretation of Kolmogorov was incorrect. To a physicist that is a very important step forward."

Ahlers and his postdoctoral coworkers Ping Wei and Stephan Weiss study turbulent convection, which plays a major role in numerous natural and industrial processes. Turbulent convection results when a contained fluid is heated from below and cooled from above. As the temperature differential increases, the convective flow becomes so vigorous that the velocity field becomes turbulent….***Read More***...

Cloud streets -- long rows of cumulus clouds oriented parallel to the direction of the wind -- are an everyday example of natural turbulent convection. Image courtesy MODIS

Milky Way's center unveils supernova 'dust factory'

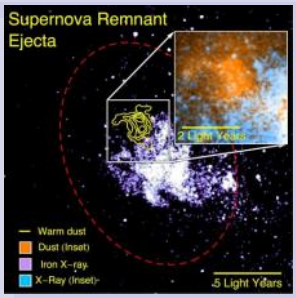
Sifting through the center of the Milky Way galaxy, astronomers have made the first direct observations - using an infrared telescope aboard a modified Boeing 747 - of cosmic building-block dust resulting from an ancient supernova.

"Dust itself is very important because it's the stuff that forms stars and planets, like the sun and Earth, respectively, so to know where it comes from is an important question," said lead author Ryan Lau, Cornell postdoctoral associate for astronomy, in research published March 19 in Science Express. "Our work strongly reinforces the theory that supernovae are producing the dust seen in galaxies of the early universe," he said.

Lau explains that one of astronomy's big questions is why galaxies - forming as recently as 1 billion years after the Big Bang - contain so much dust. The leading theory is that supernovae - stars that explode at the end of their lives - contain large amounts of metal-enriched material that, in turn, harbors key ingredients of dust, like silicon, iron and carbon.

The astronomers examined Sagittarius A East, a 10,000-year-old supernova remnant near the center of our galaxy. Lau said that when a supernova explodes, the materials in its center expand and form dust. This has been observed in several young supernova remnants - such as the famed SN1987A and Cassiopeia A. In the turbulent supernova environment, scientists expect the churning dust to be destroyed. "That is theoretically," Lau said. "There have been no direct observations of any dust surviving the environment of the supernova remnant ... until now, and that's why our observations of an 'old' supernova are so important," he said.

The astronomers captured the observations via FORCAST (the Faint Object Infrared Camera Telescope) aboard SOFIA (the Stratospheric .***Read More***..



The dust (yellow contours) that formed from the supernova survives in a cooler, less harsh region of the ejecta as can be seen from its spatial displacement from the x-ray emission from highly excited iron (purple). The red dashed ellipse delineates the forward shock of the ...

Desktop App has potential to increase asteroid detection

A software application based on an algorithm created by a NASA challenge has the potential to increase the number of new asteroid discoveries by amateur astronomers. Analysis of images taken of our solar system's main belt asteroids between Mars and Jupiter using the algorithm showed a 15 percent increase in positive identification of new asteroids.

During a panel Sunday at the South by Southwest Festival in Austin, Texas, NASA representatives discussed how citizen scientists have made a difference in asteroid hunting. They also announced the release of a desktop software application developed by NASA in partnership with Planetary Resources, Inc., of Redmond, Washington.

The application is based on an Asteroid Data Hunter-derived algorithm that analyzes images for potential asteroids. It's a tool that can be used by amateur astronomers and citizen scientists.
The Asteroid Data Hunter challenge was part of NASA's Asteroid Grand Challenge. The data hunter contest series, which was conducted in partnership with Planetary Resources under a Space Act Agreement, was announced at the 2014 South by Southwest .**Read More**..

NASA's Asteroid Data Hunter contest series was part of NASA's Asteroid Grand Challenge, which is focused on finding all asteroid threats to human populations and knowing what to do about them. Image courtesy NASA.

Helicopter Drones on Mars

NASA's Jet Propulsion Laboratory recently announced that it is developing a small drone helicopter to scout the way for future Mars rovers. Why would Mars rovers need such a robotic guide? The answer is that driving on Mars is really hard.

Here on Earth, robots exploring volcanic rims, or assisting rescuers, can be driven by remote control, with a joystick. This is because radio signals reach the robot from its control center almost instantly. Driving on the moon isn't much harder. Radio signals traveling at the speed of light take about two and half seconds to make the round trip to the moon and back. This delay isn't long enough to seriously interfere with remote control driving. In the 1970's Soviet controllers drove the Lunokhod moon rovers this way, successfully exploring more than 40 km of lunar terrain.

Driving on Mars is much harder, because it is so much further away. Depending on its position with respect to Earth, signals can take between 8 and 42 minutes for the round trip. Pre-programmed instructions must be sent to the rover, which it then executes on its own. Each Martian drive takes hours of careful planning. Stereo images taken by the rover's navigation cameras are carefully scrutinized by engineers. Images from spacecraft orbiting Mars sometimes provide additional information.

A rover can be programmed either to simply execute a list of driving commands sent from Earth, or it can use images taken by its navigation cameras and processed by its on-board computers to measure speed and detect obstacles or hazards by...***Read More***...

A small drone helicopter currently being developed by engineers at NASA's Jet Propulsion Laboratory could serve as a reconnaissance scout for future Mars rovers, greatly enhancing their effectiveness. Credit NASA JPL

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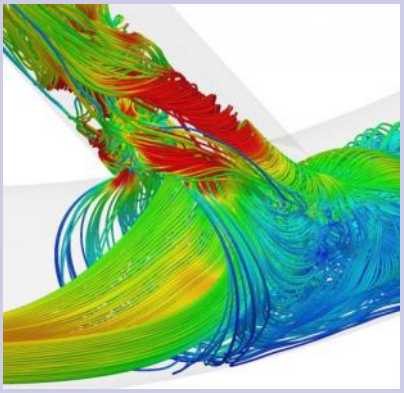
How rocket science may improve kidney dialysis

A team of researchers in the United Kingdom has found a way to redesign an artificial connection between an artery and vein, known as an Arterio-Venous Fistulae, which surgeons form in the arms of people with end-stage renal disease so that those patients can receive routine dialysis, filtering their blood and keeping them alive after their kidneys fail.

The new design, described in the journal Physics of Fluids, from AIP Publishing, may decrease the likelihood of blockages in Arterio-Venous Fistulae, which is a major complication of dialysis….***Read More***...



Streamlines of flow within an idealized Arterio-Venous Fistulae are shown. The color of the lines corresponds to the speed of the blood--red being highest, and blue lowest. Credit: Peter Vincent/Imperial College London

UK physicists getting closer to reading the inside of stars

UK nuclear physicists are one step closer to being able to read the inside of stars and discover new elements that exist for only a trillionth of a trillionth of a second inside exploding supernovae.

Part of an international project, R3B, they have taken the latest step towards the development of a detector that will reveal missing information about extreme states of matter, with the successful commissioning of one its first silicon detector modules.

R3B is developing a ground breaking detector system that will provide key technology for NuSTAR (Nuclear Structure, Astrophysics and Reactions), one of the four main international experiments planned for FAIR (Facility for Antiproton and Ion Research) in Germany which, when completed, will be the most advanced nuclear physics research facility in the world.

The Science and Technology Facilities Council's (STFC) physicist Roy Lemmon said: "Nobody knows exactly how many elements are out there waiting to be discovered, or how they are created, but we will be able to study new nuclei that have never ...***Read More***….

Model aerial view of FAIR (Facility for Antiproton and Ion Research). Image courtesy FAIR.

The new frontier in plasma medicine

Applications of plasmas in medicine are a new frontier in therapeutic treatment. For example, they can help in stimulating tissue regeneration in the contexts of wound healing and dermatology. Before these and further applications can be developed, it is essential to understand the processes at work in plasmas - a unique kind of gas-like state of matter containing charged particles. Now a study published in EPJ D by a team led by Zoran Petrovi? from the University of Belgrade, Serbia, provides previously unavailable data on oxygen ion transport and the likelihood of such ions interacting with water molecules. These could contribute to new models of plasmas in liquids which account for how discharges are created in water vapor...***Read More***...