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Inside this issue:

Physicists discover flaws in superconductor theory

University of Houston physicists report finding major theoretical flaws in the generally accepted understanding of how a superconductor traps and holds a magnetic field. More than 50 years ago, C.P. Bean, a scientist at General Electric, developed a theoretical explanation known as the "Bean Model" or "Critical State Model."

The basic property of superconductors is that they represent zero "resistance" to electrical circuits. In a way, they are the opposite of toasters, which resist electrical currents and thereby convert energy into heat. Superconductors consume zero energy and can store it for a long period of time. Those that store magnetic energy —known as "trapped field magnets" or TFMs—can behave like a magnet.

In the Journal of Applied Physics, the researchers describe experiments whose results exhibited "significant deviations" from those of the Critical State Model. They revealed unexpected new behavior favorable to practical applications, including the possibility of using TFMs in myriad new ways.

Much of modern technology is already based on magnets. "Without magnets, we'd lack generators [electric lights and toasters], motors [municipal water supplies, ship engines], magnetrons [microwave ovens], and much ...Read More...

This image of a magnet levitated over a high-temperature superconductor array shows rectangular TFMs (black) levitating a heavy ferromagnet (silver) above a container of liquid nitrogen. Credit: Weinstein/University of Houston

From IT to black holes: Nano-control of light pioneers new paths

An Australian research team has created a breakthrough chip for the nano-manipulation of light, paving the way for next gen optical technologies and enabling deeper understanding of black holes.

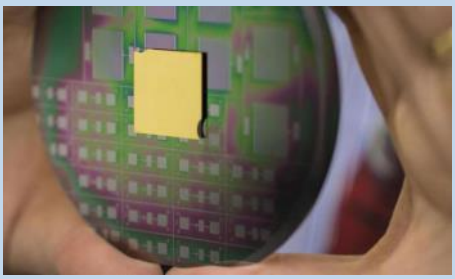
Led by Professor Min Gu at RMIT University in Melbourne, Australia, the team designed an integrated nanophotonic chip that can achieve unparalleled levels of control over the angular momentum (AM) of light.

The pioneering work opens new opportunities for using AM at a chip-scale for the generation, transmission, processing and recording of information, and could also be used to help scientists better understand the evolution and nature of black holes.

While traveling approximately in a straight line, a beam of light also spins and twists around its optical axis. The AM of light, which measures the amount of that dynamic rotation, has attracted tremendous research interest in recent decades.

A key focus is the potential of using AM to enable the mass expansion of the available capacity of optical fibres through the use of parallel light channels - an approach known as "multiplexing".

But realising AM multiplexing on a ...Read More..



The breakthrough nanophotonic chip that can harness the angular momentum of light, paving the way for next generation optical technologies and enabling scientists to gain a deeper understanding of black holes. Credit: RMIT University

LIGO researchers suggest background noise due to gravity waves may be much greater than thought

The research team working with the LIGO project has proposed that the data gleaned from the discovery of gravity waves last year allows for calculating the likely level of cosmic background noise due to gravitational waves, and that it is much greater than previous models have suggested. In their paper published in Physical Review Letters, researchers with the LIGO Scientific Collaboration along with a companion group from the Virgo Collaboration, describe their reasoning behind their estimates and why they believe they will be able to offer more support for their theory within just a few years.

Prior to the landmark experiments that led to the detection of gravitational waves, researchers believed that there was likely a very nearly constant stream of background gravitational noise moving through the cosmos, generated by black holes and neutron stars merging, but had lacked any physical data that might allow them to estimate how much background noise might exist. With the detection of the gravitational waves that resulted from the merger of two binary black holes, the researchers suddenly found themselves with actual concrete data, which they have now used as a basis for calculating the likely amount of gravitational wave noise constantly bombarding our planet.

To make predictions based on data from just one event, the team started with the assumption that the event that was measured was not one that was out of the ordinary—that allowed for making energy density estimates for all possible black hole binaries, based on the energy ...Read More...

An aerial view of the Laser Interferometer Gravitational-wave Observatory (LIGO) detector in Livingston, Louisiana. LIGO has two detectors: one in Livingston and the other in Hanaford, Washington. LIGO is funded by NSF; Caltech and MIT conceived, built and operate the laboratories. Credit: LIGO Laboratory

Record-breaking steel could be used for body armor, shields for satellites

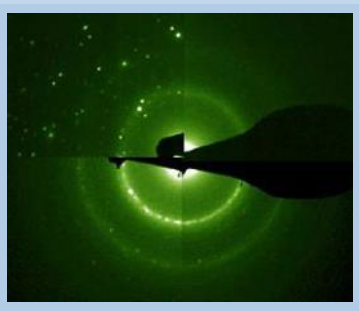
A team of engineers has developed and tested a type of steel with a record-breaking ability to withstand an impact without deforming permanently. The new steel alloy could be used in a wide range of applications, from drill bits, to body armor for soldiers, to meteor-resistant casings for satellites.

The material is an amorphous steel alloy, a promising subclass of steel alloys made of arrangements of atoms that deviate from steel's classical crystal-like structure, where iron atoms occupy specific locations.

Researchers are increasingly looking to amorphous steel as a source of new materials that are affordable to manufacture, incredibly hard, but at the same time, not brittle. The researchers believe their work on the steel alloy, named SAM2X5-630, is the first to investigate how amorphous steels respond to shock.

SAM2X5-630 has the highest recorded elastic limit for any steel alloy, according to the researchers - essentially the highest threshold at which the material can withstand an impact without deforming permanently. The alloy can withstand pressure and stress of up to 12.5 giga-Pascals or about 125,000 atmospheres without undergoing permanent deformations.

The researchers, from the University of California, San Diego, the University of Southern California and the California Institute of Technology, describe the material's fabrication and testing in a recent issue of Nature Scientific ...Read More...

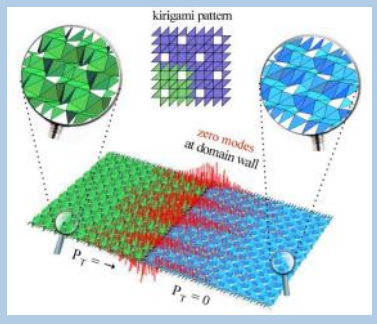


This is a transmission electron microscopy image of different levels of crystallinity in the amorphous alloy. Image courtesy Jacobs School of Engineering/UC San Diego.

Topological origami and kirigami techniques applied experimentally to metamaterials

A team of researchers with members from Universiteit Leiden in the Netherlands, Cornell University and the University of Massachusetts has developed for the first time metamaterials that are based on topological origami and kirigami techniques. In their paper published in Physical Review Letters, the team describes their techniques and the benefits of such materials.

Over the past several years as researchers have looked for new ways to create metamaterials—those that are artificial that have well-defined, tunable properties—they have become increasingly interested in the Japanese arts of origami (paper folding) and kirigami (paper folding and cutting). Thousands of years of working with paper has led to constructs that exhibit remarkable properties, (it has also been noted that the ancient art could lead to the creation of metamaterials with properties such as Poisson ratio, curvature and states that could be tuned using nothing but geometric criteria) which modern researchers would like to apply to new metamaterial development efforts. In this new endeavor, the researchers used their knowledge of origami to construct a metamaterial that has the properties of being soft along one edge, while remaining stiff on the other—two distinct topological phases while being made from a just single base material. ...Read More...



Topologically protected zero mode (red) in a kirigami heterostructure. Credit: arXiv:1508.00795 [cond-mat.soft]

Proof that ancient supernovae zapped Earth sparks hunt for after effects

Two new papers appearing in the journal Nature this week are "slam-dunk" evidence that energies from supernovae have buffeted our planet, according to astrophysicist Adrian Melott of the University of Kansas.

Melott offers his judgment of these studies in an associated letter, entitled "Supernovae in the neighborhood," also appearing this week in Nature.

One paper, authored by Anton Wallner and colleagues, proves the existence of ancient seabed deposits of iron-60 isotopes, tracing their source to supernovae occurring about 325 light years from Earth. The second paper, by a team headed by Deiter Breitschwerdt, estimates explosion times of these supernovae, isolating two events: one 1.7 to 3.2 million years ago, and the other 6.5 to 8.7 million years ago.

"This research essentially proves that certain events happened in the not-too-distant past," said Melott, a KU professor of physics and astronomy. "They make it clear approximately when they happened and how far away they were. Knowing that, we can consider what the effect may have been with definite numbers. Then we can look for events in the history of the Earth that might be connected to them."

Melott said both supernovae events were beyond the "kill zone" of roughly 30 light years, but they might have had other impacts - including influence on human evolution. "Our local research group is working on ...Read More...

Supernova. Image courtesy NASA.

NASA: Global warming is now changing how Earth wobbles

Global warming is shifting the way the Earth wobbles on its polar axis, a new NASA study finds.

Melting ice sheets—especially in Greenland—are changing the distribution of weight on Earth. And that has caused both the North Pole and the wobble, which is called polar motion, to change course, according to a study published Friday in the journal Science Advances.

Scientists and navigators have been accurately measuring the true pole and polar motion since 1899 and for almost the entire 20th century they migrated a bit toward Canada. But that has changed with this century and now it's moving toward England, said study lead author Surendra Adhikari at NASA's Jet Propulsion Lab. "The recent shift from the 20th-century direction is very dramatic," Adhikari said.

While scientists say the shift is harmless, it is meaningful. Jonathan Overpeck, professor of geosciences at the University of Arizona who wasn't part of the study, said "this highlights how real and profoundly large an impact humans are having on the planet."...Read More...

In this July 26, 2011 file photo, drops of water fall from a melting iceberg near Nuuk, Greenland. Global warming is shifting the way the Earth wobbles on its polar axis, a new NASA study finds. Melting ice sheets, especially in Greenland, are changing the distribution of weight on Earth. And that has caused both the North Pole and the wobble, which is called polar motion, to change course, according to a study published Friday, April 8, 2016, in the journal Science Advances. (AP Photo/Brennan Linsley, File)

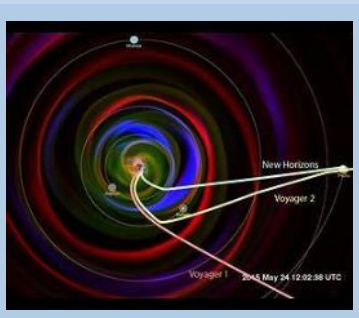
New Horizons fills gap in space environment observations

When NASA's New Horizons sped past Pluto on July 14, 2015, it took the best-ever pictures of the rocky world s surface, giving us new insight into its geology, composition and atmosphere. These stunning images are the most famous result of New Horizons, but the spacecraft also sent back over three years worth of measurements of the solar wind the constant flow of solar particles that the sun flings out into space from a region that has been visited by only a few spacecraft.

This unprecedented set of observations give us a peek into an almost entirely unexplored part of our space environment - filling a crucial gap between what other missions see closer to the sun and what the Voyager spacecraft see further out. A new study to appear in The Astrophysical Journal Supplement lays out New Horizons observations of the solar wind ions that it encountered on its journey.

Not only does the New Horizons data provide new glimpses of the space environment of the outer solar system, but this information helps round out our growing picture of the suns influence on space, from near-Earth effects to the boundary where the solar wind meets interstellar space. The new data shows particles in the solar wind that have picked up an initial burst of energy, an acceleration boost that kicks them up just past their original speed.

These particles may be the seeds of extremely energetic particles called anomalous cosmic rays. When these super-fast, energetic rays travel closer to Earth, they can pose a radiation hazard to astronauts. Further away, at ...Read More...



Space environment data collected by New Horizons over a billion miles of its journey to Pluto will play a key role in testing and improving models of the space environment throughout the solar system. This visualization is one example of such a model: It shows the simulated space environment out to Pluto a few months before New Horizons' closest approach. Drawn over the model is the path of New Horizons up to ...

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Astronomical Facts in the Quran

Speaker:
Mr. Omar Adwan
Lecturer –UoS

Date:
Apr. 09, 2016

Time:
18-19:00

Location:
SCASS

Simulating supermassive black holes

Near the edge of the visible Universe are some of the brightest objects ever observed, known as quasars, which are believed to contain supermassive black holes of more than a billion times the mass of our Sun.

Simulations by Kentaro Nagamine at Osaka University's Department of Earth and Space Science, Isaac Shlosman at the University of Kentucky and co-workers have revealed for the first time exactly how these black holes formed 700 million years after the Big Bang.

"The early Universe was a dense, hot and uniform plasma," explains Nagamine. "As it cooled, fluctuations in the mass distribution formed seeds around which matter could gather due to gravity." These are the origins of the first stars. Similar processes might have later seeded the growth of bigger structures such as supermassive black holes.

Until recently, many researchers thought supermassive black holes were seeded by the collapse of some of the first stars. But modeling work by several groups has suggested that this process would only lead to small black holes….Read More...

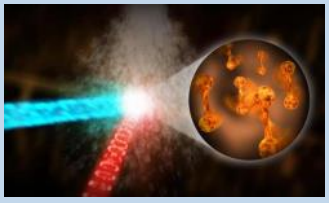
imulation of a network of dark matter filaments in a high-density region of the early universe. Each dense bright spot is a dark matter halo into which gas collapses to form large galaxies and supermassive black holes. Image courtesy 2015 Kentaro Nagamine, Osaka University.

World's fastest electron diffraction snapshots of atomic motions in gases

Scientists have made a significant advance toward making movies of extremely fast atomic processes with potential applications in energy production, chemistry, medicine, materials science and more. Using a superfast, high-resolution "electron camera," a new instrument for ultrafast electron diffraction (UED) at the Department of Energy's SLAC National Accelerator Laboratory, researchers have captured the world's fastest UED images of nitrogen molecules rotating in a gas, with a record shutter speed of 100 quadrillionths of a second.

Scientists have long dreamed of watching nature's smallest and speediest phenomena in real time. For instance, watching biomolecules facilitate life-sustaining chemical reactions at high speed and in atomic detail could teach scientists new ways of producing efficient chemical catalysts. However, most available techniques excel at speed or detail, not both.

"Our new UED instrument can do both: It achieves an unprecedented combination of atomic resolution and extraordinary speed," said researcher Xijie Wang, SLAC's UED team lead and co-author of a new study published today in ...Read More...

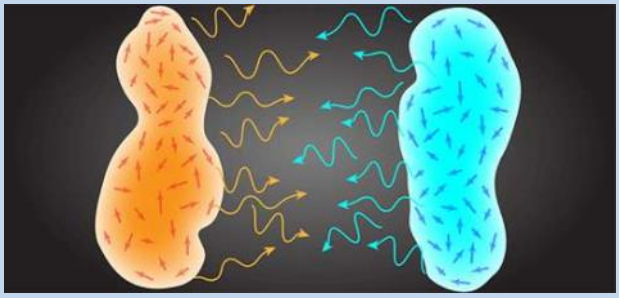


Researchers have taken the world's fastest "electron images" of rotating nitrogen molecules with SLAC's new instrument for ultrafast electron diffraction (UED), demonstrating the technology's potential for making real-

Researchers develop formula describing ghostly transfer of heat

The sun's warmth crosses millions of miles of empty space to create a summer day; a campfire roasts marshmallows from several feet away. Scientists have understood the mathematics behind this ghostly transfer of heat since the late 19th century. But that math breaks down at very close quarters—within, for example, nano-scale electronics and solar electricity cells (with components separated or spanning billionths of a meter) where heat transfer is critical.

In a recent study, a researcher at Princeton and colleagues at the Massachusetts Institute of Technology have come up with a formula that describes the maximum heat transfer in such tight scenarios. Surprisingly—and encouragingly—the formula suggests that a million times more heat transfer is possible between close objects than previously thought. "We now have a ceiling for how much heat transfer we can expect," said Alejandro Rodriguez, an assistant ...Read More...



Two bodies at different temperatures in vacuum constantly exchange heat. This energy flux is mediated by photons (shown here as wavy lines), which are generated by thermally fluctuating electrical currents (arrows) inside each body.