100 Million Stars in the Andromeda galaxy.

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

INTERNATIONAL YEAR OF LIGHT 2015

Inside this issue:

Theory of the strong interaction verified

The fact that the neutron is slightly more massive than the proton is the reason why atomic nuclei have exactly those properties that make our world and ultimately our existence possible. Eighty years after the discovery of the neutron, a team of physicists from France, Germany, and Hungary headed by Zoltán Fodor, a researcher from Wuppertal, has finally calculated the tiny neutron-proton mass difference. The findings, which have been published in the current edition of Science, are considered a milestone by many physicists and confirm the theory of the strong interaction. As one of the most powerful computers in the world, JUQUEEN at Forschungszentrum Jülich was decisive for the simulation.

The existence and stability of atoms relies heavily on the fact that neutrons are slightly more massive than protons. The experimentally determined masses differ by only around 0.14 percent. A slightly smaller or larger value of the mass difference would have led to a dramatically different universe, with too many neutrons, not enough hydrogen, or too few heavier elements. The tiny mass difference is the reason why free neutrons decay on average after around ten minutes, while protons - the unchanging building blocks of matter - remain stable for a practically unlimited period...***Read More***...

Supercomputer JUQUEEN. Credit: Forschungszentrum Jülich

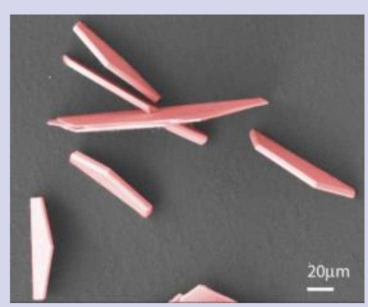
Chemists make new silicon-based nanomaterials

Chemists from Brown University have found a way to make new 2-D, graphene-like semiconducting nanomaterials using an old standby of the semiconductor world: silicon.

In a paper published in the journal Nanoletters, the researchers describe methods for making nanoribbons and nanoplates from a compound called silicon telluride. The materials are pure, p-type semiconductors (positive charge carriers) that could be used in a variety of electronic and optical devices. Their layered structure can take up lithium and magnesium, meaning it could also be used to make electrodes in those types of batteries.

"Silicon-based compounds are the backbone of modern electronics processing," said Kristie Koski, assistant professor of chemistry at Brown, who led the work. "Silicon telluride is in that family of compounds, and we've shown a totally new method for using it to make layered, two-dimensional nanomaterials."

Koski and her team synthesized the new materials through vapor deposition in a tube furnace. When heated in the tube, silicon and tellurium vaporize and react to make a ...***Read More***...



By adjusting the fabrication technique, researchers can make different semiconductor structures, including nanoplates that lie flat or stand upright. Credit: Koski lab / Brown University

Now you see it: Real-space observation of many-body proton tunneling in water nanocluster

There's more to quantum tunneling than meets the eye – or rather, the visualization technique. Most quantum tunneling discussion focus on incoherent single-particle tunneling; on the other hand, quantum tunneling in the context of proton dynamics usually involves many hydrogen bonds at once, which leads to what is known as correlated many-body tunneling. (The many-body problem refers to the properties of microscopic systems that are described by quantum mechanics, comprising a large number of interacting particles – that is, ≥ 3 – which can become entangled.) The downside is that while single-particle tunneling is well understood, many-body tunneling is still shrouded in mystery. Recently, however, scientists at Peking University, Beijing reported the real-space observation of concerted proton tunneling in a cyclic water tetramer – a macromolecular nanocluster consisting of four water molecules arranged in a loop or ring – by using a cryogenic scanning tunneling microscope (STM). The scientists found that the presence of the Cl- chlorine anion (a negatively charged chlorine ion) at the STM tip apex may either enhance or suppress the concerted tunneling process based on the coupling symmetry between the ion and the protons, adding that their work may allow the control the quantum states of protons with atomic-scale precision.

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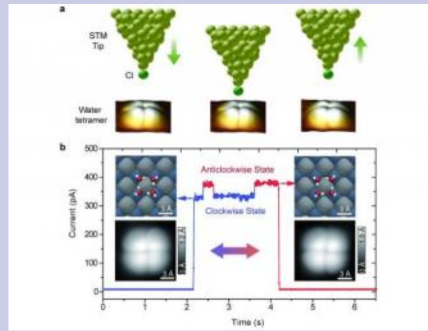


Chirality switching of a H2O tetramer. a, Schematic showing manipulation of the chirality of the tetramer by a Cl-terminated tip. Left: the tetramer stays in the clockwise state (CS) when the tip is far away from the tetramer (gap set with V…...

Using magnetic fields to understand high-temperature superconductivity

Taking our understanding of quantum matter to new levels, scientists at Los Alamos National Laboratory are exposing high-temperature superconductors to very high magnetic fields, changing the temperature at which the materials become perfectly conducting and revealing unique properties of these substances.

"High magnetic-field measurements of doped copper-oxide superconductors are paving the way to a new theory of superconductivity," said Brad Ramshaw, a Los Alamos scientist and lead researcher on the project. Using world-record high magnetic fields available at the National High Magnetic Field Laboratory (NHMFL) Pulsed Field Facility, based in Los Alamos, Ramshaw and his coworkers are pushing the boundaries of how matter can conduct electricity without the resistance that plagues normal materials carrying an electrical current.

The eventual goal of the research would be to create a superconductor that operates at room temperature and needs no cooling at all. At this point, all devices that make use of superconductors, such as the MRI magnets found in hospitals, must be cooled to temperatures far below zero with liquid nitrogen or helium, adding to the cost and complexity of the enterprise.

"This is a truly landmark experiment that illuminates a problem of central importance to condensed matter physics," said MagLab Director Gregory Boebinger, who is also chief scientist for Condensed Matter Science at the ***...Read More***...

Los Alamos National Laboratory scientist Brad Ramshaw conducts an experiment at the Pulsed Field Facility of the National High Magnetic Field Lab, exposing high-temperature superconductors to very high magnetic fields, changing the temperature at which the materials become perfectly conducting and revealing unique properties of these substances. Credit: Los Alamos National Laboratory

New way to calculate how long it would take to fall through a hole in the Earth

Alexander Klotz a student at McGill University in Canada has calculated a new answer to the commonly asked physics question, how long would it take a person to fall all the way through the Earth? Instead of the commonly accepted 42 minutes, he claims it is 38. He has published his reasoning, math and conclusions in a paper published in The American Journal of Physics.

If someone were to drill a hole all the way through the planet, and then somehow manage to fall into it, how long would it take them to arrive on the other side? That is a physics question put to students every year, and those who give it expect the answer to be 42 minutes. But is that answer correct? Klotz says no and has the math to prove it, Science reported.

The accepted answer of 42 minutes takes into account the constantly changing impact that gravity will have (and ignoring drag due to the presence of air) on the person falling, becoming less and less of a factor as the center of the Earth is approached then growing stronger and stronger as the person heads "up" against gravity on the other side. It is accepted that the speed attained during the descent on the first half of the journey would be significant enough to cause the person to continue moving against gravity on the other side of the planet, right up until the surface is reached.

But Klotz argues that it is time to start taking the different densities of the Earth's layers into consideration—after all, a lot of research has shown that our planet...***Read More***...

A composite image of the Western hemisphere of the Earth. Credit: NASA

Galaxy clusters collide—dark matter still a mystery

When galaxy clusters collide, their dark matters pass through each other, with very little interaction. Deepening the mystery, a study by scientists at EPFL and the University of Edinburgh challenges the idea that dark matter is composed of particles.

Dark matter is one of science's great mysteries. It makes up an enormous amount matter in the universe, it is invisible, and it does not correspond to anything in the realm of our experience. Different theories compete for an explanation, but so far none of them has prevailed. In a collaborative study between École Polytechnique Fédérale de Lausanne (EPFL) and the University of Edinburgh, scientists have studied how dark matter behaves when galaxy clusters collide with each other over billions of years. Published in Science, their findings challenge at least one major theory on dark matter.

Dark matter and galaxy clusters

Although it accounts for 90% of all matter in the universe and more than a quarter of its energy, we know very little about dark matter. One major idea among astronomers is that dark matter consists of a new subatomic particle that we haven't discovered yet. More exotic theories want dark matter to be a quantum defect from the birth of the universe, extra-dimensional mass, and even a modified form of gravity.

What we do know is that dark matter interacts with cosmic structures through gravity, shaping and molding them. For example, dark matter bends light that passes through it, distorting images of distant space objects. In addition, dark matter speeds up the motion of galaxies inside galaxy clusters, which are collections of hundreds of galaxies, containing literally astronomical amounts of stars, planets, and gases. Galaxy clusters are also 90% dark matter, which makes them ideal for studying it, especially when they collide into each other ***..Read More***...

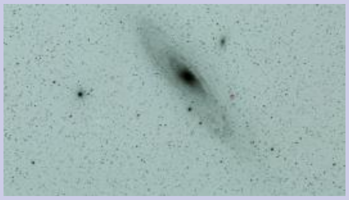
Individual image of A370 with dark matter model overlaid. Credit: NASA, ESA, D. Harvey (École Polytechnique Fédérale de Lausanne, Switzerland), R. Massey (Durham University, UK), the Hubble SM4 ERO Team and ST-ECF

Using 19th century technology to time travel to the stars

In the late 19th century, astronomers developed the technique of capturing telescopic images of stars and galaxies on glass photographic plates. This allowed them to study the night sky in detail. Over 500,000 glass plate images taken from 1885 to 1992 are part of the Plate Stacks Collection of the Harvard-Smithsonian Center for Astrophysics (CfA), and is is the largest of its kind in the world.

"The images captured on these plates remain incredibly valuable to science, representing a century of data on stars and galaxies that can never be replaced," writes astronomer Michael Shara, who is Curator in the Department of Astrophysics at the American Museum of Natural History in New York City, who discussed the plates and their significance in a new episode of AMNH's video series, "Shelf Life." These plates provide a chance to travel back in time, to see how stars and galaxies appeared over the past 130 years, allowing astronomers to do what's called "time domain astronomy": studying the changes and variability of objects over time. These include stars, galaxies, and jets from stars or galactic nuclei.

But viewing these plates is difficult. The glass plates can still be viewed on a rather archaic plate viewer—a device that's like an X-ray light box in a doctor's ..***Read More***...



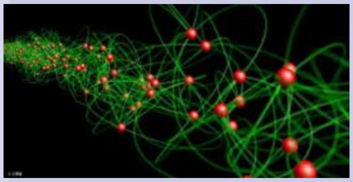
This image of a spiral galaxy, taken on a glass photographic plate, is one in a series of photos taken over decades. From the Harvard Plate collection. Credit: American Museum of Natural History

First glimpse inside a macroscopic quantum state

In a recent study published in Physical Review Letters, the research group led by ICREA Prof. at ICFO Morgan Mitchell has detected, for the first time, entanglement among individual photon pairs in a beam of squeezed light.

Quantum entanglement is always related to the microscopic world, but it also has striking macroscopic effects, such as the squeezing of light or superconductivity, a physical phenomenon that allows high-speed trains to levitate. Squeezed light is not physically compressed but it is it manipulated in such a way that one of its properties is super well defined, for example its polarization. Compared with normal light, laser light, composed of independent photons, has an extremely small but nonzero polarization uncertainty. This uncertainty or "quantum noise" is directly linked to the existence of photons, the smallest energy quanta of light. Now, squeezed light has an uncertainty that is farther below this level. Therefore, in optical communications, squeezed light can help transmit much weaker signals with the same signal to noise ratio and the same light power. It can also be used to distribute secret keys to two distant parties through quantum cryptography.

Although it has long been believed that many macroscopic phenomena are caused by large-scale entanglement, up to now, this link has only been proposed theoretically. On the other hand, current computer simulations of entangled particles have not been able to help discern any new properties regarding this relationship since the memory and processor time required grow exponentially with the number of entangled particles, thus .***Read More***..



This is an artist's impression of a beam of entangled photons. Image: ICFO

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

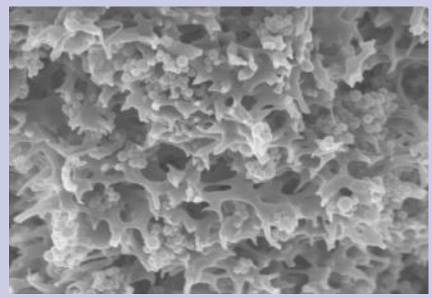
UAEU College of Science

جامعة الإمارات العربية المتحدة
United Arab Emirates University

Simple method of binding pollutants in water

New types of membrane adsorbers remove unwanted particles from water and also, at the same time, dissolved substances such as the hormonally active bis-phenol A or toxic lead. To do this, researchers at the Fraunhofer Institute for Interfacial Engineering and Biotechnology IGB imbed selective adsorber particles in filtration membranes.

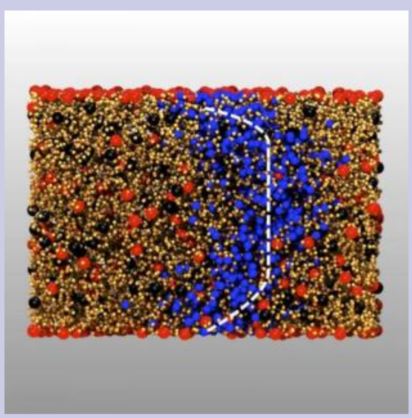
It was not until January 2015 that the European Food Safety Authority (EFSA) lowered the threshold value for bisphenol A in packaging. The hormonally active bulk chemical is among other things a basic material for polycarbonate from which, for example, CDs, plastic tableware or spectacles glasses are manufactured. Due to its chemical structure ...***Read More***...



Behind the dogmas of good old hydrodynamics

A new theory, which gives insights into the transport of liquid flowing along the surface under an applied electric field, was developed by a group of Russian scientists lead by Olga Vinogradova who is a professor at the M.V.Lomonosov Moscow State University and a laboratory head at the A.N. Frumkin Institute of Physical chemistry and Electrochemistry of the Russian Academy of Sciences. It may be used in the future in research in physics, chemistry and biology and has many applications in medicine and pharmaceuticals. An article describing the theory and simulations is published in Physical Review Letters.

The motion of liquid through the capillaries, porous membranes, or the thin channel under an applied electric field is called an electro-osmotic flow. This effect was discovered in 1807 by a professor of Moscow University, Ferdinand Friedrich Reuss, during a simple experiment. It involves a curved glass tube filled with water; its bend is filled with an insoluble powdered substance such as grated stone or sand, which creates a porous barrier separating both ends of the tube from each other. When a voltage is applied to the water, it begins to seep through the barrier as shown in Figure 2. The motion of ...***Read More***…



An electric field, created by a small battery or another power source, could be a cause of a fast fluid flow along a solid surface. In the figure the red and the black beads stand for the ions and the yellow ones for the solvent. And the blue beads represent the molecules of the fluid. They illustrate the fluid velocity profile and it is clear that the profile in the center of the channel is flat. Credit: Olga Vinogradova et al.

Engineering students use sound waves to put out fires

Two engineering students at George Mason University have found a way to use sound waves to quash fires and have built a type of extinguisher using what they have learned that they hope will revolutionize fire fighting technology. Viet Tran a computer engineering major and Seth Robertson, an electrical engineering major, chose to investigate the possibility of using sound to put out fires as a senior research project and now believe they have found something that might really work.

Prior research has shown that sound waves can impact fires, and other researchers, such as those working for DARPA a couple of years ago, even investigated the possibility of using sound to put out fires, but thus far, no sound based extinguishers have been built and sold as a means to stop fires. The research by the duo at GMU might change that.
As the two students told members of the press, they started with the simple idea ...***Read More***...