100 Million Stars in the Andromeda galaxy.

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

INTERNATIONAL YEAR OF LIGHT 2015

Inside this issue:

Three-decade quest backs physics' 'Standard Model'

Scientists on Wednesday said that after a nearly three-decade bid they had detected a telltale change in a sub-atomic particle, further backing a key theory about the Universe.

Researchers at the world's biggest particle collider said they had observed an extremely rare event—the decay of the neutral B meson into a pair of muons, the heavy cousins of electrons.

The results provide further support for the so-called Standard Model, the conceptual framework for the particles and forces that constitute the cosmos, they said in the journal Nature.

Neutral B mesons are unstable composites of two kinds of particles called quarks, bound by the "strong" force.

Their decay into muons is predicted under the Standard Model. But getting evidence to confirm the prediction has been a puzzler since the mid-1980s.

For one thing, neutral B mesons themselves are produced in extreme conditions—in particle colliders or in cosmic-ray interactions, for instance—which makes them hard or very costly to study.

And the transition into muons only occurs about four times in every billion "decays." ...***Read More***...

Credit: CERN

Physicist finds mysterious anti-electron clouds inside thunderstorm

A terrifying few moments flying into the top of an active thunderstorm in a research aircraft has led to an unexpected discovery that could help explain the longstanding mystery of how lightning gets initiated inside a thunderstorm.

University of New Hampshire physicist Joseph Dwyer and lightning science colleagues from the University of California at Santa Cruz and Florida Tech describe the turbulent encounter and discovery in a paper to be published in the Journal of Plasma Physics.

In August 2009, Dwyer and colleagues were aboard a National Center for Atmospheric Research Gulfstream V when it inadvertently flew into the extremely violent thunderstorm—and, it turned out, through a large cloud of positrons, the antimatter opposite of electrons, that should not have been there.

To encounter a cloud of positrons without other associated physical phenomena such as energetic gamma-ray emissions was completely unexpected, thoroughly perplexing and contrary to currently understood physics...***Read More***...

Lightning and severe weather are two of the most visible products of thunderstorms. However, scientists are discovering that the storms also contain a fascinating variety of strange phenomena, including powerful gamma-ray flashes and puzzling clouds of positrons—the anti-matter version of the electron. Credit: iStock.com

ORNL demonstrates first large-scale graphene fabrication

One of the barriers to using graphene at a commercial scale could be overcome using a method demonstrated by researchers at the Department of Energy's Oak Ridge National Laboratory.

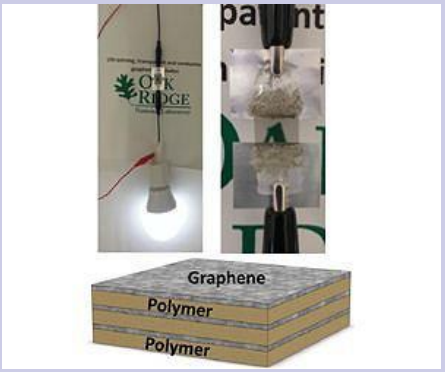
Graphene, a material stronger and stiffer than carbon fiber, has enormous commercial potential but has been impractical to employ on a large scale, with researchers limited to using small flakes of the material.

Now, using chemical vapor deposition, a team led by ORNL's Ivan Vlassiouk has fabricated polymer composites containing 2-inch-by-2-inch sheets of the one-atom thick hexagonally arranged carbon atoms.

The findings, reported in the journal Applied Materials and Interfaces, could help usher in a new era in flexible electronics and change the way this reinforcing material is viewed and ultimately used.

"Before our work, superb mechanical properties of graphene were shown at a micro scale," said Vlassiouk, a member of ORNL's Energy and Transportation Science Division. "We have extended this to a larger scale, which considerably extends the potential applications and market for graphene."

While most approaches for polymer nanocomposition construction employ tiny flakes of graphene or other carbon nanomaterials that are difficult to disperse in the polymer, Vlassiouk's team used larger sheets of ...***Read More***….



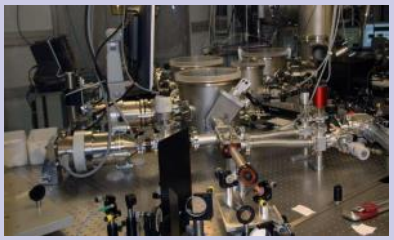
ORNL's ultrastrong graphene features layers of graphene and polymers and is an effective conductor of electricity. Image courtesy ORNL.

Physicists observe attosecond real-time restructuring of electron cloud in molecule

The recombination of electron shells in molecules, taking just a few dozen attoseconds (a billionth of a billionth of a second), can now be viewed "live," thanks to a new method developed by MIPT researchers and their colleagues from Denmark, Japan and Switzerland. An article detailing the results of their study has been published in the journal Nature Communications.

In recent years, scientists have learned how to study ultrafast processes taking place at the atomic and molecular levels, and research in this field is expected to yield some very important results. In Germany, for instance, scientists are creating the European X-Ray Free-Electron Laser (XFEL). Russia, too, is participating in the project. Once built, XFEL should give the scientists an opportunity to observe changes occurring in the nuclei of molecules during chemical reactions, which matters a great deal for the study of biochemical processes and proteins' structural properties.

Two groups of scientists—experimentalists led by Professor Hans Jakob Wörner of the Swiss Federal Institute of Technology in Zurich and theoreticians from Denmark, Japan and Russia headed by MIPT's Oleg Tolstikhin—have joined their efforts to study attophysical processes, which are processes lasting several attoseconds (10-18 seconds)...***Read More***...



High harmonic spectrometer. Credit: © ETH Zurich

Researchers build new fermion microscope

Fermions are the building blocks of matter, interacting in a multitude of permutations to give rise to the elements of the periodic table. Without fermions, the physical world would not exist.

Examples of fermions are electrons, protons, neutrons, quarks, and atoms consisting of an odd number of these elementary particles. Because of their fermionic nature, electrons and nuclear matter are difficult to understand theoretically, so researchers are trying to use ultracold gases of fermionic atoms as stand-ins for other fermions.

But atoms are extremely sensitive to light: When a single photon hits an atom, it can knock the particle out of place—an effect that has made imaging individual fermionic atoms devilishly hard.

Now a team of MIT physicists has built a microscope that is able to see up to 1,000 individual fermionic atoms. The researchers devised a laser-based technique to trap and freeze fermions in place, and image the particles simultaneously.

The new imaging technique uses two laser beams trained on a cloud of fermionic atoms in an optical lattice. The two beams, each of a different wavelength, cool the cloud, causing individual fermions to drop down an energy level, eventually bringing them to their lowest energy states—cool and stable enough to stay in place. At the same time, each fermion releases light, which is captured by the microscope and used to image the fermion's exact position in the lattice—to an accuracy better than the ...***Read More***….

Laser beams are precisely aligned before being sent into the vacuum chamber. Credit: Jose-Luis Olivares/MIT

Left-handed cosmic magnetic field could explain missing antimatter

The discovery of a 'left-handed' magnetic field that pervades the universe could help explain a long standing mystery – the absence of cosmic antimatter. A group of scientists, led by Prof Tanmay Vachaspati from Arizona State University in the United States, with collaborators at the University of Washington and Nagoya University, announce their result in Monthly Notices of the Royal Astronomical Society.

Planets, stars, gas and dust are almost entirely made up of 'normal' matter of the kind we are familiar with on Earth. But theory predicts that there should be a similar amount of antimatter, like normal matter, but with the opposite charge. For example, an antielectron or positron has the same mass as its conventional counterpart, but a positive rather than negative charge.

In 2001 Prof Vachaspati published theoretical models to try to solve this puzzle, which predict that the entire universe is filled with helical (screw-like) magnetic fields. He and his team were inspired to search for evidence of these fields in data from the NASA Fermi Gamma ray Space Telescope (FGST).

FGST, launched in 2008, observes gamma rays (electromagnetic radiation with a shorter wavelength than X-rays) from very distant sources, such as the supermassive black holes found in many large galaxies. The gamma rays are sensitive to effect of the magnetic field they travel through on their long journey to the Earth. If the field is helical, it will imprint a spiral pattern on the distribution of gamma rays.

An artist's concept of the Fermi Gamma ray Space Telescope (FGST) in orbit. Credit: NASA.

Vachaspati and his team see exactly this effect in the FGST data, allowing them to not only detect the magnetic field but to measure its properties. The data shows not ...***Read More***...

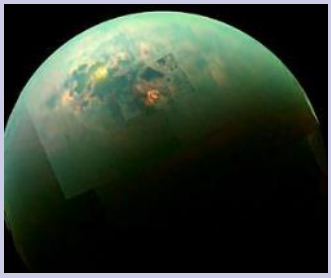
Ether Compounds Could Work like DNA On Oily Worlds

In the search for life beyond Earth, scientists have justifiably focused on water because all biology as we know it requires this fluid. A wild card, however, is whether alternative liquids can also suffice as life-enablers. For example, Saturn's frigid moon Titan is awash in inky seas of the hydrocarbon methane.

Here on warm, watery Earth, the molecules DNA and RNA serve as the blueprints of life, containing creatures' genetic instruction manuals. An immense family of proteins carries out these instructions. Yet in a hydrocarbon medium on Titan, these molecules could never perform their profound chemical duties. Other molecules must therefore step up to the plate if non-water-based, alien life is to operate and evolve in a Darwinian sense, with genetic changes leading to diversity and complexity.

A new study proposes that molecules called ethers, not used in any genetic molecules on Earth, could fulfill the role of DNA and RNA on worlds with hydrocarbon oceans. These worlds must be a good deal toastier though than Titan, the study found, for plausibly life-like chemistry to take place.

"The genetic molecules we have ...***Read More***...



Sunlight glints off of hydrocarbon seas on Saturn's moon Titan, as seen here in near-infrared light by the Cassini spacecraft. Image courtesy NASA/JPL-Caltech/Univ. Arizona/Univ. Idaho.

When an electron splits in two

As an elementary particle, the electron cannot be broken down into smaller particles, at least as far as is currently known. However, in a phenomenon called electron fractionalization, in certain materials an electron can be broken down into smaller "charge pulses," each of which carries a fraction of the electron's charge. Although electron fractionalization has many interesting implications, its origins are not well understood.

Now in a new paper published in Nature Communications, a team of physicists led by Gwendal Fève at the Ecole Normale Supérieure in Paris and the Laboratory for Photonics and Nanostructures in Marcoussis have applied an experiment typically used to study photons to investigate the underlying mechanisms of electron fractionalization. The method allows the researchers to observe single-electron fractionalization on the picosecond scale.

"We have been able to visualize the splitting of an electronic wavepacket into two fractionalized packets carrying half of the original electron charge," Fève told Phys.org. "Electron fractionalization has been studied in previous works, mainly during roughly the last five years. Our work is the first to combine single-electron resolution—which allows us to address the fractionalization process at the elementary scale—with time resolution to directly visualize the fractionalization process."

The technique that the researchers used is called the Hong-Ou-Mandel experiment, which can be used to measure the degree of resemblance between two photons, or in this case ...***Read More***...

An artistic illustration of electron fractionalization. When an electron travels along the outer 1D wire in an interferometer, the Coulomb interaction between the outer and inner 1D wires produces two types of excitation pairs, as shown here: two pulses of the same sign (carrying a net charge) and two pulses of opposite signs (which together are neutral). Because the two different excitation pairs travel at different velocities, the original electron eventually splits into two distinct charge pulses in the inner wire. Credit: Freulon, et al. ©2015 Nature

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UAEU College of Science

جامعة الإمارات العربية المتحدة
United Arab Emirates University

The Physics Department cordially invites you to the seminar:

Is Dark Matter made of Small Black Holes?

Prof. Pascal Chardonnet

Laboratoire de Physique Théorique — Annecy (France)

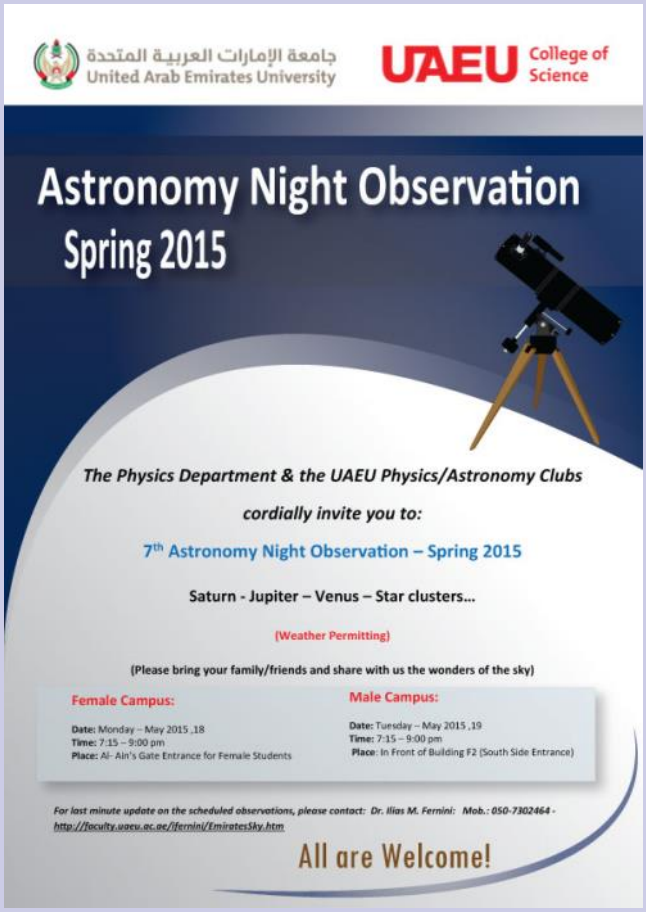
Abstract

Dark matter is an essential piece of the Universe and constitutes a great mystery in astrophysics. The most favorable scenario is that dark matter is made of neutral massive elementary particles. However, despite many efforts and research with accelerators and underground experiments, it has not yet been detected: dark matter remains as elusive as ever.

Another possibility could be to understand dark matter with the primordial black holes. In this seminar, I will develop such a scenario and present the evidence for this possibility. I will also review the consequences of this scenario in astrophysics and cosmology.

Thursday, May 21st 2015 @ 11:00 AM, Room F1-2119

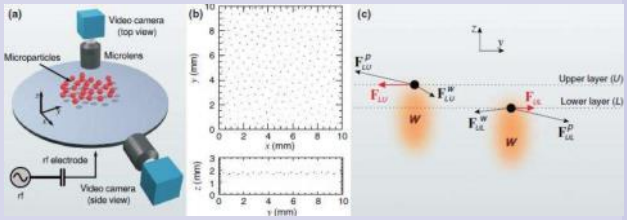
All are Welcome!



What happens when Newton's third law is broken?

Even if you don't know it by name, everyone is familiar with Newton's third law, which states that for every action, there is an equal and opposite reaction. This idea can be seen in many everyday situations, such as when walking, where a person's foot pushes against the ground, and the ground pushes back with an equal and opposite force. Newton's third law is also essential for understanding and developing automobiles, airplanes, rockets, boats, and many other technologies.

Even though it is one of the fundamental laws of physics, Newton's third law can be violated in certain nonequilibrium (out-of-balance) situations. When two objects or particles violate the third law, they are said to have nonreciprocal interactions. Violations can occur when the environment becomes involved in the interaction between the two particles in some ...*Read More*...



In the new experiments, two layers of microparticles levitating at two different heights above an electrode have allowed researchers to investigate the statistical mechanics of nonreciprocal interactions, which violate Newton's third law. Credit: A. V. Ivlev, et al. CC-BY-3.0