January 31, 2015
Volume 5, Issue 5

Astronomy & Physics News

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

100 Million Stars in the Andromeda galaxy.

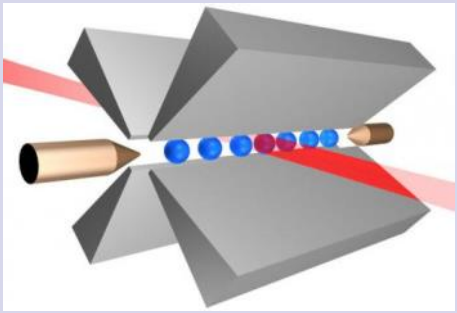
Inside this issue:

Quantum computer makes finding new physics more difficult

Physicists often work unusual hours. You will find them running experiments at 4am and 10pm. This is because, so long as the pertinent conditions inside a lab – such as temperature or light level – are fixed, the outcome of an experiment should not depend on location of the lab in space or time.

This property of the world to behave according to the same laws of physics everywhere is called Lorentz covariance, after the Dutch Nobel-Prize winner Hendrik Lorentz. All existing evidence suggests that the world is naturally Lorentz covariant.

Even a small violation of this property would be shocking. In particular, it would imply the existence of a "preferred frame": by travelling at an appropriate velocity, in just the right part of the universe, an observer would perceive physics to be significantly simpler than it is from all other points of view. Such a violation would break the standard model, our best description of the behaviour of light and matter….***Read More***...



An ion trap of the type used in the experiment. Credit: Institute of Theoretical Physics, Innsbruck

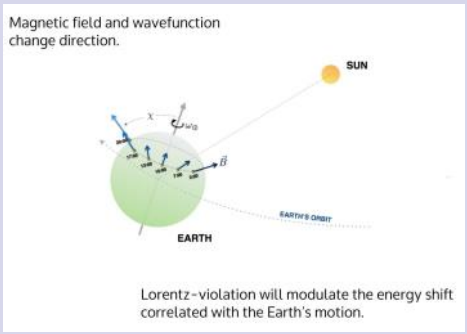
Quantum computer as detector shows space is not squeezed

Ever since Einstein proposed his special theory of relativity in 1905, physics and cosmology have been based on the assumption that space looks the same in all directions - that it's not squeezed in one direction relative to another.

A new experiment by University of California, Berkeley, physicists used partially entangled atoms - identical to the qubits in a quantum computer - to demonstrate more precisely than ever before that this is true, to one part in a billion billion.

The classic experiment that inspired Albert Einstein was performed in Cleveland by Albert Michelson and Edward Morley in 1887 and disproved the existence of an "ether" permeating space through which light was thought to move like a wave through water. What it also proved, said Hartmut Häffner, a UC Berkeley assistant professor of physics, is that space is isotropic and that light travels at the same speed up, down and sideways.

"Michelson and Morley proved that space is not squeezed," Häffner said. "This isotropy is fundamental to all physics, including the Standard Model of physics. If you take away isotropy, the whole Standard Model will collapse. That is why people are interested in testing this."..***Read More***



Huge distant planet has rings 200 times larger than Saturn's

It's a super Saturn, 434 light-years from Earth. It has more than 30 rings, with a total diameter of some 120 million kilometers. If we could replace Saturn's rings with these rings, they'd be easily visible from Earth and larger in our sky than a full moon.

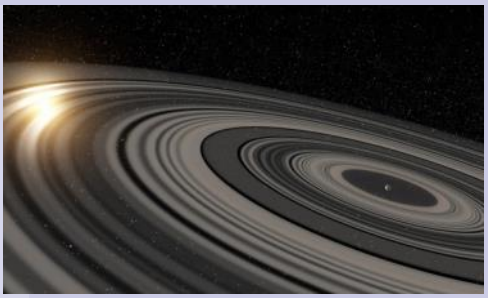
An international team of astronomers have discovered that a ring system around a distant planet – called J1407b – is of enormous proportions, much larger and heavier than the ring system of Saturn.

The planet orbits star J1407, located approximately 434 light-years from Earth. Astronomers first identified the ring system – the first of its kind to be found outside our solar system – in 2012. A new analysis of the data, published in the Astrophysical Journal, shows that the ring system consists of more than 30 rings, each of them tens of millions of kilometers in diameter. Furthermore, the analysis found gaps in the rings, which indicate that satellites ("exomoons") may have formed.

Erik Mamajek is a professor of physics and astronomy at the University of Rochester and a co-author of the ring study. He said:

"This planet is much larger than Jupiter or Saturn, and its ring system is roughly 200 times larger than Saturn's rings are today. You could think of it as kind of a super Saturn."

The disk of rings is so vast that, were it around Saturn, it would dominate our night sky, the astronomers said. According to Matthew Kenworthy of the Leiden Observatory ...***Read More***...



Artist's concept of the ring system around the young giant planet or brown dwarf J1407b. Image via Ron Miller

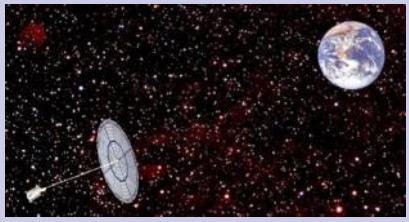
New space telescope concept could image objects at far higher resolution than Hubble

University of Colorado Boulder researchers will update NASA officials next week on a revolutionary space telescope concept selected by the agency for study last June that could provide images up to 1,000 times sharper than the Hubble Space Telescope.

CU-Boulder Professor Webster Cash said the instrument package would consist of an orbiting space telescope and an opaque disk in front of it that could be up to a half mile across. According to Cash, diffracted light waves from a target star or other space object would bend around the edges of the disk and converge in a central point. That light would then be fed into the orbiting telescope to provide high-resolution images, he said.

The new telescope concept, named the Aragoscope after French scientist Francois Arago who first detected diffracted light waves around a disk, could allow scientists to image space objects like black hole "event horizons" and plasma swaps between stars, said Cash of CU-Boulder's Center for Astrophysics and Space Astronomy. The novel telescope system also could point toward Earth and image objects as small as a rabbit, giving it the ability to hunt for lost campers in the mountains, he said.

The CU-Boulder Aragoscope was one of 12 proposals selected for Phase One funding in June 2014 by the NASA Innovative Advanced Concept (NIAC) program, designed to turn science fiction into reality through pioneering technology development. Other Phase One NIAC ….***Read More***...



A new orbiting telescope concept developed at CU-Boulder could allow scientists to image objects in space or on Earth at hundreds of times the resolution of the Hubble Space Telescope. Credit: NASA

Physicist suggests new experiments could make or break axion as dark matter theory

Leslie Rosenberg, a physicist with the University of Washington has published a paper in Proceedings of the National Academy of Sciences, describing the current state of research that involves investigating the possibility that axions are what make up dark matter. He also offers some perspective on the work suggesting that at least one project is likely to lead to either proving or disproving that axions are dark matter.

For several years now, scientists have been hard at work trying to detect WIMPs, the thinking has been that if they can be detected, then it would go a long way towards proving that they are what makes up dark matter—the theoretical stuff that is now believed to make up approximately 85 percent of all mass in the universe. Unfortunately, despite their best efforts, scientists have not yet been able to detect the presence of a single one, causing some to wonder if they exist at all. That doubt has led some scientists to consider other types of particles as dark matter candidates—one of them is the neutrino, though more and more it appears to be falling from favor. Another is the axion, a particle first theorized in the early 70's. One of its major proponents is Rosenburg, who has been developing experimental devices with the purpose of either proving that dark matter is made up of axions, or it is not.

Axion theory suggests that axions can decay into photons—one axion into two photons, and vice-versa—the inbetween state is known as the virtual axion. Because of this property, most axion detectors are dedicated to measuring them after ...***Read More***...

A massive cluster of yellowish galaxies, seemingly caught in a red and blue spider web of eerily distorted background galaxies, makes for a spell-binding picture from the new Advanced Camera for Surveys aboard NASA's Hubble Space Telescope.

New laser could upgrade the images in tomorrow's technology

A new semiconductor laser developed at Yale has the potential to significantly improve the imaging quality of the next generation of high-tech microscopes, laser projectors, photolithography, holography, and biomedical imaging.

Based on a chaotic cavity laser, the technology combines the brightness of traditional lasers with the lower image corruption of light emitting diodes (LEDs). The search for better light sources for high-speed, full-field imaging applications has been the focus of intense experimentation and research in recent years.

The new laser is described in a paper in the online edition of the Proceedings of the National Academy of Sciences. Several Yale labs and departments collaborated on the research, with contributions from scientists in applied physics, electrical and biomedical engineering, and diagnostic radiology.

"This chaotic cavity laser is a great example of basic research ultimately leading to a potentially important invention for the social good," said co-author A. Douglas Stone, the Carl A. Morse Professor and chair of applied physics, and professor of physics.

"All of the foundational work was primarily motivated by a desire to understand certain classes of lasers -- random and chaotic -- with no known applications. Eventually, with input from other disciplines, we discovered that these lasers are uniquely suited for a wide class of problems in imaging and microscopy."

One of those problems is known as "speckle." Speckle is a random, grainy pattern, caused by high spatial coherence that can corrupt the formation of images when traditional lasers are used. A way to avoid such distortion is by using LED light sources. The problem is, LEDs are not bright enough for high-speed imaging….***Read More***...

File image.

Scientists slow down light particles

The speed of light is a limit, not a constant -- that's what researchers in Glasgow, Scotland, say. A group of them just proved that light can be slowed down, permanently.

Scientists already knew light could be slowed temporarily. Photons change speeds as they pass through glass or water, but when they exit the other side and return to a vacuum (like outer space) they speed back up.

In a new experiment at the University of Glasgow, however, scientists were able to permanently manipulate light's speed by passing photons through a device that alters their structure. The device, created in collaboration with researchers at Heriot-Watt University in Edinburgh, is a filter of sorts that the scientists refer to as a mask.

"That mask looks a little bit like a bull's-eye target," researcher Miles Padgett told BBC News. "And that mask patterns the light beam, and we show that it's the patterning of the light beam that slows it down.

"But once that pattern has been imposed -- even now the light is no longer in the mask, it's just propagating in free space -- the speed is still slow,...***Read More***...

Disclaimer: image is for illustration purposes only

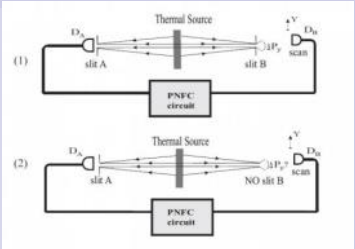
Popper's experiment realized again—but what does it mean?

Like Einstein, the philosopher Karl Popper was a realist who was deeply bothered by some of the odd implications of quantum mechanics. Both Popper and Einstein disliked the idea in Heisenberg's uncertainty principle, for instance, that precisely measuring one property of a particle means that the particle's conjugate property is completely undetermined. This idea undermines the basic principle of common-sense realism: that every particle's properties must have precise pre-existing values, which do not depend on being measured.

Both Popper and Einstein proposed thought experiments critiquing the uncertainty principle. But while Einstein, Podolsky, and Rosen's EPR experiment is quite famous, Popper's experiment is not as widely known.

Popper first published his proposed experiment in 1934, and in 1999, physicists Yoon-Ho Kim and Yanhua Shih realized Popper's experiment for the first time. In what came as a surprise to many, their results agreed with Popper's predictions, yet are not generally considered to be a true violation of the uncertainty principle, as Popper believed. The findings ignited a great deal of critique, both of Popper's original ideas and how they might be realized and interpreted.

Now in a new study published in EPL, Shih and coauthors at the University of Maryland in Baltimore and Oakland Community College in Waterford, Michigan, have again realized Popper's experiment using a different approach. Once again, their results agree with Popper's predictions, yet still do not violate the uncertainty principle...***Read More***...



lustration of Popper's experiment realized with randomly paired photons in a thermal state. In the second set-up, there is no "slit B" for the photon on the right. The new results show that this photon is not affected by a measurement on the left photon (which does travel through a slit), in agreement with Popper's prediction. Credit: Tao Peng, et al. ©2015 EPLA

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

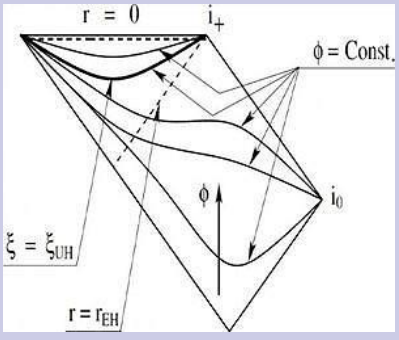
In theory black holes exist with unbounded speeds of propagation

Lorentz invariance (LI) is a cornerstone of modern physics, and strongly supported by observations. In fact, all the experiments carried out so far are consistent with it, and no evidence to show that such a symmetry needs to be broken at a certain energy scale. Nevertheless, there are various reasons to construct gravitational theories with broken LI.

In particular, our understanding of space-times at Plank scale is still highly limited, and the renomalizability and unitarity of gravity often lead to the violation of LI.

One concrete example is the Horava theory of quantum gravity, in which the LI is broken in the ultraviolet (UV), and the theory can include higher-dimensional spatial derivative operators, so that the UV behavior is dramatically improved and can be made (power-counting) renormalizable.

On the other hand, the exclusion of high-dimensional time derivative operators prevents the ghost instability, whereby the unitarity of the theory -- a problem that has been faced since 1977 [K.S. Stelle, Phys. Rev. D16, 953 (1977)] -- is assured...***Read More***...

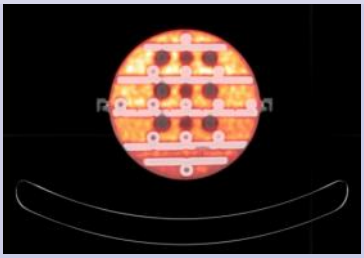


The foliation of the timelike hypersurfaces on which the khronon phi becomes a constant, and the location of the universal horizon xi = xi_{UH}. The khronon defines globally an absolute time, and the trajectory of a particle is always along the increasing direction of phi. Thus, once it cross the horizon, the particle move toward the singularity r = 0 and reaches it within a finite proper time. Image courtesy Anzhong Wang.

Prototype for first traceable PET-MR phantom

As cancer diagnostic tools, a new class of imagers – which combines positron-emission tomography (PET) with magnetic resonance imaging (MR or MRI) – has shown promise in the few years since these hybrid machines have been commercially available. But to thoroughly assess PET-MR scanners' clinical performance, researchers will need to calibrate the machines in a way that is traceable to a national standard.

Aiding that effort, a collaboration of NIST scientists from PML's Radioactivity and Magnetics groups has created a prototype of the world's first traceable phantom..***Read More***..



A fused PET-CT image of the new phantom with its traceably calibrated amount of fluorine-18 (orange). The circular objects are the MR-visible test spheres; in this PET-CT image they appear as regions with no PET response.