



INTERNATIONAL
YEAR OF LIGHT
2015

[100 Million Stars in the Andromeda galaxy.](#)

June 27, 2015
Ramadhan 10, 1436
Volume 5, Issue 26

Astronomy & Physics News

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

Inside
this
issue:

*How frequency combs have enhanced
fundamental science research* 1

*High-Tc superconductivity found
under high pressure* 1

*Physicists observe magnetic 'devil's
staircase'* 2

*World's first full-color, flexible, skin
-like display developed* 2

*The quantum spin Hall effect is a
fundamental property of light* 2

*Mars crater wetter than thought, had
water tracks in the last million years* 3

*How the brightest lights in the uni-
verse 'flicker'* 3

Hot lava flows discovered on Venus 3

*Veteran NASA Spacecraft Nears
60,000th Lap Around Mars, No
Pit Stops* 4

*Researchers create transparent,
stretchable conductors using nano-
accordion structure* 4

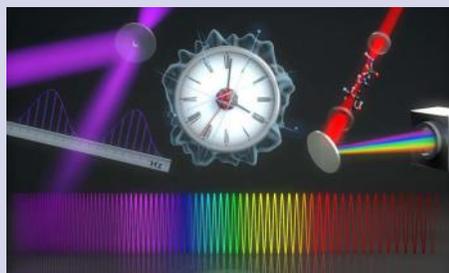
*Renewable energy from evaporating
water* 4

How frequency combs have enhanced fundamental science research

It almost sounds like a riddle: What tool has transformed basic scientific research and led to new technologies in so many different fields—timekeeping, medical research, communications, remote sensing, astronomy, just to name a few?

It is not a tool that most people have heard of, yet its impact is undeniable: laser frequency combs. These "rulers" of light very simply measure different light frequencies that are evenly spaced. The exact spacing of frequencies is key to manipulating light for various applications.

One application has dramatically improved optical atomic clocks. Another is a medical breath analyzer that can detect and measure trace amounts of simple molecules, such as hydrogen peroxide and carbon monoxide, to diagnose diseases. Laser frequency combs are also used as precision rulers to search for exoplanets outside our solar system. In the lab, experimental physicists use them to watch chemical ... [Read More...](#)



Precision rulers of light (laser frequency combs) span millions of frequencies of light, and can operate from the mid-infrared through the visible to the extreme ultraviolet. They are at the heart of new technologies such as optical atomic clocks, molecular fingerprinting and a noninvasive breath analyzer. Credit: The Ye group and Steve Burrows, JILA

High-Tc superconductivity found under high pressure

Drastic enhancement of superconducting transition temperature (T_c) can be induced by placing materials under high pressure, state Yoshihiro Kubozono and his team at Okayama University.

In previous studies, Metal-intercalated FeSe's prepared using liquid ammonia technique showed very high T_c of 30 - 45 K. With an increase in FeSe plane spacing (d), the T_c increased rapidly, showing that the increase in two-dimensionality leads to the higher T_c .

Until recently, the limit of T_c was recognized as 45 K, because of a saturation of $T_c - d$ plot. Sun et al. conducted a study during which, in the pressure-induced high- T_c superconducting phase for two metal doped

FeSe materials ($Tl_{0.6}Rb_{0.4}Fe_{1.67}Se_2$ and $K_{0.8}Fe_{1.7}Se_2$), the maximum T_c reached 48 K. However, such behavior has rarely been reported because it is extremely difficult to conduct the necessary experiments.

In a recent study, Kubozono and his team applied high-pressure to ammoniated Cs doped FeSe ($(NH_3)_yCs_{0.4}FeSe$) material. They measured the temperature dependence of resistance under pressures of between ... [Read More...](#)



Figure 1. The $(NH_3)_yCs_{0.4}FeSe$ sample prepared by liquid ammonia technique.

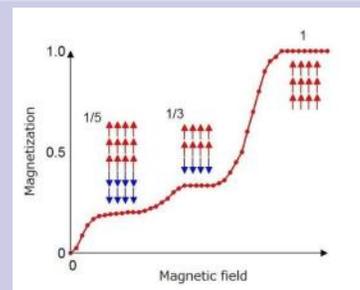
Physicists observe magnetic 'devil's staircase'

Many hiking trails feature a "devil's staircase"—a set of steps that are often steep and difficult to climb. The devil's staircase is also the name of a mathematical function whose graph exhibits a jagged step-like organization reminiscent of a real staircase, although in a highly ordered fractal pattern. Devil's staircase behavior emerges in a variety of areas, such as in crystals, phase transitions, and statistical physics.

Now in a new paper published in *Physical Review Letters*, researchers led by Hiroki Wadati, an associate professor at the University of Tokyo, have observed devil's staircase behavior in a certain magnetic material: the cobalt oxide SrCo₆O₁₁. By analyzing the microscopic behavior of this material, the

researchers found that it contains a large number of magnetic structures that have nearly "degenerate," or equal, magnetic energies. The coexistence of these many nearly degenerate magnetic structures gives rise to the devil's staircase behavior, which has the appearance of many (in principle, an infinite number of) proportional step-like structures.

Although the devil's staircase behavior emerges from microscopic effects, the behavior is also reflected in the material's macroscopic properties. One of the most intriguing properties is the material's giant magnetoresistance, which means that an applied magnetic field changes the material's electrical resistance. This property could have implications for designing artificial materials with novel functionalities...[Read More...](#)



Devil's staircase behavior emerges in the magnetic structure of a cobalt oxide material. Three magnetic phases are shown here, where the arrows represent the different spin configurations that define each phase. These phases have nearly degenerate magnetic energies, so they all coexist as stable phases, but can be easily altered by external modifications such as doping. Credit: T. Matsuda, et al. ©2015 American Physical Society

World's first full-color, flexible, skin-like display developed

Imagine a soldier who can change the color and pattern of his camouflage uniform from woodland green to desert tan at will. Or an office worker who could do the same with his necktie. Is someone at the wedding reception wearing the same dress as you? No problem - switch yours to a different color in the blink of an eye.

A breakthrough in a University of Central Florida lab has brought those scenarios closer to reality. A team led by Professor Debashis Chanda of UCF's NanoScience Technology Center and the College of Optics and Photonics (CREOL) has developed a technique for creating the world's first full-color, flexible thin-film reflective display.

Chanda's research was inspired by nature. Traditional displays like those on a mobile phone require a light source, filters and a glass plates. But animals like chameleons, octopuses and squids are born with thin, flexible, color-changing displays that don't need a light source - their skin.

"All manmade displays - LCD, LED, CRT - are rigid, brittle and bulky. But you look at an octopus, they can create color on the skin itself covering a complex body contour, and it's stretchable and flexible," Chanda said. "That was the motivation: Can we take some inspiration from biology and create a skin-like display?"...[Read More...](#)



Dr. Chanda used an iconic National Geographic photographic of an Afghan girl to demonstrate the color-changing abilities of the nanostructured reflective display developed by his team. Credit: University of Central Florida

The quantum spin Hall effect is a fundamental property of light

In a paper that crystalizes knowledge from a variety of experiments and theoretical developments, scientists from the RIKEN Center for Emergent Matter Science in Japan have demonstrated that the quantum spin Hall effect—an effect known to take place in solid state physics—is also an intrinsic property of light.

Photons have neither mass nor charge, and so behave very differently from their massive counterparts, but they do share a property, called spin, which results in remarkable geometric and topological phenomena.

The spin—a measure of the intrinsic angular momentum—can be thought of as an equivalent of the spin of a top. In the research published in *Science*, the team found that photons share with electrons a property related to spin—the quantum spin Hall effect. "We had previously done work looking at evanescent electromagnetic waves," says Konstantin Bliokh, who led the research, "and we realized the remarkable properties we found, an unusual transverse spin—was a manifestation of the fact that free-

space light exhibits an intrinsic quantum spin Hall effect, meaning that evanescent waves with opposite spins will travel in opposite directions along an interface between two media."

Evanescent waves propagate along the surface of materials, such as metals, at the interface with a vacuum, in the same way that ocean waves emerge at the interface between the air and the water, and they decay exponentially as they move away from the interface....[Read More...](#)



Credit: Petr Kratochvíl/public domain

Mars crater wetter than thought, had water tracks in the last million years

Mars is thought to have had a watery past, but when exactly it transitioned to its dry and dusty present is up for debate. Now, though, a team of scientists studying the marks on a young Martian crater has found signs that water-logged debris flowed down the Red Planet's slopes surprisingly recently - within the last million years.

The findings, described in the journal *Nature Communications*, help to fill in an increasingly complex picture on the recent Martian water cycle and have implications for the possibility of life.

The team of European scientists looked at the mid-latitude Istok crater, which has so many well-defined gullies running down its steep sides that they overlap. Given that the crater is surprisingly young - 1 million years old at most - it means that whatever falling material carved these gullies was happening in the last million years.

But was the debris dry or wet? To find out, researchers used data from the HiRISE camera on NASA's Mars Reconnaissance Orbiter to map out the gullies in three-dimensional detail and compared them with gullies carved on Earth.

They found that the debris flows likely

would have had about 20 percent to 60 percent water content in them in order to carve the tracks that they did - and they did so frequently, with sudden slides happening every 10 to 100 years, said lead author Tjalling de Haas, an earth scientist at Utrecht University. That's comparable with the rate of wet debris flows in dry areas on Earth, such as the Atacama Desert.

"It's a surprising result, but it's really solid," de Haas said. "It's just what the evidence said."

To make these tracks, the Istok crater would have to have been ...[Read More...](#)



Valles Marineris, Mars. Credit: NASA

How the brightest lights in the universe 'flicker'

Active galactic nuclei are the brightest objects in the universe. They are not lit up permanently, but rather 'flicker' extremely slowly. This insight helps ETH researchers better understand the influence these nuclei and black holes have on their host galaxy.

Supermassive black holes pull in gas with great force from their surroundings. As the gas rotates around the black hole, it becomes progressively hotter through friction and begins to radiate. This is how the brightest objects in the universe, active galactic nuclei (AGN), are formed. They often shine brighter than the hundreds of billions of stars

in their galaxy. In the center of our home galaxy, the Milky Way there is also such a black hole that, according to some studies, shone as an AGN a few millions of years ago. ETH Zurich researchers led by Professor Kevin Schawinski of the Institute for Astronomy reveal in their latest study that these AGN are not lit up permanently. Instead, they resemble a flickering lamp. In the current edition of *Monthly Notices of the Royal Astronomical Society*, ETH astronomers report for the first time that AGN 'switch on and off' every couple of hundred thousand years, a finding based on their observational data...[Read More...](#)



"Hanny's Voorwerp" (green, below) is an astronomical object that has been turned off around 200,000 year ago. Visible in the upper part is the spiral galaxy IC 2497. Credit: NASA, ESA, W. Keel, Galaxy Zoo Team

Hot lava flows discovered on Venus

ESA's Venus Express has found the best evidence yet for active volcanism on Earth's neighbour planet. Seeing the planet's surface is extremely difficult due to its thick atmosphere, but radar observations by previous missions to Venus have revealed it as a world covered in volcanoes and ancient lava flows.

Venus is almost exactly the same size as Earth and has a similar bulk composition, so is likely to have an internal heat source, perhaps due to radioactive heating. This heat has to escape somehow, and one

possibility is that it does so in the form of volcanic eruptions.

Some models of planetary evolution suggest that Venus was resurfaced in a cataclysmic flood of lava around half a billion years ago. But whether Venus is active today has remained a hot topic in planetary science. ESA's Venus Express, which completed its eight-year study of the planet last year, conducted a range of observations at different wavelengths to address this important question.

In a study published in 2010, scientists reported that the infrared

radiation coming from three volcanic regions was different to that from the surrounding terrain. They interpreted this as coming from relatively fresh lava flows that had not yet experienced significant surface weathering. These flows were found to be less than 2.5 million years old, but the study could not establish whether there is still active volcanism on the planet.

An additional piece of evidence was reported in 2012, showing a sharp rise in the sulphur dioxide content of the upper atmosphere in 2006-2007, followed by a gradual fall over the following five years. ...[Read More...](#)



Artist's impression of a volcano erupting on Venus. Whether Venus really is active today is a hot topic in planetary science. Image courtesy ESA - AOES Medialab.

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



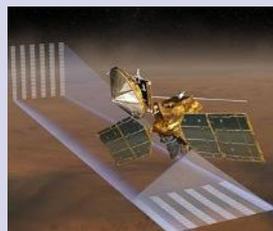
جامعة الإمارات العربية المتحدة
United Arab Emirates University

Veteran NASA Spacecraft Nears 60,000th Lap Around Mars, No Pit Stops

NASA's Mars Odyssey spacecraft has reached a major milestone on June 23, when it completed its 60,000th orbit since arriving at the Red Planet in 2001. Named after the bestselling novel "2001: A Space Odyssey" by Arthur C. Clarke, Odyssey began orbiting Mars almost 14 years ago, on Oct. 23, 2001. On Dec. 15, 2010, it became the longest-operating spacecraft ever sent to Mars, and continues to hold that record today.

Odyssey, which discovered widespread water ice just beneath the surface of the Red Planet, is still going strong today, serving as a key communications relay for NASA's Mars rovers and making continued contributions to planetary science.

"This orbital milestone is an opportunity to celebrate Odyssey's many achievements," said Jim Green, NASA's director of Planetary Science. "Odyssey will continue to help lay a foundation for the first humans to Mars in the 2030s through NASA's Journey to Mars initiative." Odyssey's major discoveries began in the early months of its two-year primary mission, with gamma-ray and neutron measurements that indicated plentiful water ice just beneath the surface at ..[Read More...](#)



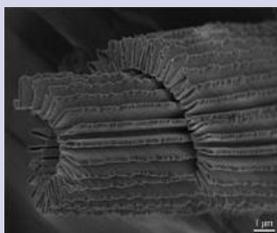
File Image.

Researchers create transparent, stretchable conductors using nano-accordion structure

Researchers from North Carolina State University have created stretchable, transparent conductors that work because of the structures' "nano-accordion" design. The conductors could be used in a wide variety of applications, such as flexible electronics, stretchable displays or wearable sensors.

"There are no conductive, transparent and stretchable materials in nature, so we had to create one," says Abhijeet Bagal, a Ph.D. student in mechanical and aerospace engineering at NC State and lead author of a paper describing the work.

"Our technique uses geometry to stretch brittle materials, which is inspired by springs that we see in everyday life," Bagal says. "The only thing different is that we made it much smaller." The researchers begin by creating a three-dimensional polymer template on a silicon substrate. The template is shaped like a series of identical, evenly spaced rectangles. The template is coated with a layer of aluminum-doped zinc oxide, which is the conducting material, and an elastic polymer is applied ...[Read More...](#)



Researchers from North Carolina State University have created stretchable, transparent conductors that work because of the structures' "nano-accordion" design. The material is shown here, rolled up to highlight its flexibility. Image courtesy Abhijeet Bagal.

Renewable energy from evaporating water

An immensely powerful yet invisible force pulls water from the earth to the top of the tallest redwood and delivers snow to the tops of the Himalayas. Yet despite the power of evaporating water, its potential to propel self-sufficient devices or produce electricity has remained largely untapped - until now.

In the online issue of Nature Communications, Columbia University scientists report the development of two novel devices that derive power directly from evaporation - a floating, piston-driven engine that generates electricity causing a light to flash, and a rotary engine that drives a miniature car.

When evaporation energy is scaled up, the researchers predict, it could one day produce electricity from giant floating power generators that sit on bays or reservoirs, or from huge rotating machines akin to wind turbines that sit above water ...[Read More...](#)



Eva, the first evaporation-powered car, rolls along, thanks to a moisture mill - a turbine engine driven by water evaporating from wet paper strips lining its walls. Eva is one of the many devices created to harness evaporation energy. Image courtesy Sabina Laboratory, Columbia University.