June 04, 2016 | Shaaban 28, 1437 | Volume 6, Issue 23

Astronomy & Physics Weekly News

Dept. of Applied Physics & Astronomy - **University of Sharjah**
Compiled by **Dr. Ilias Fernini**

مركز الشارقة لعلوم الفضاء والفلك
Sharjah Center for Astronomy & Space Sciences

Top News

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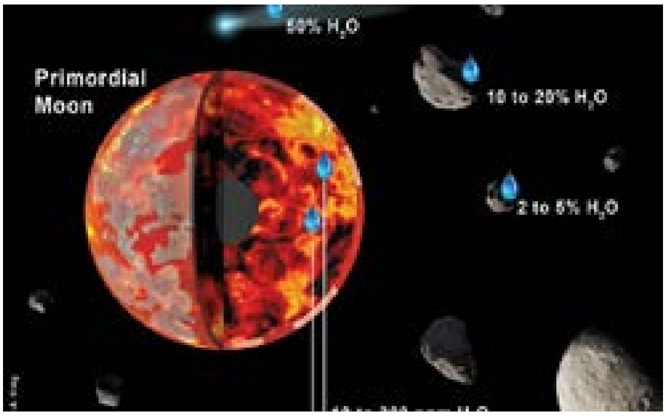


New research finds that asteroids delivered as much 80 percent of the Moon's water. Credit: LPI/David A. Kring

Scientists Identify the Source of the Moon's Water

Over the course of the past few decades, our ongoing exploration the Solar System has revealed some surprising discoveries. For example, while we have yet to find life beyond our planet, we have discovered that the elements necessary for life (i.e organic molecules, volatile elements, and water) are a lot more plentiful than previously thought. In the 1960's, it was theorized that water ice could exist on the Moon; and by the next decade, sample return missions and probes were confirming this.

Since that time, a great deal more water has been discovered, which has led to a debate within the scientific community as to where it all came from. Was it the result of in-situ production, or was it delivered to the surface by water-bearing comets, asteroids and meteorites? According to a recent study produced by a team of scientists from the UK, US and France, the majority of the Moon's water appears to have come from meteorites that delivered water to Earth and the Moon billions of years ago.

For the sake of their study, which appeared recently in Nature Communications, the international research team examined the samples of lunar rock and soil that were returned by the Apollo missions. When these samples were originally examined upon their return to Earth, it was assumed that the trace of amounts of water they contained were the result of contamination from Earth's atmosphere since the containers in which the Moon rocks were brought home weren't airtight. The Moon, it was widely believed, was bone dry. ...Read More...

Just what sustains Earth's magnetic field anyway?

Earth's magnetic field shields us from deadly cosmic radiation, and without it, life as we know it could not exist here. The motion of liquid iron in the planet's outer core, a phenomenon called a "geodynamo," generates the field. But how it was first created and then sustained throughout Earth's history has remained a mystery to scientists. New work published in Nature from a team led by Carnegie's Alexander Goncharov sheds light on the history of this incredibly important geologic occurrence.

Our planet accreted from rocky material that surrounded our Sun in its youth, and over time the most-dense stuff, iron, sank inward, creating the layers that we know exist today—core, mantle, and crust. Currently, the inner core is solid iron, with some other materials that were dragged along down during this layering process. The outer core is a liquid iron alloy, and its motion gives rise to the magnetic field.

A better understanding of how heat is conducted by the solid of the inner core and the liquid in the outer core is needed to piece together the processes by which our planet, and our magnetic field, evolved—and, even more importantly, the energy that sustains a continuous magnetic field. But these materials ...Read More...

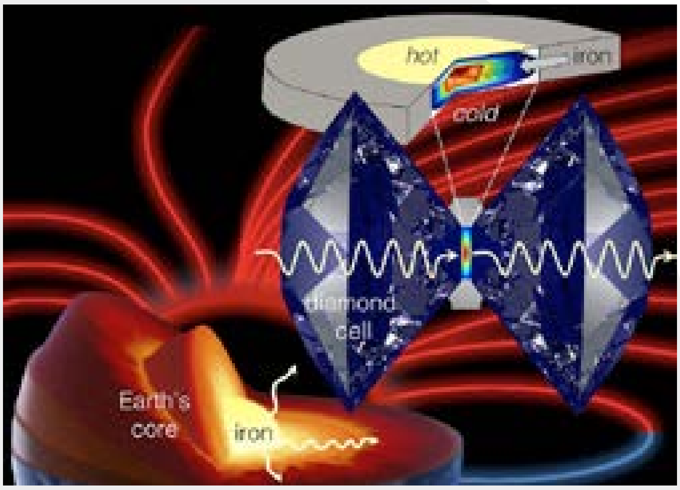
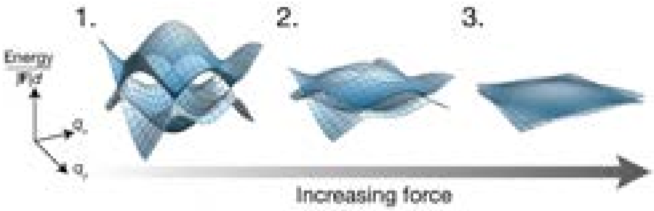


Illustration of how the diamond anvil cell is used to mimic and study planetary core conditions. Credit: Stewart McWilliams

Collapsing energy bands to explore their geometric structure

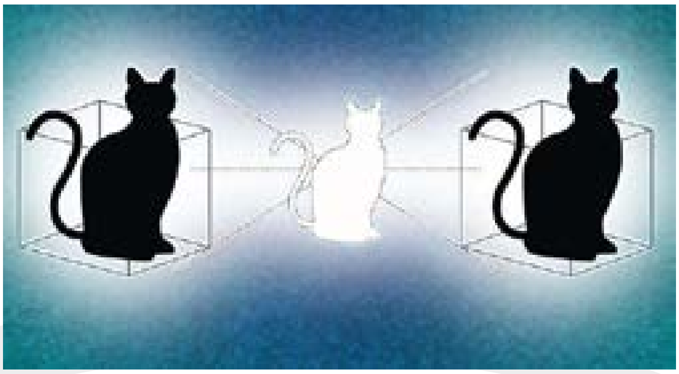


An artist's embellishment of an image of the "gain medium" used to produce terahertz frequency combs. The different colors indicate that different wavelengths of oscillating terahertz radiation travel different distances through the medium, which has a different refractive index for each of them. Credit: Yan Liang/ L2Molecule.com

The geometry and topology of electronic states in solids plays a central role in a wide range of modern condensed-matter systems including graphene or topological insulators. However, experimentally accessing this information has proven to be challenging, especially when the bands are not well-isolated from one another. As reported in last week's issue of Science, an international team of researchers has devised a straightforward method to probe the band geometry using ultracold atoms in an optical lattice. Their method, which combines the controlled steering of atoms through the energy bands with atom interferometry, is an important step in the endeavor to investigate geometric and topological phenomena in synthetic band structures.

A wide array of fundamental phenomena in condensed matter physics, such as why some materials are insulators while others are metals, can be understood simply by examining the energies of the material's constituent electrons. Indeed, band theory, which describes these electron energies, was one of the earliest triumphs of quantum mechanics and has driven much of the technological advances of our time, from the computer chips in our laptops to the liquid-crystal displays on our smartphones. We now know, however, that traditional band theory is incomplete. Among the most surprising and fruitful developments in modern condensed matter physics was the realization that there is more than the energies—rather, the geometric structure of the bands also plays an ...Read More...

Doubling down on Schrödinger's cat



Yale physicists have given Schrödinger's cat a second box to play in. Credit: Michael S. Helfenbein/Yale University

Yale physicists have given Schrödinger's famous cat a second box to play in, and the result may help further the quest for reliable quantum computing.

Schrödinger's cat is a well-known paradox that applies the concept of superposition in quantum physics to objects encountered in everyday life. The idea is that a cat is placed in a sealed box with a radioactive source and a poison that will be triggered if an atom of the radioactive substance decays. Quantum physics suggests that the cat is both alive and dead (a superposition of states), until someone opens the box and, in doing so, changes the quantum state.

This hypothetical experiment, envisioned by one of the founding fathers of quantum mechanics in 1935, has found vivid analogies in laboratories in recent years. Scientists can now place a wave-packet of light composed of hundreds of particles simultaneously in two distinctly different states. Each state corresponds to an ordinary (classical) form of light abundant in nature.

A team of Yale scientists created a more exotic type of Schrödinger's cat-like state that has been proposed for experiments for more than 20 years. This cat lives or dies in two boxes at once, which is a marriage of the idea of Schrödinger's cat and another central concept of quantum physics: entanglement. ...Read More...

Loop quantum gravity theory offers glimpse beyond the event horizon

File Image

In principle, nothing that enters a black hole can leave the black hole. This has considerably complicated the study of these mysterious bodies, which generations of physicists have debated since 1916, when their existence was hypothesized as a direct consequence of Einstein's Theory of Relativity. There is, however, some consensus in the scientific community regarding black hole entropy—a measure of the inner disorder of a physical system—because its absence would violate the second law of thermodynamics. In particular, Jacob Bekenstein and Stephen Hawking have suggested that the entropy of a black hole is proportional to its area, rather than its volume, as would be more intuitive. This assumption also gives rise to the "holography" hypothesis of black holes, which (very roughly) suggests that what appears to be three-dimensional might, in fact, be an image projected onto a distant two-dimensional cosmic horizon, just like a hologram, which, despite being a two-dimensional image, appears to be three-dimensional.

As we cannot see beyond the event horizon (the outer boundary of the back hole), the internal microstates that define its entropy are inaccessible. So how is it possible t ...Read More...

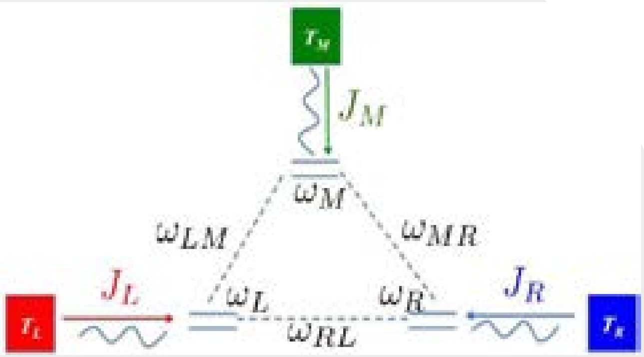
Quantum thermal transistor can control heat currents

Researchers have designed a quantum thermal transistor that can control heat currents, in analogy to the way in which an electronic transistor controls electric current. The thermal transistor could be used in applications that recycle waste heat that has been harvested from power stations and other energy systems. Currently, there are methods for transporting and guiding this heat, but not for controlling, amplifying, and switching the heat on and off, as the quantum thermal transistor can do.

The researchers, Karl Joulain et al., at the University of Poitiers and CNRS in France, have published a paper on the quantum thermal transistor in a recent issue of Physical Review Letters.

"To manage electricity, one uses electronic diodes, transistor and amplifiers," Joulain told Phys.org. "We would like to do the same thing with thermal currents. We would like to make logical thermal circuits in the same way electronic thermal circuits have been designed. In this way, wasted heat could be guided, switched on or off, amplified or modulated."

Although this is not the first thermal transistor, it is the first that is made of quantum...Read More....



The quantum thermal transistor consists of three two-level systems, which can be implemented as spins with an up and a down state. Any one of these systems can control the heat current that flows to the other two, resulting in switching their spins. Credit: Joulain et al. ©2016 American Physical Society

Meta-lens sees smaller than a wavelength of light

Light passing through the metalens is focused by the array of nanostructures on its surface. Image courtesy Capasso Lab/ Harvard John A. Paulson School of Engineering and Applied Sciences.

Curved lenses, like those in cameras or telescopes, are stacked in order to reduce distortions and resolve a clear image. That's why high-power microscopes are so big and telephoto lenses so long. While lens technology has come a long way, it is still difficult to make a compact and thin lens (rub a finger over the back of a cellphone and you'll get a sense of how difficult). But what if you could replace those stacks with a single flat - or planar - lens?

Researchers from the Harvard John A. Paulson School of Engineering and Applied Sciences (SEAS) have demonstrated the first planar lens that works with high efficiency within the visible spectrum of light - covering the whole range of colors from red to blue. The lens can resolve nanoscale features separated by distances smaller than the wavelength of light. It uses an ultrathin array of tiny waveguides, known as a metasurface, which bends light as it passes through, similar to a curved lens.

The research is described in the journal Science.

"This technology is potentially revolutionary because it works in the visible spectrum, which means it has the capacity to replace lenses in all kinds of devices, from microscopes to camera, to displays and cell phones," said Federico Capasso, Robert L. Wallace Professor of Applied Physics and Vinton Hayes Senior Research Fellow in Electrical Engineering and senior ...Read More...

Elliptical galaxies not formed by merging

File Image.

It all starts from a problem with dust: galaxies with the highest rates of star formation are also the "dustiest", because the violent process of star formation produces gas and heavy molecules.

This means that part of the electromagnetic radiation emitted by nascent stars cannot be recorded by the instruments for astronomical observation in the optical and the ultraviolet band, as it is absorbed by dust and gas and re-emitted in the infrared.

On top of this, owing to instrument limitations it is even difficult to observe this infrared radiation in the case of very distant, older galaxies. All this complicates things for astrophysicists investigating stellar and galaxy formation, and all studies to date have mostly proposed predictions based on purely theoretical models.

Claudia Mancuso, PhD student under the supervision of Andrea Lapi and Luigi Danese, SISSA professors in the astrophysics group and co-authors of the study, did the opposite: "we started from the data, available in complete form only for the closer galaxies and in incomplete form for the more distant ones, and we filled the 'gaps' by interpreting and extending the data based on a scenario we devised" comments ...Read More...

Solar telescope on track for ground-breaking observations

"DKIST's resolution and sensitivity will permit us to directly and precisely measure the magnetic fields in the solar atmosphere for the very first time," said Rimmele.

Construction of the Daniel K. Inouye Solar Telescope is on schedule for operations in 2020, say reports from the American Astronomical Society's Solar Physics Division conference. It will be the highest-resolution solar telescope in the world.

The Daniel K. Inouye Solar Telescope (DKIST) is under development on Haleakala - the highest peak on the Hawaiian island of Maui. The National Science Foundation (NSF) is funding the facility, which is under development by the National Solar Observatory (NSO) based in Boulder, Colorado. NSO is hosting the Solar Physics Division conference.

DKIST Project Manager Dr. Joseph McMullin provided the latest updates: "The external building has been completed, with the integration of major telescope systems under way. This includes the telescope mount assembly and the rotating instrument laboratory.

The optical systems will be coming on board soon." He also clarified the state of the primary mirror - the most critical element of the telescope: "It has been successfully polished to state-of-the-art specifications at the University of Arizona." ...Read More...

Tutankhamun's Meteorite Blade

The Egyptian Pyramids; instantly recognizable to almost anyone. Image: Armstrong White, CC BY 2.0

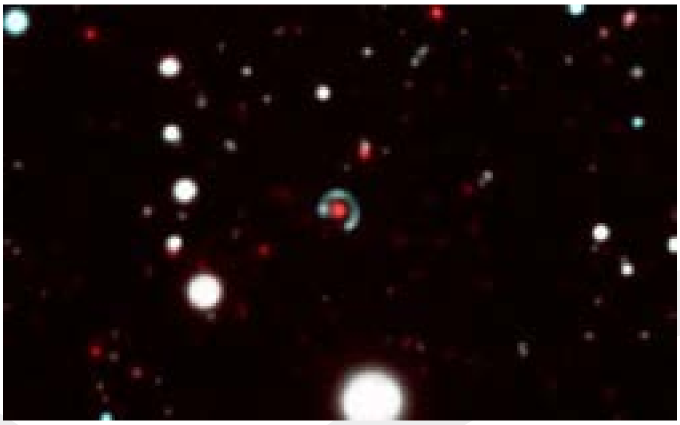
The spread of metallurgy in different civilizations is a keen point of interest for historians and archaeologists. It helps chart the rise and fall of different cultures. There are even names for the different ages corresponding to increasingly sophisticated metallurgical technologies: the Stone Age, the Bronze Age, and the Iron Age.

But sometimes, a piece of evidence surfaces that doesn't fit our understanding of a civilization.

Probably the most iconic ancient civilization in all of history is ancient Egypt. Its pyramids are instantly recognizable to almost anyone. When King Tutankhamun's almost intact tomb was discovered in 1922, it was a treasure trove of artifacts. And though the tomb, and King Tut, are most well-known for the golden death mask, it's another, little-known artifact that has perhaps the most intriguing story: King Tut's iron dagger.

King Tut's iron-bladed dagger wasn't discovered until 1925, three years after the tomb was discovered. It was hidden in the wrappings surrounding Tut's mummy. It's mere existence was a puzzle, because King Tut reigned in 1332–1323 BC, 600 years before the Egyptians developed iron smelting technology. ...Read More...

New 'Einstein Ring' Discovered By Dark Energy Camera



The "Canarias Einstein Ring." The green-blue ring is the source galaxy, the red one in the middle is the lens galaxy. The lens galaxy has such strong gravity, that it distorts the light from the source galaxy into a ring. Because the two galaxies are aligned, the source galaxy appears almost circular. Image: This composite image is made up from several images taken with the DECam camera on the Blanco 4m telescope at the Cerro Tololo Observatory in Chile.

A rare object called an Einstein Ring has been discovered by a team in the Stellar Populations group at the Instituto de Astrofísica de Canarias (IAC) in Spain. An Einstein Ring is a specific type of gravitational lensing.

Einstein's Theory of General Relativity predicted the phenomena of gravitational lensing. Gravitational lensing tells us that instead of travelling in a straight line, light from a source can be bent by a massive object, like a black hole or a galaxy, which itself bends space time.

Einstein's General Relativity was published in 1915, but a few years before that, in 1912, Einstein predicted the bending of light. Russian physicist Orest Chwolson was the first to mention the ring effect in scientific literature in 1924, which is why the rings are also called Einstein-Chwolson rings.

ravitational lensing is fairly well-known, and many gravitational lenses have been observed. Einstein rings are rarer, because the observer, source, and lens all have to ....Read More...

Measuring the Milky Way: 1 massive problem, 1 new solution

Measuring the mass of our home galaxy, or any galaxy, is particularly difficult. A galaxy includes not only stars, planets, moons, gases, dust and other objects and material, but also a big helping of dark matter, a mysterious and invisible form of matter that is not yet fully understood and has not been directly detected in the lab. Astronomers and cosmologists, however, can infer the presence of dark matter through its gravitational influence on visible objects.

It is a galactic challenge, to be sure, but Gwendolyn Eadie is getting closer to an accurate answer to a question that has defined her early career in astrophysics: what is the mass of the Milky Way?

The short answer, so far, is 7 X 1011 solar masses. In terms that are easier to comprehend, that's about the mass of our Sun, multiplied by 700 billion. The Sun, for the record, has a mass of two nonillion (that's 2 followed by 30 zeroes) kilograms, or 330,000 times the mass of Earth. "And our galaxy isn't even the biggest galaxy," Eadie says.

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مـركـز الشـارقـة لعـلـوم الفضـاء والفـلـك
Sharjah Center for Astronomy & Space Sciences
Sharjah Center for Astronomy and Space Sciences
Sharjah, United Arab Emirates
Phone: 00-971-6-5166000
Website: www.scass.ae
E-mail: planetarium@scass.ae

جامعة الشارقة
UNIVERSITY OF SHARJAH
College of Sciences - University of Sharjah
POB 27272 - Sharjah, United Arab Emirates
Phone: 00-971-6-5050351
Email: physics@sharjah.ac.ae