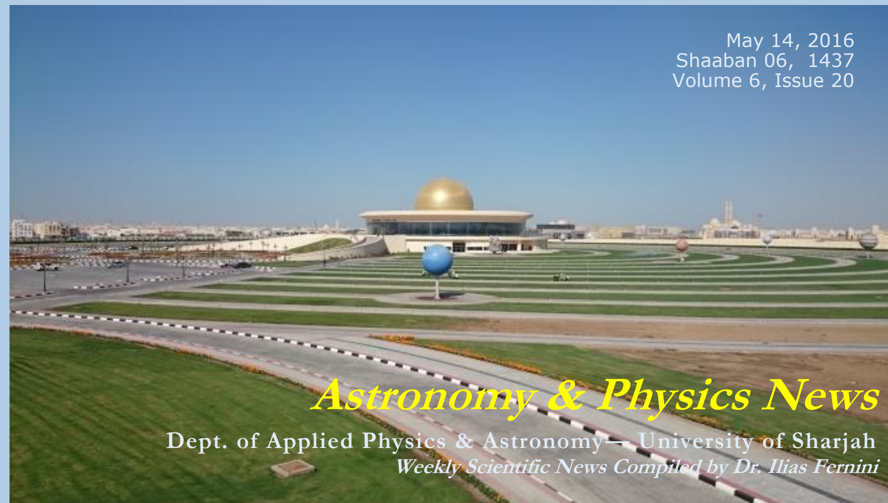


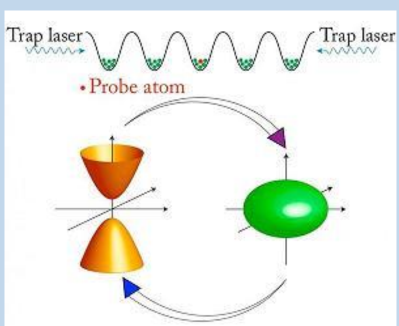
جامعة الشارقة
UNIVERSITY OF SHARJAH

Inside this issue:

Scientists take a major leap toward a 'perfect' quantum metamaterial

Scientists have devised a way to build a "quantum metamaterial" - an engineered material with exotic properties not found in nature - using ultracold atoms trapped in an artificial crystal composed of light. The theoretical work represents a step toward manipulating atoms to transmit information, perform complex simulations or function as powerful sensors.

The research team, led by scientists at the Department of Energy's Lawrence Berkeley National Laboratory (Berkeley Lab) and UC Berkeley, proposes the use of an accordion-like atomic framework, or "lattice" structure, made with laser light to trap atoms in regularly spaced nanoscale pockets. Such a light-based structure, which has patterned features that in some ways resemble those of a crystal, is essentially a "perfect" structure - free of the typical defects found in natural materials. ...Read More...



The wavelike pattern at the top shows the accordion-like structure of a proposed quantum material - an artificial crystal made of light - that can trap atoms in regularly spaced nanoscale pockets. These pockets can be made to hold a large collection of ultracold 'host' atoms (green), slowed to a standstill by laser light, and individually planted "probe" atoms (red) that can be made to transmit quantum information in the form of a photon (particle of light). The lower panel shows how the artificial crystal can be reconfigured with light from an open (hyperbolic) geometry to a closed (elliptical) geometry, which greatly affects the speed at which the probe atom can release a photon. Image courtesy Pankaj K. Jha/UC Berkeley.

NASA's Kepler Mission Announces Largest Collection of Planets Ever Discovered

NASA's Kepler mission has verified 1,284 new planets – the single largest finding of planets to date.

"This announcement more than doubles the number of confirmed planets from Kepler," said Ellen Stofan, chief scientist at NASA Headquarters in Washington. "This gives us hope that somewhere out there, around a star much like ours, we can eventually discover another Earth."

Analysis was performed on the Kepler space telescope's July 2015 planet candidate catalog, which identified 4,302 potential planets. For 1,284 of the candidates, the probability of being a planet is greater than 99 percent – the minimum required to earn the status of "planet." An additional 1,327 candidates are more likely than not to be actual planets, but they do not meet the 99 percent threshold and will require additional study. The remaining 707 are more likely to be some other astrophysical phenomena. This analysis also validated 984 candidates previously verified by other techniques.

"Before the Kepler space telescope launched, we did not know whether exoplanets were rare or common in the galaxy. ...Read More...

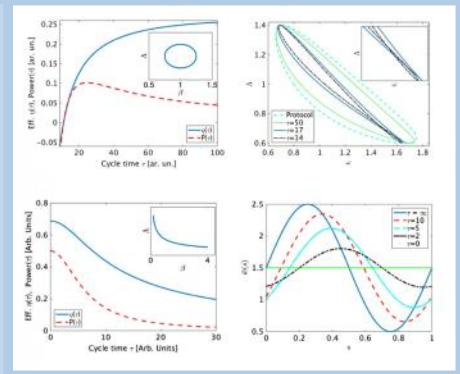
This artist's concept depicts select planetary discoveries made to date by NASA's Kepler space telescope.

Credits: NASA/W. Stenzel

Geometric heat engine simultaneously maximizes both power and efficiency

As its name suggests, a heat engine converts heat into mechanical energy that can be used to do work—for example, to power a car. Heat engines can operate either in a steady state (where heat is constantly being supplied) or in a cyclic state (where heat is added only during parts of the cycle). Over the past several years, researchers have discovered that steady state heat engines are inherently limited by a power-efficiency trade-off, meaning that their power and efficiency cannot be maximized simultaneously. Although it's not clear if the same is true for cyclic heat engines, some studies have seemed to suggest this to be the case, since operating certain models of cyclic heat engines at slower rates leads to a decrease in power but an increase in efficiency, and vice versa.

Now in a new paper published in Physical Review Letters, Oren Raz and Yigit Subasi from the University of Maryland and Rami Pugatch from the Institute for Advanced Study at Princeton have shown that certain cyclic heat engines do not suffer from a trade-off between power and efficiency like steady state heat engines do. To demonstrate, they designed a cyclic heat engine that can attain both its maximum power and maximum efficiency at the same time. However, the researchers also showed that cyclic heat engines still have their limits, since it is not possible to design a heat engine that achieves the highest possible theoretical efficiency—the Carnot limit—while producing nonzero power. This limitation is expected, as such a protocol would violate the second law of thermodynamics...Read More..



(Top left) In a typical cyclic heat engine protocol, the power and efficiency rapidly decrease at high driving rates (when the cycle time drops below about 20). (Top right) The decrease, and resulting negative power, can be explained geometrically as the engine trajectory forming ...

Quantum dot replaces metallic 'island' to improve electronic turnstile

A team of researchers with members from France, Russia and Finland has improved on the current design of an electronic turnstile, by replacing the conventional metallic "island" with a quantum dot. In their paper published in Physical Review Letters, the team describes how the design works, why it is better than the conventional approach and how much the error rate was reduced.

Scientists have for some time had a goal of being able to control electric current down to the single electron level, doing so would allow for the development of a whole host of new types of nanoelectronic devices, super small optics and perhaps other types of quantum technologies. Currently, the best approach to achieving this goal is through use of an electronic turnstile—one that only lets one electron through at a time. It is generally created by sandwiching a metallic region between superconducting materials—electrons are then forced to tunnel their way through. Such tunneling is controlled by varying the voltage that arrives via one of the superconducting leads, then out via the second superconducting lead. And while this method has proven to be useful, it does not meet the overall objective, because sometimes an inadvertent electron can sneak through, causing errors. In this new effort, the researchers have replaced the metallic bit with a quantum dot (a semiconducting nanoparticle) to reduce such errors. The thinking was that the dot would be much smaller, allowing only those electrons through that ...Read More...

Credit: David van Zanen/CNRS, via Physics

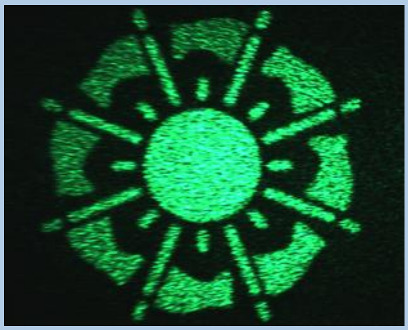
Nanotechnology improves holographic capabilities by encoding light polarization

Holograms are a ubiquitous part of our lives. They are in our wallets—protecting credit cards, cash and driver's licenses from fraud—in grocery store scanners and biomedical devices.

Even though holographic technology has been around for decades, researchers still struggle to make compact holograms more efficient, complex and secure.

Researchers at the Harvard John A. Paulson School of Engineering and Applied Sciences have programmed polarization into compact holograms. These holograms use nanostructures that are sensitive to polarization (the direction in which light vibrates) to produce different images depending on the polarization of incident light. This advancement, which works across the spectrum of light, may improvement anti-fraud holograms as well as those used in entertainment displays.

The research is described in Science Advances. "The novelty in this research is that by using nanotechnology, we've made holograms that are highly efficient, meaning that very little light is lost to create the image," said Federico Capasso, the Robert L. Wallace Professor of Applied Physics and Vinton Hayes Senior Research Fellow in Electrical Engineering and senior author of the paper. "By using incident polarized light, you can see far a crisper image and can store and ...Read More...



New hologram produces 3-D images across different spectrums of light. Credit: Capasso Lab

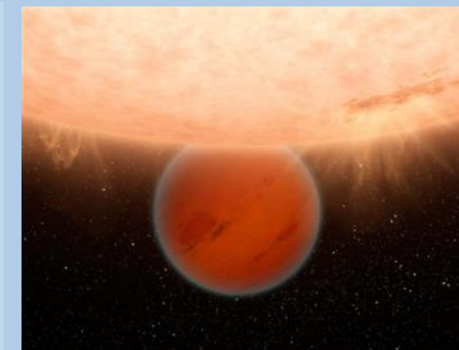
Tightly packed four-planet system formed by planet migration

How did our solar system reach its current configuration? One of the leading candidates to explain things like the sparseness of the Asteroid Belt and the small size of Mars is the grand tack, in which Jupiter originally migrated inward toward the Sun until its interactions with Saturn pulled them both back outward.

The idea that giant planets may go for a wander around their star's orbital neighborhood has picked up some support from many of the exosolar systems we've discovered. We've spotted tightly packed systems of large planets when there probably wasn't enough material in the region to form all of them, suggesting that they formed somewhere else and then migrated into place.

But this idea raises some questions. What stops the planets from their wanderings, keeps them from smashing into each other, and prevents them from falling into their host star? A phenomenon known as orbital resonance may be the answer, and researchers argue that it explains the presence of four exoplanets all with orbits of less than 20 days.

The exosolar system is named Kepler-223 and has been known about for some time. But it has been a bit difficult to study given that the signals of the transiting planets are difficult to pick out from the fluctuations of its host star (which is 6 billion years old and Sun-like). Nevertheless, enough Kepler data is available for their signals to clearly stand out from the noise. The planets have orbital periods ...Read More...



Artist's conception of a hot Neptune orbiting close to its host star. Kepler-223 has four such planets, all with orbital periods of less than 20 days. By contrast, Mercury's orbit takes 88 days. NASA/JPL-Caltech

Flying observatory detects atomic oxygen in Martian atmosphere

An instrument onboard the Stratospheric Observatory for Infrared Astronomy (SOFIA) detected atomic oxygen in the atmosphere of Mars for the first time in 40 years. These atoms were found in the upper layers of the martian atmosphere known as the mesosphere.

Atomic oxygen affects how other gases escape Mars and therefore has a significant impact on the planet's atmosphere. Scientists detected only about half the amount of oxygen expected, which may be due to variations in the martian atmosphere. Scientists will continue to use SOFIA to study these variations to help better understand the atmosphere of the Red Planet.

"Atomic oxygen in the martian atmosphere is notoriously difficult to measure," said Pamela Marcum, SOFIA project scientist. "To observe the far-infrared wavelengths needed to detect atomic oxygen, researchers must be above the majority of Earth's atmosphere and use highly sensitive instruments, in this case a spectrometer. SOFIA provides both capabilities." The Viking and Mariner missions of the 1970s made the last measurements of atomic oxygen in the martian atmosphere. These more ...Read More...

SOFIA/GREAT spectrum of oxygen [O I] superimposed on an image of Mars from the MAVEN mission. The amount of atomic oxygen computed from this SOFIA data is about half the amount expected. SOFIA/GREAT spectrum: NASA/DLR/USRA/ DSI/MPIfR/GREAT Consortium/ MPIfS/Rezac et al. 2015. Mars image: NASA/MAVEN (Mars Atmosphere and Volatile Evolution Mission)

Is Earth's Magnetic Field Ready to Flip?

Although invisible to the eye, Earth's magnetic field plays a huge role in both keeping us safe from the ever-present solar and cosmic winds while making possible the opportunity to witness incredible displays of the northern lights. Like a giant bar magnet, if you could sprinkle iron filings around the entire Earth, the particles would align to reveal the nested arcs of our magnetic domain. The same field makes your compass needle align north to south.

We can picture our magnetic domain as a huge bubble, protecting us from cosmic radiation and electrically charged atomic particles that bombard Earth in solar winds. Satellites and instruments on the ground keep a constant watch over this bubble of magnetic energy surrounding our planet. For good reason: it's always changing.

The European Space Agency's Swarm satellite trio, launched at the end of 2013, has been busy measuring and untangling the different magnetic signals from Earth's core, mantle, crust, oceans, ionosphere (upper atmosphere where the aurora occurs) and magnetosphere, the name given to the region of space dominated by Earth's magnetic field.

At this week's Living Planet Symposium in Prague, Czech Republic, new results from the constellation of Swarm satellites show where our protective field is weakening and strengthening, and how fast these changes are taking place.

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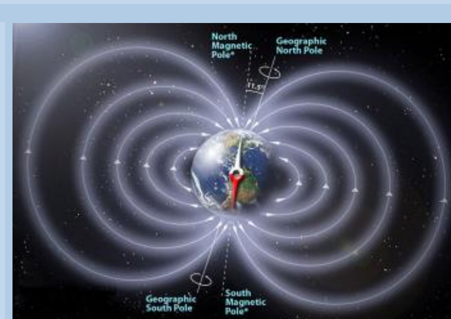


Illustration of the invisible magnetic field lines generated by the Earth. Unlike a classic bar magnet, the matter governing Earth's magnetic field moves around. The flow of liquid iron in Earth's core creates electric currents, which in turn creates the magnetic field. Credit and copyright: Peter Reid, University of Edinburgh.

Dept. of Applied Physics & Astronomy

College of Sciences - University of Sharjah
POB 27272 - Sharjah
United Arab Emirates
Phone: *00-971-6-5050351*
Email: *physics@sharjah.ac.ae*

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*

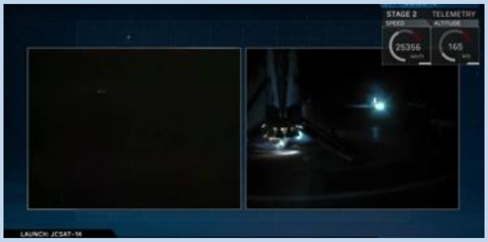
SpaceX pulled off its hardest sea landing yet

SpaceX had its second successful at-sea return of a first stage rocket last night, bringing a Falcon 9 back down from orbit. But the feat was even harder than last month's successful return: the rocket came down at 4,400 miles per hour.

Those speeds owed to the demanding launch. SpaceX carried a television communications satellite, JCSAT-14, to geostationary orbit aboard a Falcon 9. Earlier this week, the company remarked that it wasn't sure they'd be able to pull off the landing due to the high speeds. The rocket, at one point, traveled 37,000 miles per hour to get to that high orbit.

SpaceX is just one of many companies working on reusable vehicles. Blue Origin, which has tried to keep up a competition, has recently returned a suborbital rocket a few times. And Sierra Nevada has a small-scale space shuttle called the Dreamchaser which launches on a rocket but lands on a runway. It will begin making uncrewed ISS resupplies in 2019, and may move up eventually to crewed missions.

It may seem an odd fit to discuss the SpaceX landing in Astronomy, but reusable launch vehicles could potentially drive ...Read More...



Click on the image to see a video of the vertical landing.

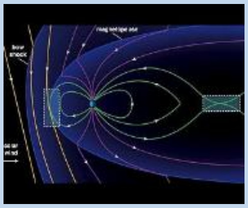
Memories of May 09, 2016: Mercury Transit—SCASS Observatory

Spacecraft fly through magnetic phenomenon to understand space weather

For the first time, spacecraft have flown through the heart of a magnetic process that controls Earth's space weather and geomagnetic storms. The Earth is surrounded by a magnetic bubble, called the magnetosphere, which protects us from harmful radiation from space. The magnetosphere is defined by magnetic field lines, stretching out into space from the Earth.

When these lines come up against field lines in different orientations - for example from the Sun - a process called magnetic reconnection occurs. Magnetic reconnection is when the field lines clash and rearrange themselves in an explosive reaction. The process throws out hot jets of particles, allowing them to cross boundaries normally created by the field lines.

In the Earth system, this process plays the key role in causing geomagnetic storms that can disrupt communications systems on the surface and satellites in space. It also leads to the creation of the auroras in the northern and southern hemispheres. At the heart of magnetic reconnection is an extremely fast reaction ..Read More...



This is a sketch of the Earth's magnetosphere showing where reconnection occurs between oppositely-directed magnetic fields. This material relates to a paper that appeared in the May 13, 2016, issue of Science, published by AAAS. The paper, by J.L. Burch at Southwest Research Institute in San Antonio, TX, and colleagues was titled, "Electron-scale measurements of magnetic reconnection in space." Image courtesy James Burch.