INTERNATIONAL YEAR OF LIGHT 2015

100 Million Stars in the Andromeda galaxy.

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Inside this issue:

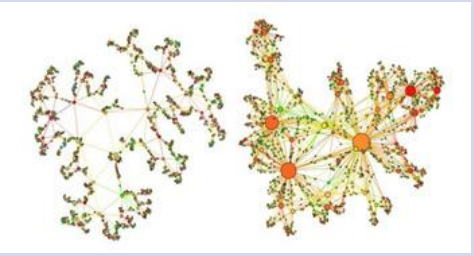
Understanding of complex networks could help unify gravity, quantum mechanics

Mathematicians investigating one of science's great questions—how to unite the physics of the very big with that of the very small—have discovered that when the understanding of complex networks such as the brain or the Internet is applied to geometry the results match up with quantum behavior.

The findings, published in Scientific Reports, by researchers from Queen Mary Univ. of London and Karlsruhe Institute of Technology, could explain one of the great problems in modern physics.

Currently ideas of gravity, developed by Einstein and Newton, explain how physics operates on a very large scale, but do not work at the subatomic level. Conversely, quantum mechanics works on the very small scale but does not explain the interactions of larger objects like stars. Scientists are looking for a so called "grand unified theory" that joins the two, known as quantum gravity.

Several models have been proposed for how different quantum spaces are linked but most assume that the links between quantum spaces are fairly uniform, with little deviation from the average number of links between ...Read More...



An image illustrating the different dimensions of Complex Quantum Network Manifolds. Annotations in other image. Image: QMUL

NASA Telescopes Find Galaxy Cluster with Vibrant Heart

Astronomers have discovered a rare beast of a galaxy cluster whose heart is bursting with new stars. The unexpected find, made with the help of NASA's Spitzer and Hubble space telescopes, suggests that behemoth galaxies at the cores of these massive clusters can grow significantly by feeding off gas stolen from another galaxy.

"Usually, the stars at the centers of galaxy clusters are old and dead, essentially fossils," said Tracy Webb of McGill University, Montreal, Canada, lead author of a new paper on the findings accepted for publication in the Astrophysical Journal. "But we think the giant galaxy at the center of this cluster is furiously making new stars after merging with a smaller galaxy."

Galaxy clusters are vast families of galaxies bound and grouped by the ties of gravity. Our own Milky Way resides in a small galaxy group, called the Local Group, which itself is on the periphery of the vast Laniakea supercluster of 100,000 galaxies. (Laniakea is Hawaiian for "immeasurable heaven.")

The cluster in the new study, referred to by astronomers as SpARCS1049+56, has at least 27 galaxy members, and a combined mass equal to nearly 400 trillion suns. ...Read More...

A massive cluster of galaxies, called SpARCS1049+56, can be seen in this multi-wavelength view from NASA's Hubble and Spitzer space telescopes. Image credit: NASA/STScI/ESA/JPL-Caltech/McGill

Physicists create exotic states that could lead to new kinds of sensors and optical devices

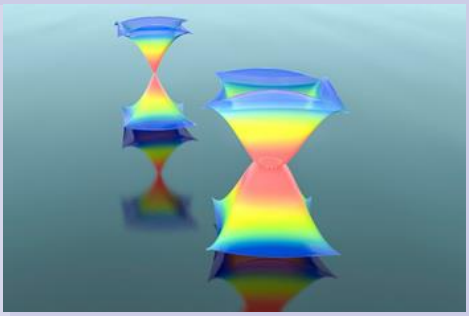
The Dirac cone, named after British physicist Paul Dirac, started as a concept in particle and high-energy physics and has recently became important in research in condensed matter physics and material science. It has since been found to describe aspects of graphene, a 2-D form of carbon, suggesting the possibility of applications across various fields.

Now physicists at Massachusetts Institute of Technology (MIT) have found another unusual phenomenon produced by the Dirac cone: It can spawn a phenomenon described as a "ring of exceptional points." This connects two fields of research in physics and may have applications in building powerful lasers, precise optical sensors, and other devices.

The results are published in Nature by MIT postdoc Bo Zhen, Yale Univ. postdoc Chia Wei Hsu, MIT physics professors Marin Soljačić and John Joannopoulos, and five others.

This work represents "the first experimental demonstration of a ring of exceptional points," Zhen says, and is the first study that relates research in exceptional points with the physical concepts of parity-time symmetry and Dirac cones.

Individual exceptional points are a peculiar phenomenon unique to an unusual class of physical systems that can lead to counterintuitive phenomena. For example, around these points, opaque materials may seem more transparent, and light may be transmitted only in one direction. However, the practical usefulness of these ...Read More..



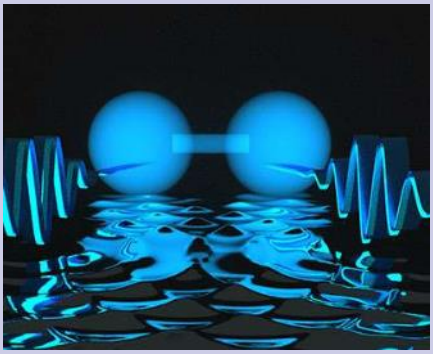
A schematic drawing of how a ring of exceptional points (shown in white) can be spawned from a Dirac point (a dot), and thus change the dispersion from the normal, widely known conical shape into an exotic lantern-like shape. Courtesy of the researchers

Physicists show 'molecules' made of light may be possible

It's not lightsaber time, not yet. But a team including theoretical physicists from the National Institute of Standards and Technology (NIST) has taken another step toward building objects out of photons, and the findings hint that weightless particles of light can be joined into a sort of "molecule" with its own peculiar force.

The findings build on previous research that several team members contributed to before joining NIST. In 2013, collaborators from Harvard, Caltech and MIT found a way to bind two photons together so that one would sit right atop the other, superimposed as they travel. Their experimental demonstration was considered a breakthrough, because no one had ever constructed anything by combining individual photons—inspiring some to imagine that real-life lightsabers were just around the corner.

Now, in a paper forthcoming in Physical Review Letters, the NIST and University of Maryland-based team (with other collaborators) has showed theoretically that by tweaking a few parameters of the binding process, photons could travel side by side, a specific distance from each other. The arrangement is akin to the way that two hydrogen atoms sit next to each other in a hydrogen molecule….Read More...



Researchers show that two photons, depicted in this artist's conception as waves (left and right), can be locked together at a short distance. Under certain conditions, the photons can form a state resembling a two-atom molecule, represented as the blue dumbbell shape at center. Credit: E. Edwards/JQI

Physicists catch a magnetic wave that offers promise for more energy-efficient computing

A team of physicists has taken pictures of a theorized but previously undetected magnetic wave, the discovery of which offers the potential to be an energy-efficient means to transfer data in consumer electronics.

The research, which appears in the journal Physical Review Letters, was conducted by scientists at New York University, Stanford University, and the SLAC National Accelerator Laboratory.

"This is an exciting discovery because it shows that small magnetic waves—known as spin-waves—can add up to a large one in a magnet, a wave that can maintain its shape as it moves," explains Andrew Kent, a professor of physics at NYU and the study's senior author. "A specialized x-ray method that can focus on particular magnetic elements with very high spatial resolution enabled this discovery and should enable many more insights into this behavior."

"Magnetism has been used for navigation for thousands of years and more recently to build generators, motors, and data storage devices," adds co-author Hendrik Ohldag, a scientist at the Stanford Synchrotron Radiation Laboratory (SSRL), where the soliton was discovered.

"However, magnetic elements were mostly viewed as static and uniform. To push the limits of energy efficiency in the future we need to understand better how ...Read More...

A team of physicists has taken pictures of a theorized but previously undetected magnetic wave, the discovery of which offers the potential to be an energy-efficient means to transfer data in consumer electronics. Credit: Purestock

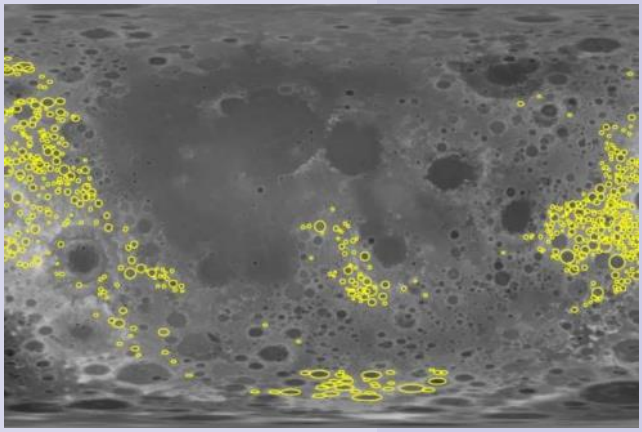
Moon's crust as fractured as can be

Scientists believe that about 4 billion years ago, during a period called the Late Heavy Bombardment, the moon took a severe beating, as an army of asteroids pelted its surface, carving out craters and opening deep fissures in its crust. Such sustained impacts increased the moon's porosity, opening up a network of large seams beneath the lunar surface.

Now scientists at MIT and elsewhere have identified regions on the far side of the moon, called the lunar highlands, that may have been so heavily bombarded—particularly by small asteroids—that the impacts completely shattered the upper crust, leaving these regions essentially as fractured and porous as they could be. The scientists found that further impacts to these highly porous regions may have then had the opposite effect, sealing up cracks and decreasing porosity.

The researchers observed this effect in the upper layer of the crust—a layer that scientists refer to as the megaregolith. This layer is dominated by relatively small craters, measuring 30 kilometers or less in diameter. In contrast, it appears that deeper layers of crust, that are affected by larger craters, are not quite as battered, and are less fractured and porous.

Jason Soderblom, a research scientist in MIT's Department ...Read More...



Researchers analyzed the gravity signatures of more than 1,200 craters (in yellow) on the far side of the moon.

What are asteroids?

4.6 billion years ago, our solar system formed from a collection of gas and dust surrounding our nascent sun. While much of the gas and dust in this protoplanetary disk coalesced to form the planets, some of the debris was left over.

Some of debris was shattered remnants of planetesimals – bodies within the young sun's solar nebula that never grew large enough to become planets, and scientists theorize that large collisions in the early, chaotic solar system pulverized these planetesimals into smaller pieces. Other debris never came together due to the massive gravitational pull from Jupiter.

These rocky remnants are now the asteroids that travel about our solar system. Since these "leftovers" contain clues about the early days of our solar system, scientists are eager to study them.

Definition of an Asteroid

Asteroids are rocky, metallic bodies that orbit the sun. They are made from different kinds of rock and metals, with the metals being mostly nickel and iron. They are sometimes called "minor planets" but they are much, much smaller than the planets or moons. They don't have atmospheres, but about 150 asteroids are ...Read More….

Artist's depiction of the asteroid belt between Mars and Jupiter. Credit: David Minton

SOHO Nears 3,000 Comet Discoveries

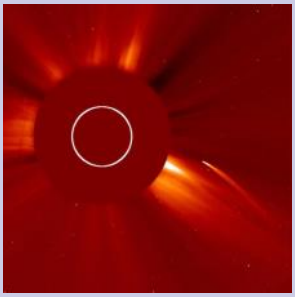
It's a discovery that could come any day now.

The Solar Heliospheric Observatory spacecraft known as SOHO is set to cross the 3,000 comet discovery threshold this month. Launched atop an Atlas II rocket on December 2nd, 1995, SOHO is a joint NASA/ESA mission, and has observed the Sun now for almost 20 years from the sunward L1 lagrange point. That fact is amazing enough, as SOHO has already followed the goings on of our tempestuous host star for nearly two full solar cycles.

And though SOHO wasn't initially designed as a comet hunter extraordinaire, it has gone on to discover far more comets than anyone—human or robotic.

The U.S. Naval Research Laboratory's (NRL) sungrazer website lists the discovery count as 2,987 as of July 31, 2015, with more comets awaiting verification daily. "In the past, SOHO has often discovered as many as four or five comets in a single day," Karl Battams, a solar scientist at the NRL told Universe Today. "Suffice to say, it really could be any day now, given how close we are to 3,000! I actually expected it to be a month ago, so I'm surprised it's dragging out like this. Predicting comets is fraught with uncertainty!"

Part of what gives SOHO an edge is its LASCO (the Large Angle and Spectrometric Coronagraph) C2 and C3 coronagraphs. With a field of view about 15 degrees wide, the C3 imager monitors the faint corona of the Sun, while blocking its dazzling disk. The corona is the pearly white outer atmosphere of the Sun, and is about half as bright as a Full Moon. On Earth, we only see the corona briefly during a total solar eclipse. SOHO routinely sees sungrazing comets 'photobomb' ...Read More...



A fine sungrazer nears its doom as seen via SOHOs LASCO C2 camera. Image credit: NASA/ESA/SOHO/NRLSungrazers

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Power Up

Anything portable needs a battery. We wouldn't have the cell phones, laptops or other consumer electronic gadgets we use daily without battery technology—the research is ubiquitous. This is especially true of lithium-ion batteries.

The face of battery research has changed since the 1980s where it was considered a "dirty science" and researchers would mix carbon and other elements in their laboratories. Noted as the first generation of lithium-ion batteries, the 1980s gave birth to lithium-metal battery technology, which is now seeing a resurgence today. And, in 1991, when Japan's Sony first released the lithium-ion battery to power music players and camcorders, they probably didn't anticipate the crucial impact the technology would have over all society. And they probably didn't foresee Asia's dominance in battery technology R&D.

However, now there's another shift in battery technology happening within transportation and storage on the grid, which are an order-of-magnitude larger than personal electronics. To run ...Read More...

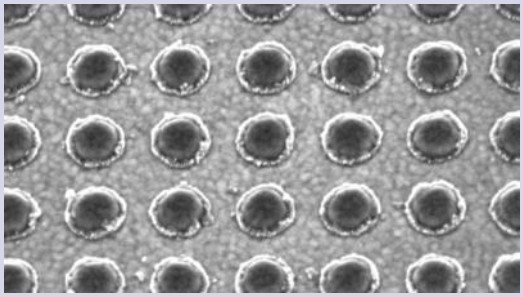
Image: Shutterstock

Team announces breakthrough observation of Mott transition in a superconductor

An international team of researchers, including the MESA+ Institute for Nanotechnology at the University of Twente in The Netherlands and the U.S. Department of Energy's Argonne National Laboratory, announced today in Science the observation of a dynamic Mott transition in a superconductor.

The discovery experimentally connects the worlds of classical and quantum mechanics and illuminates the mysterious nature of the Mott transition. It also could shed light on non-equilibrium physics, which is poorly understood but governs most of what occurs in our world. The finding may also represent a step towards more efficient electronics based on the Mott transition.

Since its foundations were laid in the early part of the 20th century, scientists have been trying to reconcile quantum mechanics with the rules of classical or Newtonian physics (like how you describe the path of an apple thrown into the air—or dropped ...Read More...

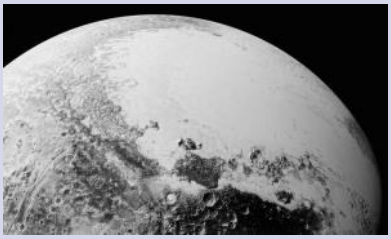


New Pluto images from NASA's New Horizons

New close-up images of Pluto from NASA's New Horizons spacecraft reveal a bewildering variety of surface features that have scientists reeling because of their range and complexity.

"Pluto is showing us a diversity of landforms and complexity of processes that rival anything we've seen in the solar system," said New Horizons Principal Investigator Alan Stern, of the Southwest Research Institute (SwRI), Boulder, Colorado. "If an artist had painted this Pluto before our flyby, I probably would have called it over the top—but that's what is actually there."

New Horizons began its yearlong download of new images and other data over the Labor Day weekend. Images downlinked in the past few days have more than doubled the amount of Pluto's surface seen at resolutions as good as 400 meters (440 yards) per pixel. They reveal new features as diverse as possible dunes, nitrogen ice flows that apparently oozed out of mountainous regions onto plains, and even networks of valleys that may have been carved by material flowing over Pluto's surface. They also show large regions that ...Read More...



This synthetic perspective view of Pluto, based on the latest high-resolution images to be downlinked from NASA's New Horizons spacecraft, shows what you would see if you were approximately 1,100 miles (1,800 kilometers) ...