October 17, 2015
Muharram 03, 1437
Volume 5, Issue 42

Astronomy & Physics News

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Weekly Scientific News Compiled by Dr. Ilias Fernini

INTERNATIONAL YEAR OF LIGHT 2015

Inside this issue:

CubeSat Launchers Expected to Open Research Opportunities for All

NASA opened a new avenue for exploration and technology development with awards to three companies to launch missions dedicated to CubeSats. The tiny, box-shaped spacecraft have emerged in the last 16 years as a quick, viable way to test components and techniques that, if proven, can be applied to much larger missions where the stakes are far greater than a simple, 4-inch cube. The price tag for each mission is one-tenth the cost of the least-expensive traditional launcher.

Proposals were accepted from Firefly Space Systems, RocketLabs USA and Virgin Galactic to conduct demonstration CubeSat launches as soon as 2017. The first phase of launches are expected to be completed by the end of calendar year 2018. The total value of the three contracts is $17.15 million, with $6.95 million awarded to Rocket Lab, $5.5 million to Firefly Space Systems and $4.7 million to Virgin Galactic. NASA officials anticipate more Venture Class launches to serve SmallSats in the future. "The award of these contracts represent NASA's investment in the future of the commercial launch industry for SmallSats," said Mark Wiese, chief of the Flight Projects Office for NASA's Launch Services Program, or LSP, based at Kennedy Space Center...Read More...

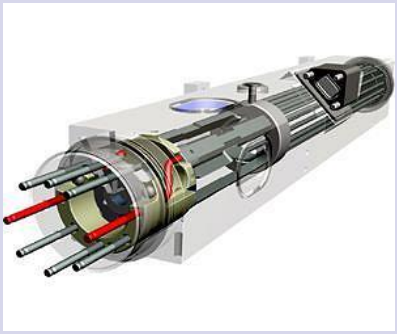
File Image.

The Journey to Mars: Bridging the Technology Gap

As the new movie "The Martian" demonstrates, there's an amazing list of technologies required to safely send human beings to the Red Planet and bring them home again. NASA's Marshall Space Flight Center in Huntsville, Alabama, is home to the Technology Demonstration Missions program office, which oversees a host of key technology development efforts at NASA and partner facilities around the country, each dedicated to doing just that: advancing and maturing technologies critical to exploration of Mars and other solar-system destinations.

From groundbreaking deep-space navigational tools to revolutionary propulsion systems and vehicle braking and planetary descent technologies, Marshall and its TDM partners, working under the leadership of NASA's Space Technology Mission Directorate in Washington, are pursuing high-value technology projects with the potential to transform how we deliver robotic and human explorers to Earth's nearest planetary neighbor.

The Deep Space Atomic Clock project led by NASA's Jet Propulsion Laboratory in Pasadena, California, seeks to validate in flight a miniaturized, ultra-precise, mercury-ion ...Read More...



An artist's rendering of the Deep Space Atomic Clock. Image courtesy NASA/JPL

On the precision frontier: A new calculation holds promise

A team of theoretical high-energy physicists in the Fermilab Lattice and MILC Collaborations has published a new high-precision calculation that could significantly advance the indirect search for physics beyond the Standard Model (SM). The calculation applies to a particularly rare decay of the B meson (a subatomic particle), which is sometimes also called a "penguin decay" process.

After being produced in a collision, subatomic particles spontaneously decay into other particles, following one of many possible decay paths. Out of one billion B mesons detected in a collider, only about twenty decay through this particular process.

With the discovery of the Higgs boson, the last missing piece, the SM of particle physics now accounts for all known subatomic particles and correctly describes their interactions. It's a highly successful theory, in that its predictions have been verified consistently by experimental measurements. But scientists know that the SM doesn't tell the whole story, and researchers around the globe are eagerly searching for evidence of physics beyond the SM.

"We have reason to believe that there are yet undiscovered subatomic particles that are not part of the SM," explains Fermilab scientist Ruth Van De Water. "Generally, we expect them to be heavier than any subatomic particles we have found so far. The new particles would be part of a new theory that would look like the SM at low energies. Additionally, the new theory should account for the astrophysical ...Read More...

Artist's rendering of a rare B-meson "penguin" (decay process) showing the quark-level process. Image courtesy Daping Du, Syracuse University.

A particle purely made of nuclear force

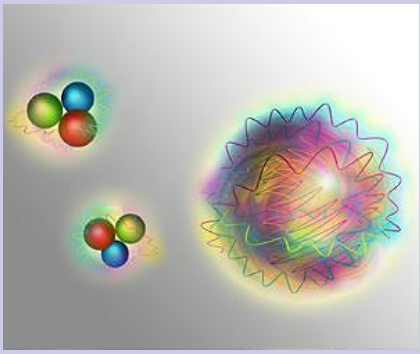
For decades, scientists have been looking for so-called "glueballs". Now it seems they have been found at last. A glueball is an exotic particle, made up entirely of gluons - the "sticky" particles that keep nuclear particles together. Glueballs are unstable and can only be detected indirectly, by analysing their decay. This decay process, however, is not yet fully understood.

Professor Anton Rebhan and Frederic Brunner from TU Wien (Vienna) have now employed a new theoretical approach to calculate glueball decay. Their results agree extremely well with data from particle accelerator experiments. This is strong evidence that a resonance called "f0(1710)", which has been found in various experiments, is in fact the long-sought glueball. Further experimental results are to be expected in the next few months.

Forces are Particles too

Protons and neutrons consist of even smaller elementary particles called quarks. These quarks are bound together by strong nuclear force. "In particle physics, every force is mediated by a special kind of force particle, and the force particle of the strong nuclear force is the gluon", says Anton Rebhan (TU Wien).

Gluons can be seen as more complicated versions of the photon. The massless photons are responsible for the forces of electromagnetism, while eight different kinds of gluons play a similar role for the strong nuclear force. However, there is one important difference: gluons ...Read More...



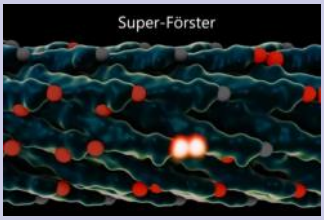
Nucleons consist (left) of quarks (matter particles) and gluons (force particles). A glueball (right) is made up purely of gluons. Image courtesy TU Wien.

Researchers use engineered viruses to provide quantum-based enhancement of energy transport

Nature has had billions of years to perfect photosynthesis, which directly or indirectly supports virtually all life on Earth. In that time, the process has achieved almost 100 percent efficiency in transporting the energy of sunlight from receptors to reaction centers where it can be harnessed—a performance vastly better than even the best solar cells.

One way plants achieve this efficiency is by making use of the exotic effects of quantum mechanics—effects sometimes known as "quantum weirdness." These effects, which include the ability of a particle to exist in more than one place at a time, have now been used by engineers at MIT to achieve a significant efficiency boost in a light-harvesting system. Surprisingly, the MIT researchers achieved this new approach to solar energy not with high-tech materials or microchips—but by using genetically engineered viruses.

This achievement in coupling quantum research and genetic manipulation, described this week in the journal Nature Materials, was the work of MIT professors Angela Belcher, an expert on engineering viruses to carry out energy-related tasks, and Seth Lloyd, an expert on quantum theory and its potential applications; research associate Heechul Park; and 14 collaborators at MIT ...Read More...



Rendering of a virus used in the MIT experiments. The light-collecting centers, called chromophores, are in red, and chromophores that just absorbed a photon of light are glowing white. After the virus is modified to adjust the spacing between the chromophores, energy can jump from one set of chromophores to the next faster and more efficiently. Credit: Courtesy of the researchers and Lauren Alexa Kaye

Flickering light reveals remarkable link with matter-eating black holes

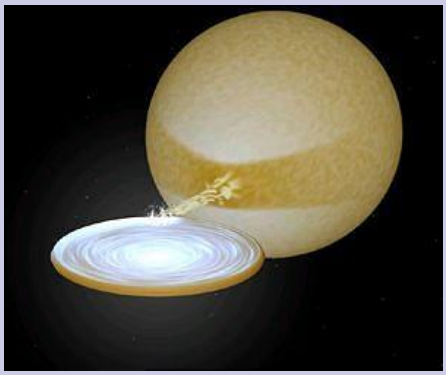
An international team of astronomers, including Dr Simon Vaughan from the University of Leicester's Department of Physics and Astronomy, has discovered a previously unknown link between the way young stars grow and the way black holes and other exotic space objects feed from their surroundings.

The study, 'Accretion-induced variability links young stellar objects, white dwarfs, and black holes', which is published in the journal Science Advances, shows how the 'flickering' in the visible brightness of young stellar objects (YSOs) - very young stars in the final stages of formation - is similar to the flickering seen from black holes or white dwarfs as they violently pull matter from their surroundings in a process known as accretion.

The researchers found that relatively cool accretion discs around young stars, whose inner edges can be several times the size of the Sun, show the same behaviour as the hot, violent accretion discs around planet-sized white dwarfs, city-sized black holes and supermassive black holes as large as the entire Solar system, supporting the universality of accretion physics.

The study found a relationship between the size of the central object and the speed of the flickering produced by the disc, suggesting the physics of the accretion must be very similar around these different astronomical objects despite them being completely different in other ways, such as size, age, temperature and gravity.

Dr Simon Vaughan, Reader in Observational Astronomy at the University of Leicester's Department of Physics and ...Read More...



An image of an accretion disc around a black hole. Image courtesy Simone Scaringi.

Researchers discover distant galactic halos

A study of spiral galaxies seen edge-on has revealed that halos of cosmic rays and magnetic fields above and below the galaxies' disks are much more common than previously thought. Edge-on galaxies, when seen with the naked eye, look like a line in the sky.

An international team of astronomers including lead author and Queen's postdoctoral student Theresa Wiegert and Queen's researcher Judith Irwin (Physics, Engineering Physics and Astronomy) used the Karl G. Jansky Very Large Array (VLA) to study 35 edge-on spiral galaxies at distances from 11 million to 137 million light-years from Earth.

The upgraded telescope is more powerful than any used before and allowed researchers to see halos much fainter than before.

"We knew before that some halos existed, but, using the full power of the upgraded VLA and the full power of some advanced image-processing techniques, we found that these halos are much more common among spiral galaxies than we had realized," says Dr. Irwin. Spiral galaxies, like our own ...Read More...

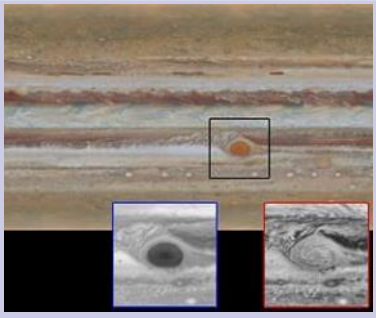
File Image.

Planetary portrait captures new changes in Jupiter's Great Red Spot

Scientists using NASA's Hubble Space Telescope have produced new maps of Jupiter - the first in a series of annual portraits of the solar system's outer planets. Collecting these yearly images - essentially the planetary version of annual school picture days for children - will help current and future scientists see how these giant worlds change over time. The observations are designed to capture a broad range of features, including winds, clouds, storms and atmospheric chemistry. Already, the Jupiter images have revealed a rare wave just north of the planet's equator and a unique filamentary feature in the core of the Great Red Spot not seen previously.

"Every time we look at Jupiter, we get tantalizing hints that something really exciting is going on," said Amy Simon, a planetary scientist at NASA's Goddard Space Flight Center in Greenbelt, Maryland. "This time is no exception."

Simon and her colleagues produced two global maps of Jupiter from observations made using Hubble's high-performance Wide Field Camera 3. The two maps represent nearly back-to-back rotations of the planet, making it possible to determine the speeds of Jupiter's winds. The findings are described in an Astrophysical Journal paper, available online. The new images confirm that the Great Red Spot continues to shrink and become more circular, as it has been doing for years. The long axis of this characteristic storm is about 150 miles (240 kilometers) shorter now than it was in 2014. Recently, the storm had been shrinking at a faster-than-usual rate, but the latest change is ...Read More...



The movement of Jupiter's clouds can be seen bycomparing the first map to the second one. Zooming in on the Great Red Spot at blue (left) and red (right) wavelengths reveals a unique filamentary feature not previously seen. Image courtesy NASA/ESA/Goddard/UCBerkeley/JPL-Caltech/STScI. For a larger version of this image please go here. Watch a video on the research here.

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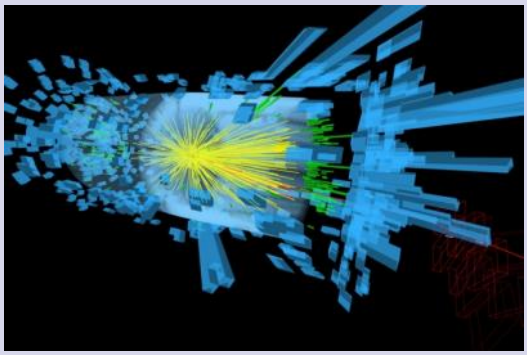
Latest experiment at Large Hadron Collider reports first results

After a two-year hiatus, the Large Hadron Collider, the largest and most powerful particle accelerator in the world, began its second run of experiments in June, smashing together subatomic particles at 13 teraelectronvolts (TeV)—the highest energy ever achieved in a laboratory. Physicists hope that such high-energy collisions may produce completely new particles, and potentially simulate the conditions that were seen in the early universe...Read More...

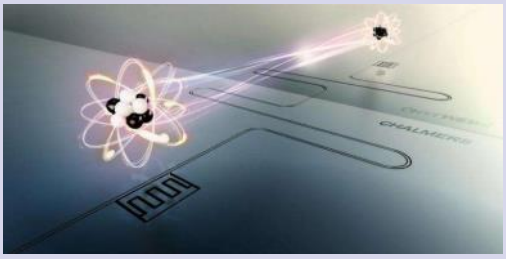


Particles created from the proton collision stream out from the center of the Compact Muon Solenoid detector. They are first detected by the Silicon Tracker, whose data can be used to reconstruct the particle trajectories, indicated by yellow lines. An Electromagnetic Calorimeter detects energy deposited by electrons and photons, indicated by green boxes. The energy detected by the Hadronic Calorimeter, the primary component of jets, is indicated by blue boxes. Particles reaching the outermost parts of the detector are indicated in red. Credit: CERN

Team extends the lifetime of atoms using a mirror

Researchers at Chalmers University of Technology have succeeded in an experiment where they get an artificial atom to survive ten times longer than normal by positioning the atom in front of a mirror. The findings were recently published in the journal Nature Physics.

If one adds energy to an atom - one says that the atom is excited—it normally takes some time before the atom loses energy and returns to its original state. This time is called the lifetime of the atom. Researchers at Chalmers University of Technology have placed an artificial atom at a specific distance in front of a short circuit that acts as a mirror. By changing the distance to the mirror, they can get the atom to live longer, up to ten times as long as if the mirror had not been there. ...Read More...



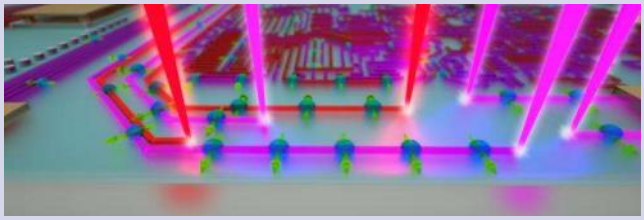
The lifetime of an atom can be extended up to ten times by placing it in front of a short circuit that acts as a mirror. The artificial atom consists of a superconducting circuit on a silicon chip. The interaction between the atom and its mirror image modifies the vacuum fluctuations seen by the atom and thus its lifetime. Credit: Moa Carlsson and Lisa Kinnerud, Krantz NanoArt

Scientists paint quantum electronics with beams of light

A team of scientists from the University of Chicago and the Pennsylvania State University have accidentally discovered a new way of using light to draw and erase quantum-mechanical circuits in a unique class of materials called topological insulators.

In contrast to using advanced nanofabrication facilities based on chemical processing of materials, this flexible technique allows for rewritable 'optical fabrication' of devices. This finding is likely to spawn new developments in emerging technologies such as low-power electronics based on the spin of electrons or ultrafast quantum computers.

The research is published today in the American Association for the Advancement of Science's new online journal Science Advances, where it is featured on the journal's front page. "This observation came as a complete surprise," said David D. Awschalom, Liew Family Professor and deputy director in the Institute of ...Read More...



Artist's rendition of optically-defined quantum circuits in a topological insulator. Credit: Peter Allen