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Dept. of Applied Physics & Astronomy— University of Sharjah
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Inside this issue:

Five-dimensional black hole could 'break' general relativity

Researchers have shown how a bizarrely shaped black hole could cause Einstein's general theory of relativity, a foundation of modern physics, to break down. However, such an object could only exist in a universe with five or more dimensions.

The researchers, from the University of Cambridge and Queen Mary University of London, have successfully simulated a black hole shaped like a very thin ring, which gives rise to a series of 'bulges' connected by strings that become thinner over time. These strings eventually become so thin that they pinch off into a series of miniature black holes, similar to how a thin stream of water from a tap breaks up into droplets.

Ring-shaped black holes were 'discovered' by theoretical physicists in 2002, but this is the first time that their dynamics have been successfully simulated using supercomputers. Should this type of black hole form, it would lead to the appearance of a 'naked singularity', which would cause the equations behind general relativity to break down. The results are published in the journal Physical Review Letters.

General relativity underpins our current understanding of gravity: everything from the estimation of the age of the stars in the universe, to the GPS signals we rely on to help us navigate, is based on Einstein's equations. In part, the theory tells us that matter warps its surrounding spacetime, and what we call gravity is the effect of that warp. In the 100 years since it was published, general relativity has passed every test that has been thrown at it, but one of ...Read More...

Gravitational waves offer glimpse into the past – but will we ever catch ripples from the Big Bang?

Einstein was right – changes in gravity do spread as waves through space. The LIGO experiment detected such waves from a collision between two black holes with masses of about 36 and 29 times that of the sun (described as 36 and 29 "solar masses"). But the merger of these 65 solar masses in total created a remnant of just 62 – so what happened to the other three? These were used to power the burst of gravitational waves, in a spectacular demonstration of Einstein's famous formula, $E=Mc^2$, where mass and energy are equivalent.

This is only the beginning. Now that we know how to measure gravitational waves, we can use experiments like LIGO to learn about events in the cosmos that we have never been able to see before, such as mergers of supermassive black holes in the early universe. But how far back can we go? What about "primordial" gravitational waves from the birth of the universe itself – will LIGO's discovery help us catch those?

Looking back in time

Although the masses involved in this event are large by stellar standards, they are dwarfed by the supermassive black holes that astronomers believe are present at the centre of almost every galaxy. Our own galaxy, the Milky ...Read More...

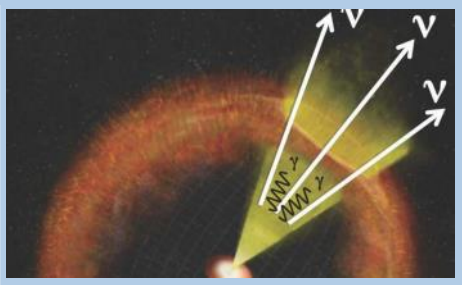
Credit: NASA/Flickr, CC BY-SA

New clues in the hunt for the sources of cosmic neutrinos

The sources of the high-energy cosmic neutrinos that are detected by the IceCube Neutrino Observatory buried in the Antarctic ice may be hidden from observations of high-energy gamma rays, new research reveals. These high-energy cosmic neutrinos, which are likely to come from beyond our Milky Way Galaxy, may originate in incredibly dense and powerful objects in space that prevent the escape of the high-energy gamma rays that accompany the production of neutrinos. A paper describing the research will be published in the early online edition of the journal Physical Review Letters on February 18, 2016.

"Neutrinos are one of the fundamental particles that make up our universe," said Kohta Murase, assistant professor of physics and of astronomy and astrophysics at Penn State and the corresponding author of the studies. "High-energy neutrinos are produced along with gamma rays by extremely high-energy radiation known as cosmic rays in objects like star-forming galaxies, galaxy clusters, supermassive black holes, or gamma-ray bursts. It is important to reveal the origin of these high-energy cosmic neutrinos in order to better understand the underlying physical mechanisms that produce neutrinos and other extremely high-energy astroparticles and to enable the use of neutrinos as new probes of particle physics in the universe."

Neutrinos are neutral particles, so they are not affected by electromagnetic forces as they travel through space. Neutrinos detected here on Earth therefore trace a direct path back to their distant astrophysical sources. ...Read More...



This illustration is an example of a hidden cosmic-ray accelerator. Cosmic rays are accelerated up to extremely high energies in dense environments close to black holes. High-energy gamma rays (marked by the "Y" gamma symbol) are blocked from escaping, while neutrinos (marked by the "V"nu symbol) easily escape and can reach the Earth. Credit: Bill Saxton at NRAO/AUI/NSF, modified by Kohta Murase at Penn State University

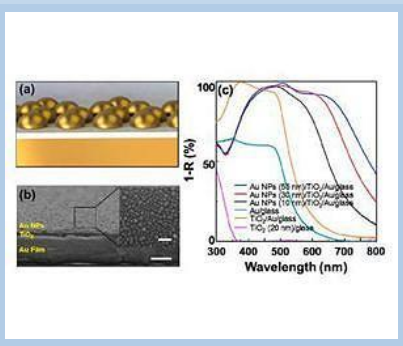
New technique for turning sunlight into hydrogen

A team of Korean researchers, affiliated with UNIST has recently pioneered in developing a new type of multilayered (Au NPs/TiO2/Au) photoelectrode that boosts the ability of solar water-splitting to produce hydrogen. According to the research team, this special photoelectrode, inspired by the way plants convert sunlight into energy is capable of absorbing visible light from the sun, and then using it to split water molecules (H2O) into hydrogen and oxygen.

This study is a collaboration among scientists, including Prof. Jeong Min Baik (School of Materials Science and Engineering, UNIST), Prof. Jae Sung Lee (School of Energy and Chemical Engineering, UNIST), Prof. Heon Lee (School of Materials Science and Engineering, Korea University), and Prof. Jonghwa Shin (Department of Materials Science and Engineering, Korea Advanced Institute of Science and Technology).

This multilayered photoelectrode takes the form of two-dimensional hybrid metal-dielectric structure, which mainly consists of three layers of gold (Au) film, ultrathin TiO2 layer (20 nm), and gold nanoparticles (Au NPs). In a study, reported in the January 21, 2016 issue of Nano Energy, the team reported that this promising photoelectrode shows high light absorption of about 90% in the visible range 380-700 nm, as well as significant enhancement in photo-catalytic applications.

Many structural designs, such as ...Read More...



Two-dimensional metastructured film with Titanium Oxide is fabricated as a photo-catalytic photoanode with exceptional visible light absorption. Image courtesy UNIST.

Physicists zoom in on gluons' contribution to proton spin

By analyzing the highest-energy proton collisions at the Relativistic Heavy Ion Collider (RHIC), a particle collider at the U.S. Department of Energy's (DOE) Brookhaven National Laboratory, nuclear physicists have gotten a glimpse of how a multitude of gluons that individually carry very little of the protons' overall momentum contribute to the protons' spin. The data described in a recently published paper indicate that these glue-like particles—named for their role in binding the quarks that make up each proton—play a substantial role in determining the intrinsic angular momentum, or spin, of these building blocks of matter.

"These results confirm our suspicion that a lot of the gluons' contribution to proton spin comes from the gluons with relatively low momentum," said Ralf Seidl, a physicist from the RIKEN-BNL Research Center (RBRC) and a member of RHIC's PHENIX collaboration, which published these results. The results also suggest that gluons' overall contribution to spin might be even greater than the contribution from quarks.

Exploring the sources of proton spin is one of the major scientific missions at RHIC, a DOE Office of Science User Facility and the only machine in the world capable of colliding protons with their spins aligned in a chosen direction. Nuclear physicists from around the globe, including many supported by the Japanese RIKEN ...Read More...

The PHENIX detector at the Relativistic Heavy Ion Collider (RHIC), a particle accelerator at Brookhaven National Laboratory uniquely capable of measuring how a proton's internal building blocks — quarks and gluons — contribute to its overall intrinsic angular momentum, or "spin."

Longest-lasting stellar eclipse discovered

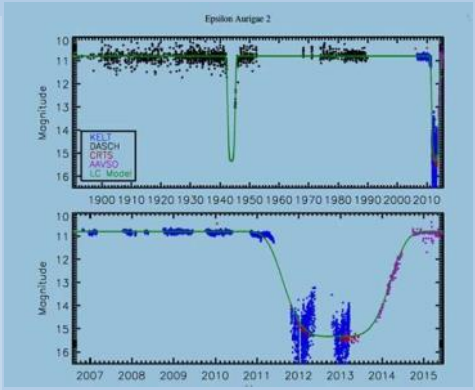
Imagine living on a world where, every 69 years, the sun disappears in a near-total eclipse that lasts for three and a half years.

That is just what happens in an unnamed binary star system nearly 10,000 light years from Earth. The newly discovered system, known only by its astronomical catalog number TYC 2505-672-1, sets a new record for both the longest duration stellar eclipse and the longest period between eclipses in a binary system.

Discovery of the system's extraordinary properties was made by a team of astronomers from Vanderbilt and Harvard with the assistance of colleagues at Lehigh, Ohio State and Pennsylvania State universities, Las Cumbres Observatory Global Telescope Network and the American Association of Variable Star Observers and is described in a paper accepted for publication in the Astronomical Journal.

"It's the longest duration stellar eclipse and the longest orbit for an eclipsing binary ever found…by far," said the paper's first author Vanderbilt doctoral student Joey Rodriguez. The previous record holder is Epsilon Aurigae, a giant star that is eclipsed by its companion every 27 years for periods ranging from 640 to 730 days.

"Epsilon Aurigae is much closer – about 2,200 light years from Earth – and brighter, which has allowed astronomers to study it extensively," said Rodriguez. The leading explanation is that Epsilon Aurigae consists of ...Read More...



Comparison of the light curves of the newly discovered system and the previous record holder, Epsilon Aurigae, shows how much longer one of its eclipses lasts. Credit: Joey Rodriguez / Vanderbilt University

Glow from the Big Bang Allows Discovery of Distant Black Hole Jet

Astronomers have used NASA's Chandra X-ray Observatory to discover a jet from a very distant supermassive black hole being illuminated by the oldest light in the Universe. This discovery shows that black holes with powerful jets may be more common than previously thought in the first few billion years after the Big Bang.

The light detected from this jet was emitted when the Universe was only 2.7 billion years old, a fifth of its present age. At this point, the intensity of the cosmic microwave background radiation, or CMB, left over from the Big Bang was much greater than it is today.

The length of the jet, found in the system known as B3 0727+409, is at least 300,000 light years. Many long jets emitted by supermassive black holes have been detected in the nearby Universe, but exactly how these jets give off X-rays has remained a matter of debate. In B3 0727+409, it appears that the CMB is being boosted to X-ray wavelengths.

"Because we're seeing this jet when the Universe was less than three billion years old, the jet is about 150 times brighter in X-rays than it would be in the nearby Universe...Read More...

Image courtesy X-ray: NASA/CXC/ISAS/A.Simionescu et al, Optical: DSS.

Quantum mechanics explored in new study

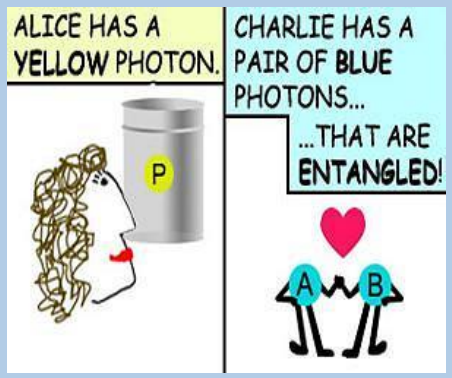
Here's a love story at the smallest scales imaginable: particles of light. It is possible to have particles that are so intimately linked that a change to one affects the other, even when they are separated at a distance.

This idea, called "entanglement," is part of the branch of physics called quantum mechanics, a description of the way the world works at the level of atoms and particles that are even smaller. Quantum mechanics says that at these very tiny scales, some properties of particles are based entirely on probability. In other words, nothing is certain until it happens.

Albert Einstein did not entirely believe that the laws of quantum mechanics described reality. He and others postulated that there must be some hidden variables at work, which would allow quantum systems to be predictable.

In 1964, however, John Bell published the idea that any model of physical reality with such hidden variables also must allow for the instantaneous influence of one particle on another. While Einstein proved that information cannot travel faster than the speed of light, particles can still affect each other when they are far apart according to Bell.

Scientists consider Bell's theorem an important foundation for modern physics. While many experiments have taken place to try to prove his theorem, no one was able to run a full, proper test of the experiment Bell would have needed until recently. In 2015, three separate studies were published on this topic, all consistent with the predictions of quantum ...Read More...



This cartoon helps explain the idea of "entangled particles." Alice and Bob represent photon detectors, which NASA's Jet Propulsion Laboratory and the National Institute of Standards and Technology developed. Credit: NASA/JPL-Caltech

Dept. of Applied Physics & Astronomy

College of Science - University of Sharjah
POB 27272
Sharjah
United Arab Emirates

Phone: 00-971-6-5050363
Fax: --
E-mail: physics@sharjah.ac.ae

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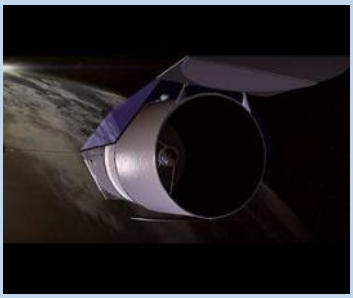
A New, Wider Set of Eyes on the Universe

After years of preparatory studies, NASA is formally starting an astrophysics mission designed to help unlock the secrets of the universe - the Wide Field Infrared Survey Telescope (WFIRST).

With a view 100 times bigger than that of NASA's Hubble Space Telescope, WFIRST will aid researchers in their efforts to unravel the secrets of dark energy and dark matter, and explore the evolution of the cosmos. It also will discover new worlds outside our solar system and advance the search for worlds that could be suitable for life.

NASA's Agency Program Management Council, which evaluates the agency's programs and projects on content, risk management and performance, made the decision to move forward with the mission on Wednesday. The mission is led by NASA's Goddard Space Flight Center in Greenbelt, Maryland. NASA's Jet Propulsion Laboratory in Pasadena, California, will manage the mission's 7.8-foot (2.4-meter) telescope and ...Read More...



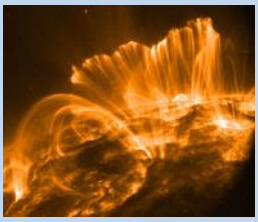
"WFIRST has the potential to open our eyes to the wonders of the universe, much the same way Hubble has," said John Grunsfeld, astronaut and associate administrator of NASA's Science Mission Directorate at Headquarters in Washington. "This mission uniquely combines the ability to discover and characterize planets beyond our own solar system with the sensitivity and optics to look wide and deep into the universe in a quest to unravel the mysteries of dark energy and dark matter."

NASA Helps Power Grids Weather Geomagnetic Storms

On March 9, 1989, a huge cloud of solar material exploded from the sun, twisting toward Earth. When this cloud of magnetized solar material - called a coronal mass ejection, or CME - reached our planet, it set off a chain of events in near-Earth space that ultimately knocked out power to the Canadian province Quebec for about nine hours. Though CMEs hit Earth often, those with the potential to shut down an entire power grid are rare - and scientists want to make sure that next time, we're prepared.

Because space weather can have - at its very worst - such significant consequences, scientists from NASA's Goddard Space Flight Center in Greenbelt, Maryland, are creating models to simulate how space weather can impact our power grid. Scientists developing this next-generation project - called Solar Shield - have recently incorporated six test sites around the country, where they compare computer simulations of forecasted space weather impacts with the actual observations on the ground.

Solar Shield, which combines research efforts from several agencies, is supported by the Department of Homeland Security Science and Technology directorate. Simulations - like those used ...Read More...



Solar storms. NASA

Exploiting high speed light for super slow science

Scientists at the world's premier science conference - the American Association for the Advancement of Science (AAAS) annual meeting - will this year be discussing the advances enabled by the UK's pioneering Long-Duration Experiment facility (LDE). Unmatched anywhere in the world, the LDE allows scientists to closely study the atomic and molecular behaviour of matter under different conditions and over a period of two years.

Based at the UK's synchrotron science facility, Diamond Light Source, the LDE exploits powerful synchrotron light - which is 10 billion times brighter than the sun - to penetrate to the heart of matter. But unlike Diamond's 25 other experimental stations, the LDE allows scientists to study the behaviour of material as it changes over an extended period of time, meaning that experiments can last not hours or days, but months or years.

Prof Trevor Rayment, Diamond's Director of Physical Sciences, "Historically, synchrotrons have been racing to provide scientists with experimental tools that glean rapid results. ...Read More...

Dr Claire Corkhill, Sheffield, investigating the hydration of cements used by the nuclear industry for the storage of waste. Image courtesy Sean Dillow. www.TheBigCheesePhotography.co.uk Diamond Light Source.