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Inside this issue:

Gravitational waves detected 100 years after Einstein's prediction

For the first time, scientists have observed ripples in the fabric of spacetime called gravitational waves, arriving at Earth from a cataclysmic event in the distant universe. This confirms a major prediction of Albert Einstein's 1915 general theory of relativity and opens an unprecedented new window to the cosmos.

Gravitational waves carry information about their dramatic origins and about the nature of gravity that cannot be obtained from elsewhere. Physicists have concluded that the detected gravitational waves were produced during the final fraction of a second of the merger of two black holes to produce a single, more massive spinning black hole. This collision of two black holes had been predicted but never observed.

The gravitational waves were detected on Sept. 14, 2015 at 5:51 a.m. EDT (09:51 UTC) by both of the twin Laser Interferometer Gravitational-wave Observatory (LIGO) detectors, located in Livingston, Louisiana, and Hanford, Washington. The LIGO observatories are funded by the National Science Foundation (NSF), and were conceived, built and are operated by the California Institute of Technology (Caltech) and the Massachusetts Institute of Technology (MIT). The discovery, accepted for publication ...Read More..

An aerial view of the Laser Interferometer Gravitational-wave Observatory (LIGO) detector in Livingston, Louisiana. LIGO has two detectors: one in Livingston and the other in Hanaford, Washington. LIGO is funded by NSF; Caltech and MIT conceived, built and operate the laboratories. Credit: LIGO Laboratory

Einstein's waves: a 100-year odyssey

When Albert Einstein forged the bedrock theory of modern physics 100 years ago, he had no computer, no internet, no printer—ballpoint pens and pocket calculators did not exist and few homes had telephones.

Yet it took one of the most sophisticated science tools ever built, at a cost of hundreds of millions of dollars, to prove an idea the scientist had crafted with little more than paper, a fountain pen, hard work and a mind sharper than most.

On Thursday, physicists announced they had detected gravitational waves—hitherto a key unproven element of Einstein's general theory of relativity.

The thesis was published 100 years ago this year, when the world was a very different place, inhabited by a man way ahead of his time.

Radios had been invented, but not yet entered people's homes.

The first transcontinental telephone call was made in 1915, from New York City to San Francisco, as was the first transatlantic call between Arlington, Virginia and Paris, France.

Electric refrigerators were not yet a thing, and motorcars shared the road with ...Read More...

"The elegance of Einstein's theory of gravity does not rely on computational power, but rather on the elegance of its principles," said David Cerdeno of Durham University's Institute for Particle Physics Phenomenology

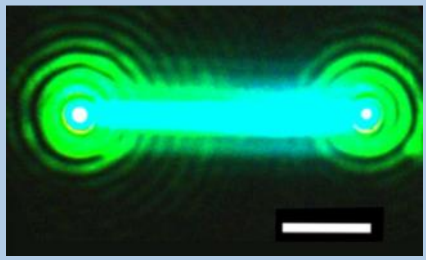
'Lasers rewired': Scientists find a new way to make nanowire lasers

The nanowires, with diameters as small as 200 nanometers (billionths of a meter) and a blend of materials that has also proven effective in next-generation solar cell designs, were shown to produce very bright, stable laser light. Researchers say the excellent performance of these tiny lasers is promising for the field of optoelectronics, which is focused on combining electronics and light to transmit data, among other applications.

Light can carry far more data, far more rapidly than standard electronics—a single fiber in a fiber-optic cable, measuring less than a hair's width in diameter, can carry tens of thousands of telephone conversations at once, for example. And miniaturizing lasers to the nanoscale could further revolutionize computing by bringing light-speed data transmission to desktop and ultimately handheld computing devices.

"What's amazing is the simplicity of the chemistry here," said Peidong Yang, a chemist in Berkeley Lab's Materials Sciences Division who led the research, published Feb. 9 in Proceedings of the National Academy of Sciences. More standard techniques that produce nanowires can require expensive equipment and exotic conditions, such as high temperatures, and can suffer from other shortcomings.

The research team developed a simple chemical-dipping solution process to produce a self-assembled blend of nanoscale crystals, plates and wires composed of cesium, lead and bromine (with the chemical formula: $CsPbBr_3$). The same chemical blend, with a molecular ...Read More…



A nanowire, composed of cesium, lead and bromide ($CsPbBr_3$), emits bright laser light after hit by a pulse from another laser source. The nanowire laser proved to be very stable, emitting laser light for over an hour. It also was demonstrated to be broadly tunable across green and blue wavelengths. The white line is a scale bar that measures 2 microns, or millionths of an inch. Credit: Credit: Sam Eaton/UC Berkeley

Absorbing acoustics with soundless spirals

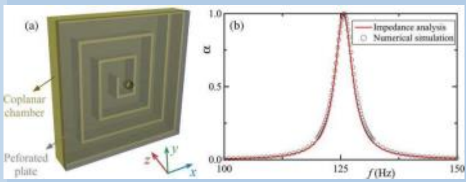
Researchers at the French National Centre for Scientific Research, CNRS, and the University of Lorraine have recently developed a design for a coiled-up acoustic metasurface which can achieve total acoustic absorption in very low-frequency ranges.

"The main advantage is the deep-subwavelength thickness of our absorber, which means that we can deal with very low-frequencies - meaning very large wavelengths - with extremely reduced size structure," said Badreddine Assouar, a principal research scientist at CNRS in Nancy, France.

Assouar and Li, a post-doc in his group at the Institut Jean Lamour, affiliated with the CNRS and the University of Lorraine, describe their work this week in Applied Physics Letters.

Acoustic absorption systems work by absorbing sound energy at a resonant frequency and dissipating it into heat. Traditional acoustic absorbers consist of specially perforated plates placed in front of hard objects to form air cavities; however, in order to operate at low frequencies, these systems must also be relatively thick in length, which makes them physically impractical for most applications.

To remedy this, Assouar's group, whose previous work consisted of developing coiled channel systems, designed an acoustic absorber in which sound waves enter an internal coiled air channel through a perforated center hole. This forces the acoustic waves to travel through ...Read More...



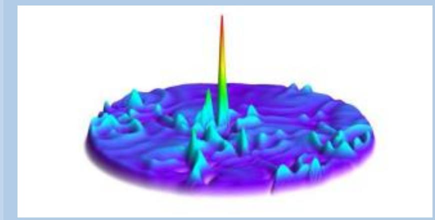
(Left) The metasurface composed of a perforated plate (transparent gray region) with a hole and a coiled coplanar air chamber (yellow region). (right) The absorption coefficient, a, of the presented metasurface with a total absorption at 125.8 Hz. Results from the impedance analysis and numerical simulations show excellent agreement.

Optical rogue waves reveal insight into real ones

Rogue waves in the middle of the ocean often appear out of nowhere and vanish just as quickly. But in their short lifetimes, they can generate walls of water 15 to 30 meters (50 to 100 feet) high, crashing down with enough force to sink even the largest ships. Although rare, when rogue waves do occur they often take ships by surprise because their formation is not well-understood, and so they are difficult to detect in advance.

Since tracking down a rogue wave in order to study it would be difficult and dangerous, researchers have come up with another way to study these waves: creating a small-scale optical version in the lab that forms by similar underlying mechanisms, except in light instead of water. In the past few years, scientists have realized optical rogue waves in optical fibers, photonic crystals, and other optical systems.

Now a team of researchers, Christopher J. Gibson, Alison M. Yao, and Gian-Luca Oppo at the University of Strathclyde in Glasgow, Scotland, has proposed a new way to produce optical rogue waves in a two-dimensional space. Their work is published in a recent issue of Physical Review Letters.
"By understanding the mechanism for generating rogue waves, we can devise methods to detect their precursors—in our case, multi-vortex collisions," Oppo told Phys.org. "By knowing ...Read More...



An optical rogue wave with a peak that is 27 times the mean fluctuation from the average intensity. The peak is formed by multiple optical vortices colliding with one another. Credit: Gibson, et al. ©2016 American Physical Society

Superconductors could detect superlight dark matter

Many experiments are currently searching for dark matter—the invisible substance that scientists know exists only from its gravitational effect on stars, galaxies, and other objects made of ordinary matter. On Earth, scientists are using particle accelerators such as the Large Hadron Collider (LHC) to search for dark matter, while keeping an eye out elsewhere with detectors in space and even detectors located thousands of feet underground. Although scientists have covered all of their bases location-wise, these detectors may not be sensitive enough to detect dark matter if the mass of the dark matter is less than about 10 GeV (10 billion electron volts).

To address this problem, physicists are working on developing ever more sensitive dark matter detectors. In a new paper, researchers have proposed a new type of dark matter detector made of superconductors—materials that conduct electricity with zero resistance at ultracold temperatures—that may offer the highest sensitivity yet for detecting "superlight" dark matter. Superlight dark matter has a mass at the low end of the range of 1 keV (1000 electron volts) to 10 GeV, or in other words, up to a million times lighter than the proton.

The physicists, Yonit Hochberg and Kathryn M. Zurek at Lawrence Berkeley National Laboratory and the University of California, Berkeley, and Yue Zhao at Stanford University (now at the University of Michigan), have published a paper on the superconducting detectors in a recent issue of Physical Review Letters….Read More...

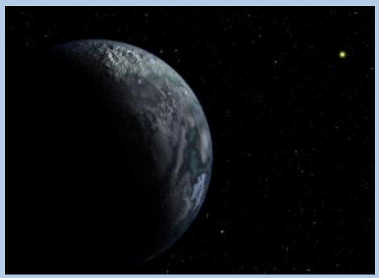
A massive cluster of yellowish galaxies, seemingly caught in a red and blue spider web of eerily distorted background galaxies, makes for a spellbinding picture from the new Advanced Camera for Surveys aboard NASA's Hubble Space Telescope. To make this unprecedented image of the cosmos, Hubble peered straight through the center of one of the most massive galaxy clusters known, called Abell 1689. The gravity of the cluster's trillion stars — plus dark matter — acts as a 2-million-light-year-wide lens in space. This gravitational lens bends and magnifies the light of the galaxies located …..

Massive Planet Gone Rogue Discovered

A massive rogue planet has been discovered in the Beta Pictoris moving group. The planet, called PSO J318.5338-22.8603 (Sorry, I didn't name it), is over eight times as massive as Jupiter. Because it's one of the few directly-imaged exoplanets we know of, and is accessible for study by spectroscopy, this massive planet will be extremely important when piecing together the details of planetary formation and evolution.

Most planets outside our solar system are not directly observable. They are discovered when they transit in front of their host star. That's how the Kepler mission finds exoplanets. After that, their properties are inferred by their gravitational interactions with their star and with any other planets in their system. We can infer a lot, and get quite detailed, but studying planets withspectroscopy is a whole other ball game.

The team of researchers, led by K. Allers of Bucknell University, used theGemini North telescope, and its Near-Infrared Spectrograph, to find PSO's radial and rotational velocities. As reported in a draft study on January 20th, PSO J318.5338-22.8603 (PSO from now on…) was confirmed as a ...Read More...



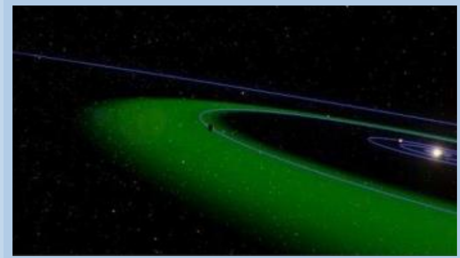
In this artist's conception, a rogue planet drifts through space. Credit: Christine Pulliam (CfA)

Model suggests carbon dioxide could cause loss of planetary water as easily as increased solar radiation

trio of researchers affiliated with the Max Planck Institute for Meteorology and Princeton University has created a computer simulation that shows that a large increase in atmospheric carbon dioxide can cause a loss of planetary water as easily as an increase in solar radiation. The team has published the details of their model and what it showed in Nature Communications.

In searching for life on other planets, space scientists look for other planets that exist in what has become known as the habitable zone—where they are in a place deemed just the right distance from their star to prevent being too hot or too cold, or too dry. But now, they may have to take another factor into consideration this new research suggests—the "moist greenhouse" as the team calls it. This is where a planet loses its water to the atmosphere, and then to space due to an increase in greenhouse gases.

The researchers came to this conclusion by starting with a standard global climate model of a simplified plant similar to Earth in some ways, such as distance from the sun and spin rate, but very different in others—the surface was completely covered in water, its orbit was perfectly circular and it was not tilted on its axis. Also, there were no land masses, ice caps or water currents and the global ocean was only 164 feet deep. The researchers put in these constraints to make their model simple, and to best utilize computer resources. To see the impact of carbon dioxide, the researchers slowly increased levels in the atmosphere, and found that once it reached approximately 1,520 parts per million, planetary instability arose—water evaporated from the ocean into the ...Read More...



An artist's conception of the habitable zone (green ring) around 55 Cancri, a star known to have a large planet orbiting in this temperature-suitable region where water could be liquid. Credit: NASA/JPL-Caltech

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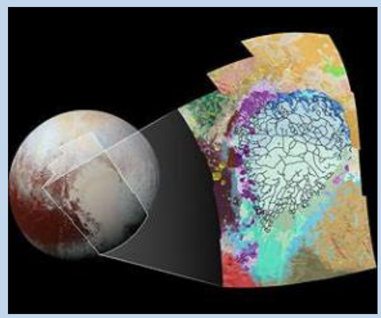
Putting Pluto's Geology on the Map

How to make sense of Pluto's surprising geological complexity? To help understand the diversity of terrain and to piece together how Pluto's surface has formed and evolved over time, mission scientists construct geological maps like the one shown above.

This map covers a portion of Pluto's surface that measures 1,290 miles (2,070 kilometers) from top to bottom, and includes the vast nitrogen-ice plain informally named Sputnik Planum and surrounding terrain. As the key in the figure below indicates, the map is overlaid with colors that represent different geological terrains. Each terrain, or unit, is defined by its texture and morphology - smooth, pitted, craggy, hummocky or ridged, for example.

How well a unit can be defined depends on the resolution of the images that cover it. All of the terrain in this map has been imaged at a resolution of approximately 1,050 feet (320 meters) per pixel or better, meaning scientists can map units with relative confidence.

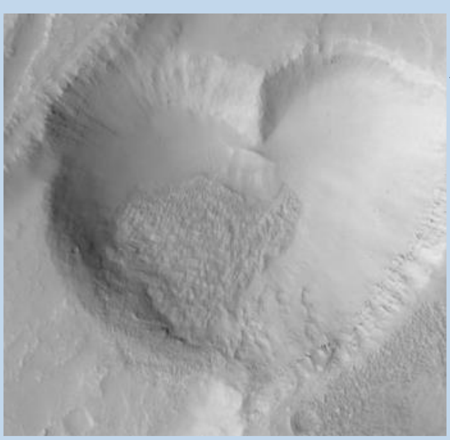
The various blue and greenish units that fill the center of the map represent different textures seen across Sputnik ...Read More...



This map of the left side of Pluto's heart-shaped feature uses colors to represent Pluto's varied terrains, which helps scientists understand the complex geological processes at work. Image courtesy NASA/JHUAPL/SwRI.

Just for Valentine's Day—Hearts

A heart-shaped feature in the Arabia Terra region of Mars taken by NASA's Mars Reconnaissance Orbiter. Image Credit: NASA/JPL-Caltech/MSSS.



This heart-shaped feature on Mars "is actually a pit formed by collapse within a straight-walled trough known in geological terms as a graben," wrote Malin Space Systems in 1999. Picture taken by Mars Global Surveyor. Credit: Malin Space Science Systems, MGS, JPL, NASA

Just for Valentine's Day— More Hearts

The Heart and Soul nebulae in an infrared mosaic from NASA's Wide-field Infrared Survey Explorer (WISE). It is located about about 6,000 light-years from Earth. Credit: NASA/JPL-Caltech/UCLA

Pluto nearly fills the frame in this image from the Long Range Reconnaissance Imager (LORRI) aboard NASA's New Horizons spacecraft, taken on July 13, 2015 when the spacecraft was 476,000 miles (768,000 kilometers) from the surface.