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

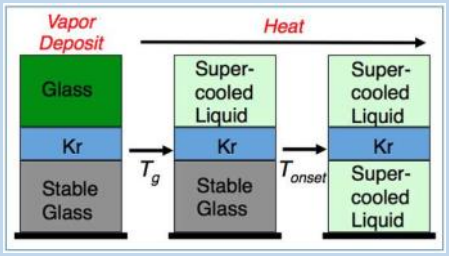
Scientists find the temperature at which glass becomes a liquid

While glass might be thought of in terms of holding wine or as a window, the stability of glass affects areas as diverse as nuclear waste storage, pharmaceuticals, and ice cream. Recently, chemical physicists at Pacific Northwest National Laboratory made a key discovery about how glass forms.

They discovered that the temperature at which glass-forming materials are deposited on a substrate affects the stability. Their findings, published in The Journal of Physical Chemistry Letters, show the ability of a technique called inert gas permeation to tell at what temperature a solid "melts." Their work brings more understanding to the fundamental properties of glass.

"Glasses are metastable materials with the mechanical properties of a solid-you can touch and hold them, versus a gas," said Dr. Scott Smith, a co-author on the paper. "But they are not like crystalline materials, which are in a perfect array. The molecules in glasses are arranged in a disordered pattern. In liquids the molecules are constantly moving, if you suddenly freeze a liquid, the molecules are randomly oriented and unstructured. In some sense, a glass can be thought of as a frozen liquid."

No matter how glass is made, understanding its properties is important. For example, the reason some medications have expiration dates is that their physical state changes from ...Read More...



Inert gas permeation, a technique developed at PNNL, is used to investigate the formation of stable glasses.

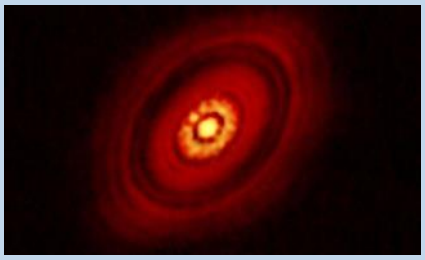
VLA shows earliest stages of planet formation

New images of a young star made with the Karl G. Jansky Very Large Array (VLA) reveal what scientists think may be the very earliest stages in the formation of planets. The scientists used the VLA to see unprecedented detail of the inner portion of a dusty disk surrounding the star, some 450 light-years from Earth.

The star and its disk were studied in 2014 with the Atacama Large Millimeter/submillimeter Array (ALMA), which produced what astronomers then called the best image ever of planet formation in progress. The ALMA image showed gaps in the disk, presumably caused by planet-like bodies sweeping out the dust along their orbits. This image, showing in real life what theorists had proposed for years, was surprising, however, because the star, called HL Tau, is only about a million years old—very young by stellar standards.

The ALMA image showed details of the system in the outer portions of the disk, but in the inner portions of the disk, nearest to the young star, the thicker dust is opaque to the short radio wavelengths received by ALMA. To study this region, astronomers turned to the VLA, which receives longer wavelengths. Their VLA images show that region better than any previous studies.

The new VLA images revealed a distinct clump of dust in the inner region of the ...Read More...



Combined ALMA/VLA image of HL Tau. Credit: Carrasco-Gonzalez, et al.; Bill Saxton, NRAO/AUI/NSF.

First successful atomically thin sheets of magnetic Van der Waals material NiPS3

Heterostructures (referred to as Van der Waals {VdW}) are attracting a great deal of attention due to their diverse physical and chemical properties. A VdW heterostructure is assembled by stacking two or more different 2D semiconducting crystals on top of each other. The structure is grown by repeating the practice, the resulting stack represents an artificial material constructed in a certain sequence, akin to Lego blocks.

There has been huge interest in these materials as they hold vast potential in helping science to find a new semiconductor that can replace silicon which decomposes and segregates in a natural environment. A VdW heterostructure can overcome the limitations of 2D crystals and offer an alternative for the construction of smaller and more powerful storage devices, supercomputers, administration of medicine and enhanced memory and graphics in hand held devices. Electrons within semiconductors roam freely and have internal states or 'spins'. These spin currents exhibit magnetic order and can be tuned to prevent energy dissipation which occurs naturally when information is processed at vast speeds.

However, not all VdW's have this spin state; scientifically known as an antiferromagnetic state. PARK Je-Geun, a scientist from CCES, explains the unique qualities of their tested material NiPS3: "The compound nickel phosphorus trisulfide (NiPS3) is an intrinsically magnetic material and is an invaluable building block for the design for multi-layered VdW heterostructures." The Center is the first to obtain ...Read More...

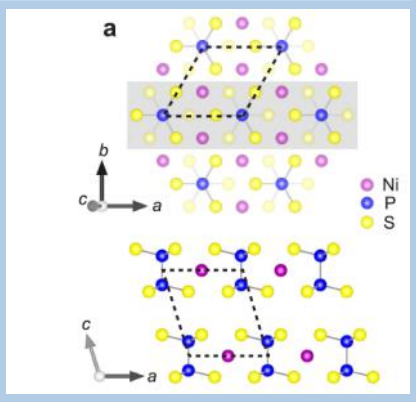


Fig_1__Atomic_structure_and_optical_characterization_of_exfoliated_NiPS3.

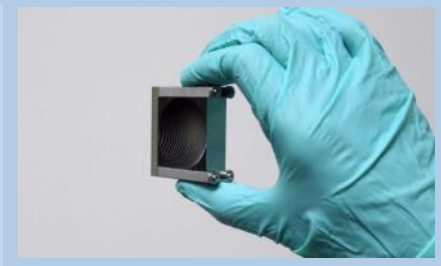
Researchers develop new lens for terahertz radiation

Terahertz radiation is a relatively unexplored slice of the electromagnetic spectrum, but it holds the promise of countless new imaging applications as well as wireless communication networks with extremely high bandwidth. The problem is that there are few off-the-shelf components available for manipulating terahertz waves.

Now, researchers from Brown University's School of Engineering have developed a new type of lens for focusing terahertz radiation (which spans from about 100 to 10,000 GHz). The lens, made from an array of stacked metal plates with spaces between them, performs as well or better than existing terahertz lenses, and the architecture used to build the device could set the stage for a range of other terahertz components that don't currently exist.

The work was led by Rajind Mendis, assistant professor of engineering (research) at Brown, who worked with Dan Mittleman, professor of engineering at Brown. The work is described in the journal Nature Scientific Reports.

"Any photonic system that uses terahertz - whether it's in imaging, wireless communications or something else - will require lenses," said Dan Mittleman, professor of engineering at Brown and the senior author on the new paper. "We wanted to look for new ways to focus terahertz radiation." Most lenses use the refractive properties of a material to focus light energy. Eyeglasses, for example, use convex glass to ...Read More...



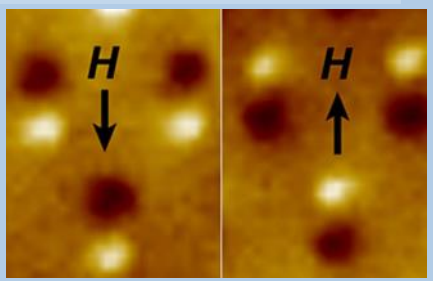
Researchers have used an array of stacked plates to make a lens for terahertz radiation. The technique could set stage for new types of components for manipulating terahertz waves. Credit: Mittleman lab / Brown University

Experiment shows magnetic chips could dramatically increase computing's energy efficiency

In a breakthrough for energy-efficient computing, engineers at the University of California, Berkeley, have shown for the first time that magnetic chips can operate with the lowest fundamental level of energy dissipation possible under the laws of thermodynamics.

The findings, to be published Friday, March 11, 2016 in the peer-reviewed journal Science Advances, mean that dramatic reductions in power consumption are possible—as much as one-millionth the amount of energy per operation used by transistors in modern computers. This is critical for mobile devices, which demand powerful processors that can run for a day or more on small, lightweight batteries. On a larger, industrial scale, as computing increasingly moves into 'the cloud,' the electricity demands of the giant cloud data centers are multiplying, collectively taking an increasing share of the country's—and world's—electrical grid.

"We wanted to know how small we could shrink the amount of energy needed for computing," said senior author Jeffrey Bokor, a UC Berkeley professor of electrical engineering and computer sciences and a faculty scientist at the Lawrence Berkeley National Laboratory. "The biggest challenge in designing computers and, in fact, all our electronics today is reducing their energy consumption." Lowering energy use is a relatively recent shift in focus in chip manufacturing after decades of emphasis on packing greater numbers ...Read More...



Magnetic microscope image of three nanomagnetic computer bits. Each bit is a tiny bar magnet only 90 nanometers long. The microscope shows a bright spot at the "North" end and a dark spot at the "South" end of the magnet. The "H" arrow shows the direction of magnetic field applied to switch the direction of the magnets. Credit: Jeongmin Hong and Jeffrey Bokor

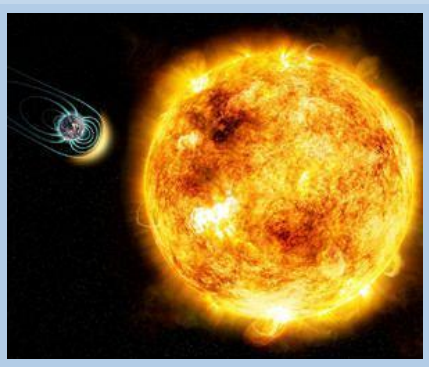
Young sun-like star shows a magnetic field was critical for life on the early Earth

Nearly four billion years ago, life arose on Earth. Life appeared because our planet had a rocky surface, liquid water, and a blanketing atmosphere. But life thrived thanks to another necessary ingredient: the presence of a protective magnetic field. A new study of the young, Sun-like star Kappa Ceti shows that a magnetic field plays a key role in making a planet conducive to life.

"To be habitable, a planet needs warmth, water, and it needs to be sheltered from a young, violent Sun," says lead author Jose-Dias Do Nascimento of the Harvard-Smithsonian Center for Astrophysics (CfA) and University of Rio G. do Norte (UFRN), Brazil.

Kappa Ceti, located 30 light-years away in the constellation Cetus, the Whale, is remarkably similar to our Sun but younger. The team calculates an age of only 400-600 million years old, which agrees with the age estimated from its rotation period (a technique pioneered by CfA astronomer Soren Meibom). This age roughly corresponds to the time when life first appeared on Earth. As a result, studying Kappa Ceti can give us insights into the early history of our solar system.

Like other stars its age, Kappa Ceti is very magnetically active. Its surface is blotched with many giant starspots, like sunspots but larger and more numerous. It also propels a steady stream of plasma, or ionized gases, out into space. The research team found that this stellar wind is 50 times stronger than our Sun's solar wind….Read More...



In this artist's illustration, the young Sun-like star Kappa Ceti is blotched with large starspots, a sign of its high level of magnetic activity. New research shows that its stellar wind is 50 times stronger than our Sun's. As a result, any Earth-like planet would need a magnetic field in order to protect its atmosphere and be habitable. The physical sizes of the star and planet and distance between them are not to scale. Image courtesy M. Weiss/CfA.

Unexpected changes in Ceres' bright spots

Astronomers have seen unexpected changes in the dwarf planet Ceres' famous bright spots. The most prominent of the Ceres bright spots lie inside the crater Occator, but there are many bright spots on this little world. One group of astronomers said in December they are likely salt deposits. The spots appeared eye-catchingly strange to the cameras of the Dawn spacecraft when it began orbiting Ceres in March, 2015.

Now astronomers on Earth have found ingenious ways to study the bright spots, too, and new work suggests that the spots brighten during the day and also show other variations. These observations suggest that the material of the spots is volatile and evaporates in the warm glow of sunlight.

The work suggests that Ceres may be a much more active world than most of its asteroid neighbors. The new study's lead author, astronomer Paolo Molaro, said:

As soon as the Dawn spacecraft revealed the mysterious bright spots on the surface of Ceres, I immediately thought of the possible measurable effects from Earth. As Ceres rotates the spots approach the Earth and then recede again, which affects the spectrum ...Read More...

Artist's concept of Ceres bright spots, based on a detailed map of the surface compiled from images taken from NASA's Dawn spacecraft. The very bright patches of material are in Ceres' crater Occator; altogether, astronomers have seen some 130 bright spots on Ceres.

Cosmic rays accelerating to unprecedented speeds at centre of Milky Way

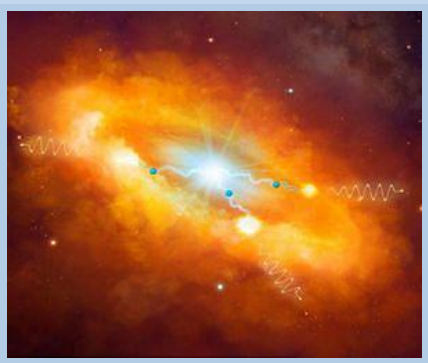
For more than ten years the H.E.S.S. observatory in Namibia, run by an international collaboration of 42 institutions in 12 countries, has been mapping the centre of our galaxy in very-high-energy gamma rays. These gamma rays are produced by cosmic rays from the innermost region of the Galaxy.

A detailed analysis of the latest H.E.S.S. data, published on 16th March 2016 in Nature, reveals for the first time a source of this cosmic radiation at energies never observed before in the Milky Way: the supermassive black hole at the centre of the Galaxy, likely to accelerate cosmic rays to energies 100 times larger than those achieved at the largest terrestrial particle accelerator, the LHC at CERN.

The Earth is constantly bombarded by high energy particles (protons, electrons and atomic nuclei) of cosmic origin, particles that comprise the so-called "cosmic radiation".

These "cosmic rays" are electrically charged, and are hence strongly deflected by the interstellar magnetic fields that pervade our galaxy. Their path through the cosmos is randomised by these deflections, making it impossible to directly identify the astrophysical sources responsible for their production. Thus, for more than a century, the origin of the cosmic rays remains one of the most enduring mysteries of science.

Fortunately, cosmic rays interact with light and gas in the neighbourhood of their sources, producing gamma rays. These gamma rays travel in straight lines, undeflected by magnetic fields, and can therefore be traced back ...Read More...



Artist's impression of the giant molecular clouds surrounding the Galactic Centre, bombarded by very high energy protons accelerated in the vicinity of the central black hole and subsequently shining in gamma rays. Image courtesy Dr Mark A. Garlick/ H.E.S.S. Collaboration.

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General Lecture on Mar. 22, 2016

Hubble unveils monster stars

Astronomers using the unique ultraviolet capabilities of the NASA/ESA Hubble Space Telescope have identified nine monster stars with masses over 100 times the mass of the Sun in the star cluster R136. This makes it the largest sample of very massive stars identified to date. The results, which will be published in the Monthly Notices of the Royal Astronomical Society, raise many new questions about the formation of massive stars.

An international team of scientists using the NASA/ESA Hubble Space Telescope has combined images taken with the Wide Field Camera 3 (WFC3) with the unprecedented ultraviolet spatial resolution of the Space Telescope Imaging Spectrograph (STIS) to successfully dissect the young star cluster R136 in the UV for ...Read More...

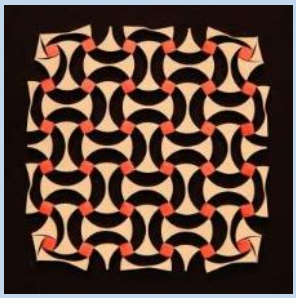
The image shows the central region of the Tarantula Nebula in the Large Magellanic Cloud. The young and dense star cluster R136 can be seen at the lower right of the image. This cluster contains hundreds of young blue stars, among them the most massive star detected in the Universe so far. Using the NASA/ESA Hubble Space Telescope astronomers were able to study the central and most dense region of this cluster in detail. Here they found nine stars with more than 100 solar masses. Credit: NASA, ESA, P Crowther (University of Sheffield)

Patterns in Islamic arts inspire stretchy metamaterials

Scholars have recognized that Medieval Islamic tiling reveals more than beauty; it also reveals mathematical prowess. A report in New Scientist in 2007 discussed how Medieval Islamic designers used elaborate geometrical tiling patterns at least 500 years before Western mathematicians developed the concept.

A set of five girih tiles decorated with lines that fit together to make regular patterns first appeared about 1200 AD, a time when Islamic mathematics was flowering. The designs grew increasingly complex. Later on, near-perfect Penrose patterns were found on the Darb-i Imam shrine in Isfahan, Iran.

The place of Islamic art in science was again made evident this week. Shannon Hall writing in New Scientist on Wednesday reported on a new class of futuristic materials that grow when stretched, supported by the geometries of ancient Islamic art. ,...Read More...

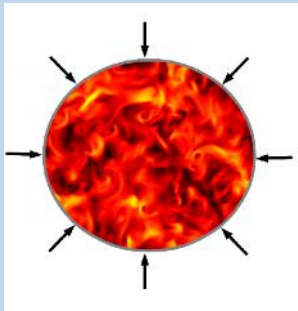


Credit: Pasini group

Compressing turbulence to improve inertial confinement fusion experiments

Physicists have long regarded plasma turbulence as unruly behavior that can limit the performance of fusion experiments. But new findings by researchers associated with the U.S. Department of Energy's (DOE) Princeton Plasma Physics Laboratory (PPPL) and the Department of Astrophysical Sciences at Princeton University indicate that turbulent swirls of plasma could benefit one of the two major branches of such research. The editors of Physical Review Letters highlighted these findings—a distinction given to one of every six papers per issue—when they published the results last week on March 11, 2016.

Lead author Seth Davidovits, a Princeton University graduate student, and Professor Nat Fisch, his thesis advisor and Associate Director for Academic Affairs at PPPL, produced the findings. They modeled the compression of fluid turbulence, showing effects that suggested a surprising positive impact of turbulence ...Read More...



Compression of a turbulent plasma. Credit: Seth Davidovits