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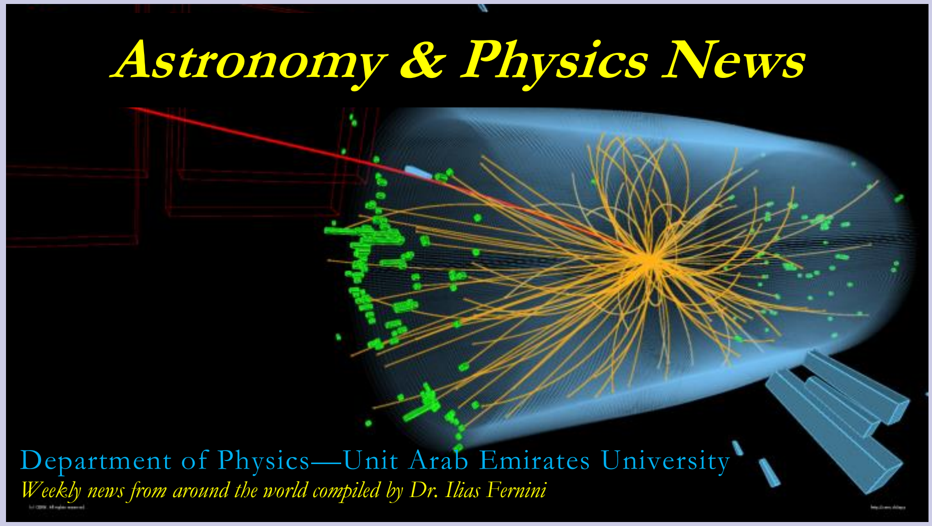


Inside this issue:

Quantum hard drive breakthrough

Physicists developing a prototype quantum hard drive have improved storage time by a factor of more than 100.

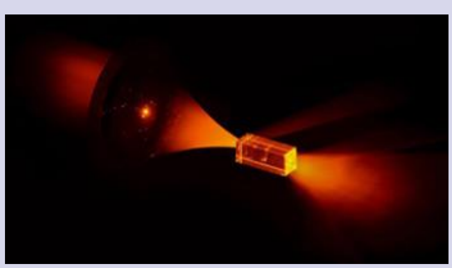
The team's record storage time of six hours is a major step towards a secure worldwide data encryption network based on quantum information, which could be used for banking transactions and personal emails.

"We believe it will soon be possible to distribute quantum information between any two points on the globe," said lead author Manjin Zhong, from the Research School of Physics and Engineering (RSPE).

"Quantum states are very fragile and normally collapse in milliseconds. Our long storage times have the potential to revolutionize the transmission of quantum information."

Quantum information promises unbreakable encryption because quantum particles such as photons of light can be created in a way that intrinsically links them. Interactions with either of these entangled particles affect the other, no matter how far they are separated.

The team of physicists at Australian National Univ. (ANU) and the Univ. ...***Read More***…



Writing quantum information onto a europium ion embedded in a crystal. Image: Solid State Spectroscopy Group, ANU

Shedding light on why blue LEDs are so tricky to make

Scientists at Univ. College London (UCL), in collaboration with groups at the Univ. of Bath and the Daresbury Laboratory, have uncovered the mystery of why blue light-emitting diodes (LEDs) are so difficult to make, by revealing the complex properties of their main component—gallium nitride—using sophisticated computer simulations.

Blue LEDs were first commercialized two decades ago and have been instrumental in the development of new forms of energy saving lighting, earning their inventors the 2014 Nobel Prize in Physics. LEDs are made of two layers of semiconducting materials (insulating materials which can be made conduct electricity in special circumstances). One has mobile negative charges, or electrons, available for conduction, and the other positive charges, or holes. When a voltage is applied, an electron and a hole can meet at the junction between the two, and a photon (light particle) is emitted.

The desired properties of a semiconductor layer are achieved by growing a crystalline film of a particular material and adding small quantities of an 'impurity' element, which has ...***Read More***...

Image: Univ. College London

Thermal memory thrives at extremely high temperatures

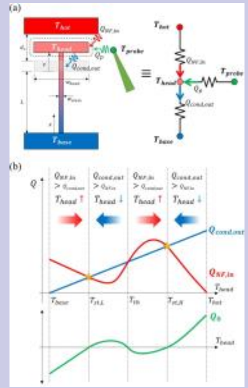
While the performance of electronic memory devices degrades at high temperatures, a newly proposed memory actually requires temperatures in excess of 600 K to operate. Called NanoThermoMechanical memory, the new device uses heat instead of electricity to record, store, and recover data. With its ability to operate at extremely high temperatures, the memory could be used in space exploration missions, deep-well drilling, and in combustion engines, among other applications.

The researchers, graduate student Mahmoud Elzouka and Assistant Professor Sidy Ndao at the University of Nebraska-Lincoln, have published a paper on the NanoThermoMechanical memory in a recent issue of Applied Physics Letters.

"The important significance is the actual design/ development of a practical, high-temperature memory (and logic) device," Ndao told Phys.org. "Currently, nothing exists that can fulfill data recording or random access memories that can function well in extreme environments."

In the proposed NanoThermoMechanical memory, the two binary memory states "0" and "1" are represented by two stable temperature states. In simulations, for example, a temperature of 1038 K represents "0" while 1341 K represents "1."

Having two distinct stable temperature states is unusual, as most devices have only one such state. The key to achieving two stable states involves careful engineering to ...***Read More***….



(a, left) Memory device layout and (right) equivalent thermal circuit. (b) The memory device has two stable states, indicated by the yellow stars, that correspond to a binary "0" and "1." The plot shows the heat conduction lost from the head through the stem (blue line), the near-field radiative heat supplied to the head (red line), and the net...

High-temperature superconductor 'fingerprint' found

Theorists and experimentalists working together at Cornell may have found the answer to a major challenge in condensed matter physics: identifying the smoking gun of why "unconventional" superconductivity occurs, they report in Nature Physics, published online Dec. 22.

Associate professor of physics Eun-Ah Kim led the way, joining forces with experimentalist J.C. Seamus Davis, the J.G. White Distinguished Professor of Physical Sciences in the College of Arts and Sciences. They have isolated a "fingerprint" that identifies specific fluctuations in electrons that force them into pairs, causing their host material, in this case, a high-temperature superconductor called lithium iron arsenic, to make way for free-flowing, resistance-free electron pairs.

Superconductivity overcomes the naturally occurring repulsion between electrons, quantified by Coulomb's law, which normally prevents their pairing. In "conventional" superconductors – metals that allow electrons to flow without resistance at temperatures around 460 degrees below zero – there's pretty good understanding of why superconductivity happens. In that case, electron pairing is driven by the exchange of vibrations in the material's crystal structure, which become strong enough to overcome Coulomb repulsion. This mechanism only works in extremely cold temperatures in which electrons move very slowly.

About three decades ago, physicists started studying "unconventional" superconductors...***Read More***...

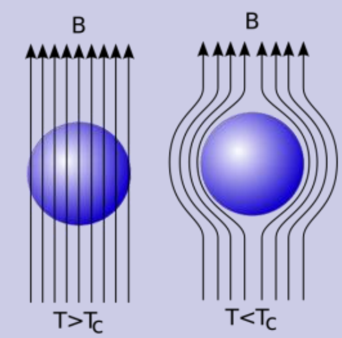


Diagram of the Meissner effect. Magnetic field lines, represented as arrows, are excluded from a superconductor when it is below its critical temperature. Wikipedia...

Levitation recreates nature's dumbbells

Splash form tektites are tiny pieces of natural glass created out of spinning drops of molten rock flung from the earth during an extra-terrestrial impact—when the earth is hit by asteroids or comets. They come in a myriad of shapes—from dumbbell to doughnut—and the formation of these shapes has been the subject of scientific investigation for centuries.

Using magnetic levitation to imitate weightlessness, researchers led by physicists at The University of Nottingham have manufactured solid wax models of these shapes. Dr Kyle Baldwin from the School of Physics and Astronomy, said: "These wax models provide the first direct experimental validation for numerical models of the equilibrium shapes of spinning droplets. This research is of importance to fundamental physics and also to study of tektite formation."

Until now the shapes of rapidly spinning, highly deformed droplets have been derived entirely from numerical simulations. It is hoped this new experimental technique can be used to better reproduce and understand tektite formation. Their research—Artificial tektites: an experimental technique for capturing the shapes of spinning drops—funded by the Engineering and Physical Sciences Research Council (EPSRC) is published today in the online, open access journal Scientific Reports.

A droplet of liquid in space is spherical, but spin it and it forms all kinds of shapes from squashed balls to bone-shaped, depending on its rate of spin. Atomic nuclei...***Read More***...

Dr. Baldwin holds splash form tektite and his manufactures solid wax model of a splash form tektite. Credit: University of Nottingham

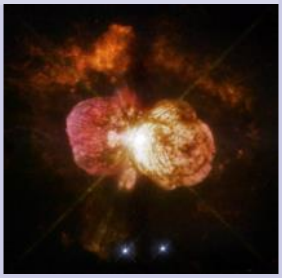
NASA observatories take an unprecedented look into superstar Eta Carinae

Eta Carinae, the most luminous and massive stellar system within 10,000 light-years of Earth, is known for its surprising behavior, erupting twice in the 19th century for reasons scientists still don't understand. A long-term study led by astronomers at NASA's Goddard Space Flight Center in Greenbelt, Maryland, used NASA satellites, ground-based telescopes and theoretical modeling to produce the most comprehensive picture of Eta Carinae to date. New findings include Hubble Space Telescope images that show decade-old shells of ionized gas racing away from the largest star at a million miles an hour, and new 3-D models that reveal never-before-seen features of the stars' interactions.

"We are coming to understand the present state and complex environment of this remarkable object, but we have a long way to go to explain Eta Carinae's past eruptions or to predict its future behavior," said Goddard astrophysicist Ted Gull, who coordinates a research group that has monitored the star for more than a decade.

Located about 7,500 light-years away in the southern constellation of Carina, Eta Carinae comprises two massive stars whose eccentric orbits bring them unusually close every 5.5 years. Both produce powerful gaseous outflows called stellar winds, which enshroud the stars and stymy efforts to directly measure their properties. Astronomers have established that the brighter, cooler primary star has about 90 times the mass of the sun and outshines it by 5 million times. While the properties of its smaller, hotter companion are more contested, Gull and his colleagues think the star has about 30 solar masses and emits a million times the sun's light.

Speaking at a press conference at the American Astronomical Society meeting in Seattle on Wednesday, the Goddard researchers discussed recent observations of Eta Carinae ...**Read More**...



Eta Carinae's great eruption in the 1840s created the billowing Homunculus Nebula, imaged here by Hubble. Now about a light-year long, the expanding cloud contains enough material to make at least 10 copies of our sun. Astronomers cannot yet explain what caused this eruption. Credit: NASA, ESA, and HST

Where did all the stars go? Dark cloud obscures hundreds of background stars

Some of the stars appear to be missing in this intriguing new ESO image. But the black gap in this glitteringly beautiful starfield is not really a gap, but rather a region of space clogged with gas and dust. This dark cloud is called LDN 483—for Lynds Dark Nebula 483. Such clouds are the birthplaces of future stars. The Wide Field Imager, an instrument mounted on the MPG/ESO 2.2-metre telescope at ESO's La Silla Observatory in Chile, captured this image of LDN 483 and its surroundings.

LDN 483 is located about 700 light-years away in the constellation of Serpens (The Serpent). The cloud contains enough dusty material to completely block the visible light from background stars. Particularly dense molecular clouds, like LDN 483, qualify as dark nebulae because of this obscuring property. The starless nature of LDN 483 and its ilk would suggest that they are sites where stars cannot take root and grow. But in fact the opposite is true: dark nebulae offer the most fertile environments for eventual star formation.

Astronomers studying star formation in LDN 483 have discovered some of the youngest observable kinds of baby stars buried in LDN 483's shrouded interior. These gestating stars can be thought of as still being in the womb, having not yet been born as ...**Read More**...

The Wide Field Imager (WFI) on the MPG/ESO 2.2-metre telescope at the La Silla Observatory in Chile snapped this image of the dark nebula LDN 483. The object is a region of space clogged with gas and dust….

Machines teach astronomers about stars

Astronomers are enlisting the help of machines to sort through thousands of stars in our galaxy and learn their sizes, compositions and other basic traits.

The research is part of the growing field of machine learning, in which computers learn from large data sets, finding patterns that humans might not otherwise see. Machine learning is in everything from media-streaming services that predict what you want to watch, to the post office, where computers automatically read handwritten addresses and direct mail to the correct zip codes.

Now astronomers are turning to machines to help them identify basic properties of stars based on sky survey images. Normally, these kinds of details require a spectrum, which is a detailed sifting of the starlight into different wavelengths. But with machine learning, computer algorithms can quickly flip through available stacks of images, identifying patterns that reveal a star's properties. The technique has the potential to gather information on billions of stars in a relatively short time and with less expense.

"It's like video-streaming services not only predicting what you would like to watch in the future, but also your current age, based on your viewing preferences," said Adam Miller of NASA's Jet Propulsion Laboratory in Pasadena, California, lead author of a new report on the findings appearing in the Astrophysical Journal. "We are predicting fundamental properties of the stars."

Miller presented the results today at the annual American Astronomical Society meeting in Seattle...**Read More**...

Astronomers have turned to a method called "machine learning" to help them understand the properties of large numbers of stars. Credit: NASA/JPL-Caltech

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Not something you see every day. Credit: Leapsecond.com

Why moving from astronomic to atomic time is a tricky business

Most people would feel they can count on one day comprising the same number of hours, minutes and seconds as the next. But this isn't always the case – June 30 will be a second longer in 2015 with the addition of a leap second, added to reconcile the differences between two definitions of time: one astronomical, the other provided by atomic clocks.

Before the 1950s, time was defined by the position of the sun in the sky, as measured by instruments that monitor the Earth's rotation. But this rotation is not constant. It is slowing due to the gravitational pull of the moon, with days lengthening by 1.7 milliseconds per century.

The varying length of the day has been known for centuries but only became a practical concern (outside astronomy) with the invention of atomic clocks in the 1950s. These provide a far more stable and easy-to-use definition of time, based on a particular microwave frequency absorbed by caesium atoms. Atomic clock signals were soon used to control ...***Read More***...

Sun may determine lifespan at birth, study finds

Could the Sun be your lucky—or unlucky—star? In an unusual study published Wednesday, Norwegian scientists said people born during periods of solar calm may live longer, as much as five years on average, than those who enter the world when the Sun is feisty.

The team overlaid demographic data of Norwegians born between 1676 and 1878 with observations of the Sun.

The lifespan of those born in periods of solar maximum—interludes marked by powerful flares and geomagnetic storms—was "5.2 years shorter" on average than those born during a solar minimum, they found.

"Solar activity at birth decreased the probability of survival to adulthood," thus truncating average lifespan, according to the paper published in the journal Proceedings of the Royal Society B.

There was a stronger effect on girls than boys, it said.

The Sun has cycles that last 11 years, give or take, from one period of greatest activity or solar maximum, to the next.

Solar maxima are marked by an increase in sunspots, solar flares and coronal mass ejections that can disrupt radio communications and electrical power on Earth, damage satellites and disturb navigational equipment.

Solar activity is also linked to levels of ultraviolet radiation— an environmental stressor known to affect survival and reproductive performance, possibly by causing cell and DNA damage, according to the study authors.

Fertility reduced

The team, from the Norwegian University of Science and Technology, based their study on demographic data from church records of some 8,600 individuals from two different mid-Norwegian populations, one poor and one wealthy.

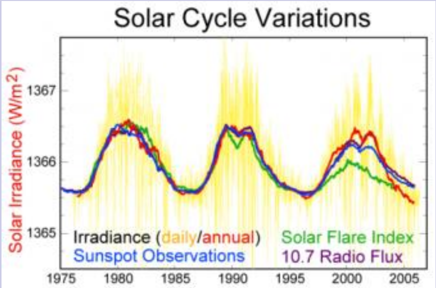
This was matched to maps of historical solar cycles.

On top of lifespan, being born in a solar maximum period also "significantly reduced" fertility for women born into the poor category, but not for wealthier women or for men, said the authors.

"We show for the first time that not only infant survival and thus lifespan but also fertility is statistically associated with solar activity at birth," they wrote.

It was not clear whether the same would necessarily hold true for people born in the modern era.

One explanation could be ultraviolet-induced degradation of the B vitamin ...***Read More***...



Credit: Robert A. Rohde/GNU General Public License