September 03, 2016 Dhu'l Hijjah 01, 1437 AH Volume 6, Issue 36

Astronomy & Physics Weekly News

Dept. of Applied Physics & Astronomy - **University of Sharjah**
Compiled by **Dr. Ilias Fernini**

مركز الشارقة لعلوم الفضاء والفلك
Sharjah Center for Astronomy & Space Sciences

Top News

SCASS ACTIVITIES:

1. Lecture: Dr. Ilia Roussev on Sep. 03
2. Lecture: Prof. John Ellis on Sep. 06
3. Mni-Workshop: Physics at the TeV Scale - Sep. 07

This Week's Sky at a Glance, Sep. 03 - 09

جامعة الشارقة
UNIVERSITY OF SHARJAH

We're no strangers to 'alien' false alarms – one was caused by a microwave oven

Credit: Shutterstock

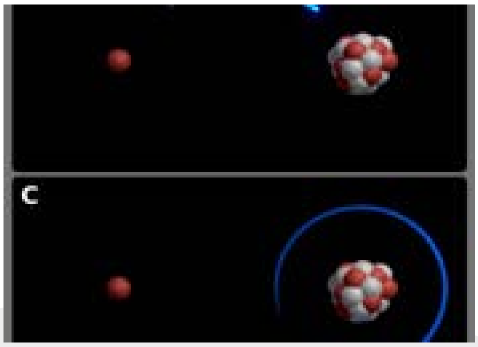
The group of Russian astronomers spotted something unusual. They were observing the rather innocuous star HD 164595, located in the constellation of Hercules 94 light years (or about 900 trillion kilometres) from Earth. It's a sun-like star of a similar age to the Sun and is known to have at least one large planet orbiting it. So it was with some surprise that the astronomers at the RATAN-600 radio telescope, located in Zelenchukskaya and led by Nikolay Bursov, received a short but loud radio burst from the direction of HD 164595.

News of the signal broke in mid August this year – even though it was originally picked up on May 15 2015. Given the possible origin of the radio signal, its frequency, and the signal strength there has been much speculation about what the source could be, including the possibility that it is a beacon signal from an advanced alien civilisation.

Such a short duration and bright radio burst is difficult to explain as a naturally occurring, if it is at the distances suggested by the direction it came from. The strength of the signal was 0.75 Janskys, which might not seem much given that a mobile phone at a distance of a kilometre has a signal strength of 110m Janskys. But at the distances involved (if it is coming from HD 164595) it is a very powerful signal indeed.

In response to the announcement, the Search for Extra-Terrestrial Intelligence (SETI) and Messaging to Extra-Terrestrial Intelligence (METI) institutes are turning the Allen Telescope Array and the Boquete Optical SETI Observatory towards the star. They hope that if this bank of radio telescopes built in part to look for alien life can recover the signal, they can learn more about its nature and origin. ...Read More...

Mysterious X-ray signal does not originate from dark matter



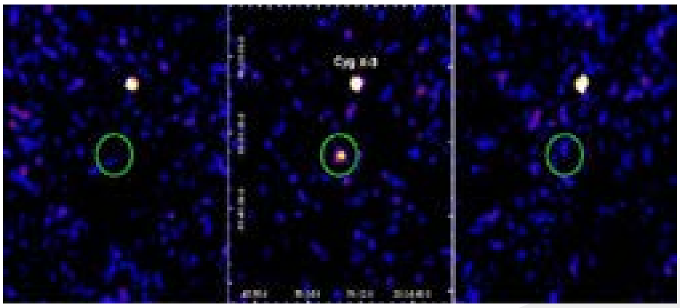
Charge exchange instead of dark matter: An X-ray signal from clusters of galaxies, which researchers have so far not been able to explain, could be produced when highly charged sulfur captures an electron. A sulfur nucleus (S16+) approaches a hydrogen atom (A) and attracts the electron (B), which ends up in a high energy level of S15+ (C) before falling back into the ground state (D), emitting X-rays as it does so. Credit: Max Planck Society

A mysterious X-ray signal from clusters of galaxies recently caused some excitement among astronomers: Does it perhaps originate from dark matter, which makes up around 80 percent of the matter in the universe, but which scientists have not yet been able to detect? In order to help answering this question, physicists at the Max Planck Institute for Nuclear Physics in Heidelberg checked an alternative explanation. Accordingly, the search for this form of matter, which is difficult to detect, must go on, as the mysterious X-ray signal seems to originate from highly charged sulfur ions that capture electrons from hydrogen atoms.

Around two years ago, the XMM-Newton X-ray satellite radioed data back to Earth which fired up great hopes with astrophysicists. It had picked up weak radiation from several galaxy clusters at an energy of around 3.5 kiloelectronvolts (keV) which the researchers were not immediately able to explain with the aid of the known X-ray spectra. Speculation quickly arose that they could be signals of decaying particles of dark matter – this would have been the first concrete trace of the long-sought form of matter. Hope was soon dampened, however: The regions in which XMM-Newton observed the X-ray radiation did not match the spatial distribution which astrophysical analyses predicted for dark matter.

In addition, there are still a large number of physical processes for which astronomers do not know the corresponding fingerprints in X-ray spectra, and so cannot yet be excluded as the possible cause of the mysterious signal. Fact is, the spectral data in the collection of tables which researchers use to evaluate astronomical spectra are still incomplete. They are sometimes based on theoretical assumptions and are correspondingly unreliable. ...Read More...

Two new fast X-ray transients discovered in the galactic plane



IBIS/ISGRI ScW image sequence (22-60 keV) from number 25 to 27 (revolution 1614) of the newly discovered transient source IGR J20344+3913 (encircled). Credit: Sguera et al., 2016.

Astronomers have identified two new X-ray sources in the galactic plane with short outbursts and very fast rise times, a category known as fast X-ray transients (FXTs). The newly detected FXTs were found in the archival data of ESA's INTErnational Gamma-Ray Astrophysics Laboratory (INTEGRAL) spacecraft. The findings are detailed in a paper published Aug. 29 on arXiv.org.

FXTs are very difficult to detect because they occur at unpredictable locations and times and their activity is very brief. INTEGRAL is one of the space observatories capable of detecting such elusive X-ray sources. Since 2002, the spacecraft, equipped in an X-ray detector, is constantly scanning the sky simultaneously in gamma rays, X-rays and visible light, searching for powerful explosions in the universe.

Now, a team of researchers led by Vito Sguera of the Institute of Space Astrophysics and Cosmic Physics of Bologna, Italy, has analyzed archival INTEGRAL data, looking for interesting FXTs in the galactic plane, still undetected by other X-ray telescopes.
"We report on the analysis of archival INTEGRAL data pertaining to observations of specific regions of the galactic plane with the aim of finding new FXTs. As result, we report on the discovery of two new such sources which have not been previously detected by any other X-ray telescope," the paper reads.

The newly found FXTs were designated IGR J03346+4414 and IGR J20344+3913. Both sources showcase a remarkable hard X-ray activity above 20 keV, in term of duration, peak-flux and dynamic range. The duration of IGR J03346+4414 is only 15 minutes and it exhibits a fast rise, lasting about three minutes, followed by a slower decay. IGR J20344+3913 lasted 33 minutes and its rise was much slower, as it took the source about 15 minutes to reach its peak activity.

"Both are characterized by short and bright outbursts as detected by INTEGRAL," the astronomers wrote in the paper.
Presenting the spectral and temporal characteristics of the two FXTs, the scientists also discuss the possible origin of these sources. According to the paper, the most plausible hypotheses that could explain the nature of the two newly detected violent X-ray events include stellar flares, symbiotic X-ray binaries (SyXBs) and blazars behind the galactic plane. ...Read More...

Images from Sun's edge reveal origins of solar wind

Conceptual animation (not to scale) showing the Sun's corona and solar wind. Credit: NASA's Goddard Space Flight Center/Lisa Poje

Ever since the 1950s discovery of the solar wind - the constant flow of charged particles from the sun - there's been a stark disconnect between this outpouring and the sun itself. As it approaches Earth, the solar wind is gusty and turbulent. But near the sun where it originates, this wind is structured in distinct rays, much like a child's simple drawing of the sun. The details of the transition from defined rays in the corona, the sun's upper atmosphere, to the solar wind have been, until now, a mystery.

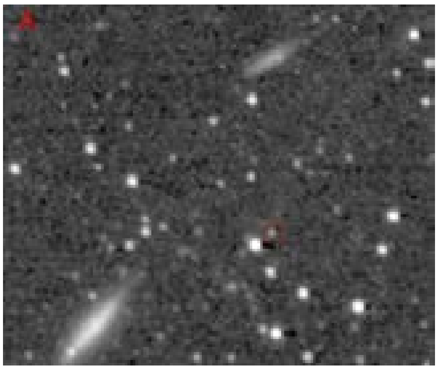
Using NASA's Solar Terrestrial Relations Observatory, or STEREO, scientists have for the first time imaged the edge of the sun and described that transition, where the solar wind starts. Defining the details of this boundary helps us learn more about our solar neighborhood, which is bathed throughout by solar material - a space environment that we must understand to safely explore beyond our planet. A paper on the findings was published in The Astrophysical Journal on Sept. 1, 2016.

"Now we have a global picture of solar wind evolution," said Nicholeen Viall, a co-author of the paper and a solar scientist at NASA's Goddard Space Flight Center in Greenbelt, Maryland. "This is really going to change our understanding of how the space environment develops."

Both near Earth and far past Pluto, our space environment is dominated by activity on the sun. The sun and its atmosphere are made of plasma - a mix of positively and negatively charged particles which have separated at extremely high temperatures, that both carries and travels along magnetic field lines. Material from the corona streams out into space, filling the solar system with the solar wind.

But scientists found that as the plasma travels further away from the sun, things change: The sun begins to lose magnetic control, forming the boundary that defines the outer corona - the very edge of the sun. ...Read More...

New Horizons Spies a Kuiper Belt Companion



In July 2016, NASA's New Horizons spacecraft observed the Kuiper Belt Object Quaoar ("Kwa-war"), which - at 690 miles or 1,100 kilometers in diameter - is roughly half the size of Pluto. This animated sequence shows composite images taken by New Horizons' Long Range Reconnaissance Imager (LORRI) at four different times over July 13-14: "A" on July 13 at 02:00 Universal Time; "B" on July 13 at 04:08 UT; "C" on July 14 at 00:06 UT; and "D" on July 14 at 02:18 UT. Each composite includes 24 individual LORRI images, providing a total exposure time of 239 seconds and making the faint object easier to see.

NASA's New Horizons is doing some sightseeing along the way, as the spacecraft speeds toward a New Year's Day 2019 date with an ancient object in the distant region beyond Pluto known as 2014 MU69.

New Horizons recently observed the Kuiper Belt object Quaoar ("Kwa-war"), which - at 690 miles or 1,100 kilometers in diameter - is roughly half the size of Pluto.

This animated sequence shows composite images taken by New Horizons' Long Range Reconnaissance Imager (LORRI) at four different times over July 13-14: "A" on July 13 at 02:00 Universal Time; "B" on July 13 at 04:08 UT; "C" on July 14 at 00:06 UT; and "D" on July 14 at 02:18 UT. Each composite includes 24 individual LORRI images, providing a total exposure time of 239 seconds and making the faint object easier to see.

New Horizons' location in the Kuiper Belt gives the spacecraft a uniquely oblique view of the small planets like Quaoar orbiting so far from the sun. When these images were taken, Quaoar was approximately 4 billion miles (6.4 billion kilometers) from the sun and 1.3 billion miles (2.1 billion kilometers) from New Horizons.

With the oblique view available from New Horizons, LORRI sees only a portion of Quaoar's illuminated surface, which is very different from the nearly fully illuminated view of the KBO from Earth. Comparing Quaoar from the two very different perspectives gives mission scientists a valuable opportunity to study the light-scattering properties of Quaoar's surface. In addition to many background stars, two far away galaxies - IC 1048 and UGC 09485, each about 370 billion times farther from ... Read More...

Scientists Observe Solar Eclipse's Effects on Weather

File Image.

When the Moon abruptly cuts off sunlight from Earth at a total solar eclipse, our weather reacts to the sudden darkness. A new issue of the Philosophical Transactions of the Royal Society of London, the oldest surviving scientific journal, deals with the effects of the March 20, 2015, eclipse. Williams College professor Jay Pasachoff, former Fulbright visitor to Williams College Marcos Penaloza-Murillo, recent alumna Allison Carter '16, and University of Michigan postdoc Michael Roman have an article in this theme issue of "Phil Trans A" discussing the effect measured.

Pasachoff and Carter had been on Svalbard, an Arctic archipelago controlled by Norway, for the eclipse. They had carried sensors for temperature and pressure borrowed from Williams College's Jay Racela of the Center for Environmental Studies. The expedition to Svalbard was supported by a grant to Pasachoff from the Committee for Research and Exploration of the National Geographic Society.

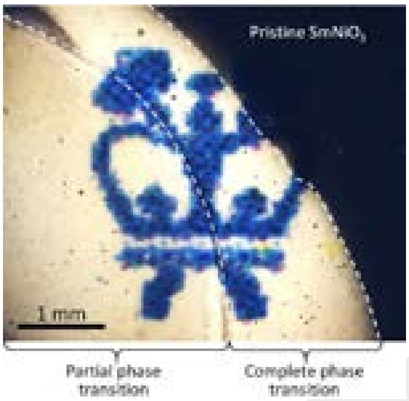
The bulk of the theme issue was about the effect of the partial eclipse that was also visible from the U.K. The dimming of sunlight over the hour or so during the partial eclipse making its effects measurable. On Svalbard, for the total eclipse, the temperature and pressure automatic sensors found only slight effects, though a thermometer hanging from one of the camera tripods recorded a dip in temperature from the -13C to which the morning temperature had risen down to -21C a few minutes after the center of totality.

Pasachoff and Penaloza-Murillo, who is professor emeritus at the Universidad de los Andes in Merida, Venezuela, have published a previous paper about the effect of a total eclipse on weather, and are planning further observations, again in collaboration with Roman, at the August 21, 2017, total solar eclipse that they will attempt to observe from Salem, Oregon.

This time the expedition will again be supported in part by the Committee for Research and Exploration of the National Geographic Society, and Williams College, with Pasachoff as Principal Investigator, has also received a research grant from the Solar Terrestrial Program of the Atmospheric and Geospace Sciences Division of the U.S. National Science Foundation.

Pasachoff has also borrowed temperature and pressure sensors, a data-logger system called HOBO made by Onset Computer Corporation, as part of his observations of the September 1 annular solar eclipse this week. Pasachoff, along with Naomi Pasachoff, Research Associate at Williams College, is observing the eclipse from Isle de la Reunion in the Indian Ocean ...Read More..

New optical material offers unprecedented control of light and thermal radiation



The picture shows a layer of phase-transition material SmNiO3 placed on top of a Columbia Engineering School logo. The transparency of the material can be controlled by electron doping under ambient conditions. Pristine SmNiO3 is opaque; partial phase-transition makes the material translucent, and complete phase-transition makes it transparent. Image courtesy Nanfang Yu, Columbia Engineering.

A team led by Nanfang Yu, assistant professor of applied physics at Columbia Engineering, has discovered a new phase-transition optical material and demonstrated novel devices that dynamically control light over a much broader wavelength range and with larger modulation amplitude than what has currently been possible.

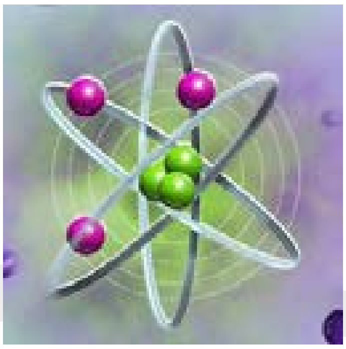
The team, including researchers from Purdue, Harvard, Drexel, and Brookhaven National Laboratory, found that samarium nickelate (SmNiO3) can be electrically tuned continuously between a transparent and an opaque state over an unprecedented broad range of spectrum from the blue in the visible (wavelength of 400 nm) to the thermal radiation spectrum in the mid-infrared (wavelength of a few tens of micrometers).

The study, which is the first investigation of the optical properties of SmNiO3 and the first demonstration of the material in photonic device applications, is published online in Advanced Materials.

"The performance of SmNiO3 is record-breaking in terms of the magnitude and wavelength range of optical tuning," Yu says.

"There is hardly any other material that offers such a combination of properties that are highly desirable for optoelectronic devices. The reversible tuning between the transparent and opaque states is based on electron doping at room temperature, and potentially very fast, which opens up a wide range of exciting applications, such as 'smart windows' for dynamic and complete control of sunlight, variable thermal emissivity ...Read More...

Argonne theorists solve a long-standing fundamental problem



Trying to understand a system of atoms is like herding gnats - the individual atoms are never at rest and are constantly moving and interacting. When it comes to trying to model the properties and behavior of these kinds of systems, scientists use two fundamentally different pictures of reality, one of which is called "statistical" and the other "dynamical." The two approaches have at times been at odds, but scientists from Argonne recently announced a way to reconcile the two pictures. Image courtesy Argonne National Laboratory.

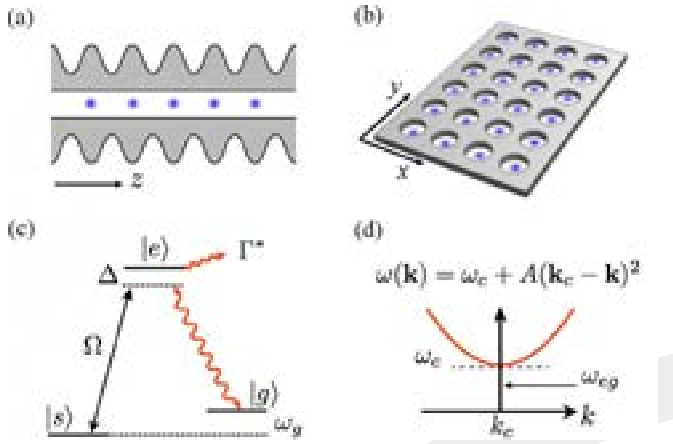
Trying to understand a system of atoms is like herding gnats - the individual atoms are never at rest and are constantly moving and interacting. When it comes to trying to model the properties and behavior of these kinds of systems, scientists use two fundamentally different pictures of reality, one of which is called "statistical" and the other "dynamical."

The two approaches have at times been at odds, but scientists from the U.S. Department of Energy's Argonne National Laboratory announced a way to reconcile the two pictures.

In the statistical approach, which scientists call statistical mechanics, a given system realizes all of its possible states, which means that the atoms explore every possible location and velocity for a given value of either energy or temperature. In statistical mechanics, scientists are not concerned with the order in which the states happen and are not concerned with how long they take to occur. Time is not a player.

In contrast, the dynamical approach provides a detailed account of how and to what degree these states are explored over time. In dynamics, a system may not experience all of the states that are in principle available to it, because the energy may not be high enough to surmount the energy barriers or because of the time window being too short. "When a system cannot 'see' states beyond an energy barrier in dynamics, it's like a hiker being unable to see the next valley behind a mountain range," said Argonne theorist Julius Jellinek. ...Read More...

Simulated quantum magnetism can control spin interactions at arbitrary distances

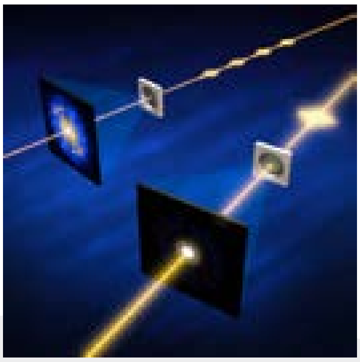


Photon-mediated atom-atom interactions in (A) 1D and (B) 2D PCWs. (C) Atomic-level scheme: atomic dipole |s> ↔|e> is coupled to an external pump, |g> ↔|e> coupled to a GM photon, and ↔*, the excited state decay rate to free space and leaky modes.† (D) Simplified band structure ↔(k) near the band edge k = kc and ↔(k-c)= ↔c. Atomic transition frequency ↔eg = ↔e − ↔g lies within the band gap. {*To simplify the discussion, in this paper, we neglect decoherence effects caused by atomic emission into free space and leaky modes as well as photon loss due to imperfections in the PCW. These effects were both carefully discussed in refs. 36 and 37, suggesting the number of spin-exchange cycles in the presence of decoherence can realistically reach N ≈35↔100 using ultra-high Q PCWs.) Credit: Hung C-L, González-Tudela A, Cirac JI, Kimble HJ (2016) Quantum spin dynamics with pairwise-tunable, long-range interactions. Proc Natl Acad Sci USA 113:34 E4946-E4955.

Quantum magnetism, in which – unlike magnetism in macroscopic-scale materials, where electron spin orientation is random – atomic spins self-organize into one-dimensional rows that can be simulated using cold atoms trapped along a physical structure that guides optical spectrum electromagnetic waves known as a photonic crystal waveguide. Recently, scientists at Purdue University, Max-Planck-Institut für Quantenoptik, Germany, and California Institute of Technology, used this approach to devise a scheme for simulating quantum magnetism that provides full control of interactions between pairs of spins at arbitrary distances in 1D and 2D lattices, and moreover demonstrated the scheme's wide utility by generating several well-known spin models. The researchers state that their results allow the introduction of geometric phases into the spin system that could generate topological models with long-range spin–spin interactions.

Dr. Chen-Lung Hung, Dr. Alejandro González-Tudela and Phys.org discussed the study, its challenges and the resulting paper that they have published with their colleagues in Proceedings of the National Academy of Sciences. These challenges included using a two-photon Raman addressing scheme to devise their proposed atom-nanophotonic system – a system that can achieve arbitrary ...Read More...

A 'nonlinear' effect that seemingly turns materials transparent is seen for the first time in X-rays at SLAC's LCLS



An illustration shows what happens in a typical experiment with SLAC's LCLS X-ray laser, top, versus what happened in this study with an especially intense X-ray pulse. Normally the X-ray pulses -- which are shown coming in from the right -- scatter off electrons in a sample and produce a pattern in a detector. But when researchers cranked up the intensity of the X-ray pulses, the pulses seemed to go straight through the sample, as if it were not there, and the pattern in the detector vanished. Two recent papers describe and explain this surprising result, which is due to a 'nonlinear' effect where particles of X-ray light team up to cause unexpected things to happen. Credit: SLAC National Accelerator Laboratory

Imagine getting a medical X-ray that comes out blank – as if your bones had vanished. That's what happened when scientists cranked up the intensity of the world's first X-ray laser, at the Department of Energy's SLAC National Accelerator Laboratory, to get a better look at a sample they were studying: The X-rays seemed to go right through it as if it were not there.

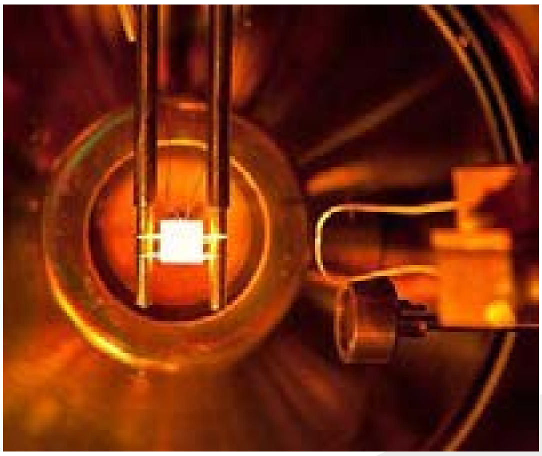
This result was so weird that the leader of the experiment, SLAC Professor Joachim Stöhr, devoted the next three years to developing a theory that explains why it happened. Now his team has published a paper in Physical Review Letters describing the 2012 experiment for the first time.

What they saw was a so-called nonlinear effect where more than one photon, or particle of X-ray light, enters a sample at the same time, and they team up to cause unexpected things to happen.

"In this case, the X-rays wiggled electrons in the sample and made them emit a new beam of X-rays that was identical to the one that went in," said Stöhr, who is an investigator with the Stanford Institute for Materials and Energy Sciences at SLAC. "It continued along the same path and hit a detector. So from the outside, it looked like a single beam went straight through and the sample was completely transparent."

This effect, called "stimulated scattering," had never been seen in X-rays before. In fact, it took an extremely intense beam from SLAC's Linac Coherent Light Source (LCLS), which is a billion times brighter than any X-ray source before it, to make this happen. ...Read More...

Fusion facilities at PPPL and Culham, England, could provide path to limitless energy



File Image.

Creating "a star in a jar" - replicating on Earth the way the sun and stars create energy through fusion - requires a "jar" that can contain superhot plasma and is low-cost enough to be built around the world. Such a device would provide humankind with near limitless energy, ending dependence on fossil fuels for generating electricity.

Physicists at the U.S. Department of Energy's Princeton Plasma Physics Laboratory (PPPL) say that a model for such a "jar," or fusion device, already exists in experimental form - the compact spherical tokamaks at PPPL and Culham, England. These tokamaks, or fusion reactors, could provide the design for possible next steps in fusion energy - a Fusion Nuclear Science Facility (FNSF) that would develop reactor components and also produce electricity as a pilot plant for a commercial fusion power station.

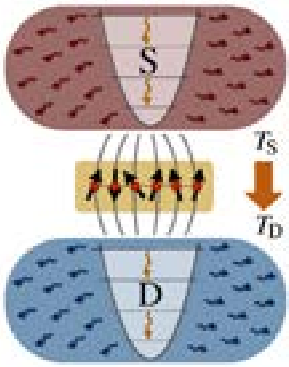
"New options for future plants"

The detailed proposal for such a "jar" is described in a paper published in August 2016 in the journal Nuclear Fusion. "We are opening up new options for future plants," said lead author Jonathan Menard, program director for the recently completed National Spherical Torus Experiment-Upgrade (NSTX-U) at PPPL. The $94-million upgrade of the NSTX, financed by the U.S. Department of Energy's Office of Science, began operating last year.

Spherical tokamaks are compact devices that are shaped like cored apples, compared with the bulkier doughnut-like shape of conventional tokamaks. The increased power of the upgraded PPPL machine and the soon-to-be completed MAST Upgrade device moves them closer to commercial fusion plants that will create safe, clean and virtually limitless energy without contributing greenhouse gases that warm the Earth and with no long-term radioactive waste.

The NSTX-U and MAST facilities "will push the physics frontier, expand our knowledge of high temperature plasmas, and, if successful, lay the scientific ...Read More...

Physicists propose first method to control single quanta of energy



In the proposed experiment, two energy reservoirs (S and D) made of trapped ions transport energy quanta to each other by coupling to the spins in a quantum magnet placed between them. Credit: Alejandro Bermudez and Tobias Schaetz, New Journal of Physics. CC-BY-3.0

Physicists have proposed what they believe to be the first method to control the transport of energy at the level of single energy quanta (which are mostly phonons). They show that it's theoretically possible to control the flow of single energy quanta through a quantum magnet using lasers with carefully controlled frequencies and intensities.

If implemented, the method could allow researchers to explore quantum energy transport phenomena that are expected to be completely different than what is observed in macroscopic energy transport. In general, understanding energy transport in small-scale devices could lead to the development of methods for reducing the energy dissipation in shrinking computer hardware (however, the researchers note that computer hardware differs from the particular setup proposed here).

The scientists, Alejandro Bermudez, at the Institute of Fundamental Physics in Madrid, Spain, and Tobias Schaetz, at the Albert Ludwigs University of Freiburg and the Freiburg Institute for Advanced Studies, both in Freiburg, Germany, have published a paper on their proposed method in a recent issue of the New Journal of Physics.

"We have identified a new quantum mechanism that would allow to control the transport of energy/heat at the level of single energy quanta," Bermudez told Phys.org. "This mechanism can be considered as an analogue of Coulomb blockade in electronic nanodevices, and we have proposed to test it using experiments with crystals of self-assembled trapped atomic ions."

In the study, the scientists propose building an energy reservoir using trapped magnesium ions. By using a laser to heat and cool the ions, the ions can be made to absorb or release tiny amounts of energy, acting as tiny energy reservoirs. ...Read More...

This Week's Sky at a Glance, Sep. 03 - 09

Sep 03	Venus 1.1° South of Moon: occultation (Local time: 14:33)
Sep 04	Spica 5.8° South of Moon (Local time: 23:56)
Sep 05	Saturn 5.9°N of Antares (Local time: 00:05)
Sep 06	Moon at apogee: 405059 km (Local time: 22:44)
Sep 09	Saturn 3.8° South of Moon (Local time: 01:23)
Sep 09	First Quarter Moon (15:48) - Meridian passage (18:17) – Altitude: 47°