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Astronomy & Physics Weekly News

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

Top News

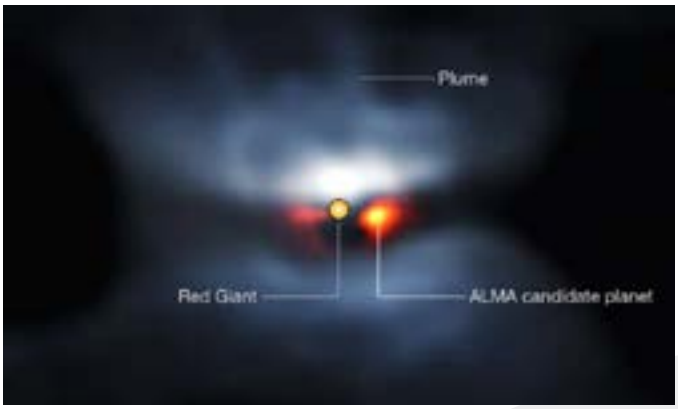
SCASS ACTIVITIES:

Interstellar Travel
Dec. 10, 2016
18:00 - 19:00

IT Support Issam Jami

Designed by Mohamed Bakir

Will Earth still exist 5 billion years from now? Old star offers sneak preview of the future



Composite view of L2 Puppis in visible light (from the VLT/SPHERE instrument, blue colors) and ALMA continuum (orange colors). The central star light has been subtracted from the ALMA image to better show the companion object. Credit: © P. Kervella et al. (CNRS / U. de Chile / Observatoire de Paris / LESIA / ESO / ALMA)

What will happen to Earth when, in a few billion years' time, the sun is a hundred times bigger than it is today? Using the most powerful radio telescope in the world, an international team of astronomers has set out to look for answers in the star L2 Puppis. Five billion years ago, this star was very similar to the sun as it is today.

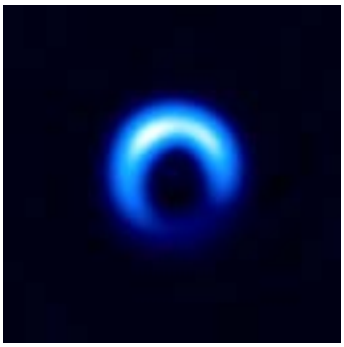
"Five billion years from now, the sun will have grown into a red giant star, more than a hundred times larger than its current size," says Professor Leen Decin from the KU Leuven Institute of Astronomy. "It will also experience an intense mass loss through a very strong stellar wind. The end product of its evolution, 7 billion years from now, will be a tiny white dwarf star. This will be about the size of the Earth, but much heavier: one tea spoon of white dwarf material weighs about 5 tons."

This metamorphosis will have a dramatic impact on the planets of our solar system. Mercury and Venus, for instance, will be engulfed in the giant star and destroyed.

"But the fate of the Earth is still uncertain," continues Decin. "We already know that our sun will be bigger and brighter, so that it will probably destroy any form of life on our planet. But will the Earth's rocky core survive the red giant phase and continue orbiting the white dwarf?"

To answer this question, an international team of astronomers observed the evolved star L2 Puppis. This star is 208 light years away from Earth - which, in astronomy terms, means nearby. The researchers used the ALMA radio telescope, which consists of 66 individual radio antennas that together form a giant virtual telescope with a 16-kilometre diameter. ...Read More...

ALMA measures size of seeds of planets



Dust disk around the young star HD 142527 observed with ALMA. Image courtesy ALMA (ESO/NAOJ/NRAO), Kataoka et al.

Researchers using the Atacama Large Millimeter/submillimeter Array (ALMA), have for the first time, achieved a precise size measurement of small dust particles around a young star through radio-wave polarization. ALMA's high sensitivity for detecting polarized radio waves made possible this important step in tracing the formation of planets around young stars.

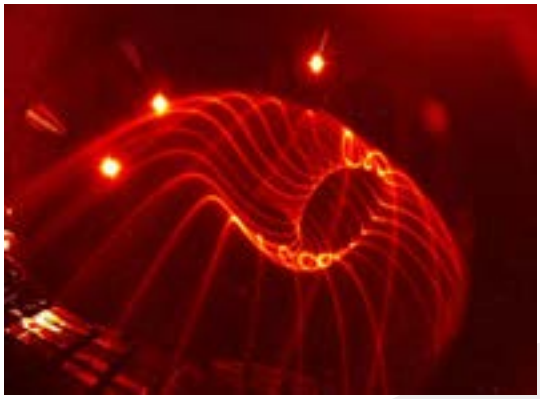
Astronomers have believed that planets are formed from gas and dust particles, although the details of the process have been veiled. One of the major enigmas is how dust particles as small as 1 micrometer aggregate to form a rocky planet with a diameter of 10 thousand kilometers. Difficulty in measuring the size of dust particles has prevented astronomers from tracing the process of dust growth.

Akimasa Kataoka, a Humboldt Research Fellow stationed at Heidelberg University and the National Astronomical Observatory of Japan, tackled this problem. He and his collaborators have theoretically predicted that, around a young star radio waves scattered by the dust particles should carry unique polarization features. He also noticed that the intensity of polarized emissions allows us to estimate the size of dust particles far better than other methods.

To test their prediction, the team led by Kataoka observed the young star HD 142527 with ALMA (note 1) and discovered, for the first time, the unique polarization pattern in the dust disk around the star. As predicted, the polarization has a radial direction in most parts of the disk, but at the edge of the disk, the direction is flipped perpendicular to the radial direction.

Comparing the observed intensity of the polarized emissions with the theoretical prediction, they determined that the size of the dust particles is at most 150 micrometers. This is the first estimation of the dust size based on polarization. Surprisingly, this estimated size is more than 10 times smaller than previously thought. "In the previous studies, astronomers have estimated the size based on radio emissions assuming hypothetical ...Read More...

Physicists confirm the precision of magnetic fields in the most advanced stellarator in the world



Experimental visualization of the field line on a magnetic surface. Credit: Nature Communications

Physicist Sam Lazerson of the U.S. Department of Energy's (DOE) Princeton Plasma Physics Laboratory (PPPL) has teamed with German scientists to confirm that the Wendelstein 7-X (W7-X) fusion energy device called a stellarator in Greifswald, Germany, produces high-quality magnetic fields that are consistent with their complex design.

The findings, published in the November 30 issue of Nature Communications , revealed an error field—or deviation from the designed configuration—of less than one part in 100,000. Such results could become a key step toward verifying the feasibility of stellarators as models for future fusion reactors.

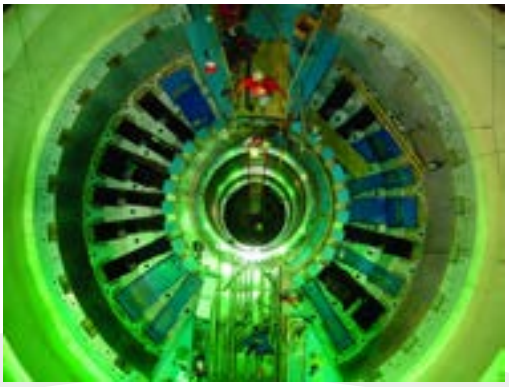
W7-X, for which PPPL is the leading U.S. collaborator, is the largest and most sophisticated stellarator in the world. Built by the Max Planck Institute for Plasma Physics in Greifswald, it was completed in 2015 as the vanguard of the stellarator design. Other collaborators on the U.S. team include DOE's Oak Ridge and Los Alamos National Laboratories, along with Auburn University, the Massachusetts Institute of Technology, the University of Wisconsin-Madison and Xanthos Technologies.

Twisty magnetic fields

Stellarators confine the hot, charged gas, otherwise known as plasma, that fuels fusion reactions in twisty—or 3-D—magnetic fields, compared with the symmetrical—or 2D—fields that the more widely used tokamaks create. The twisty configuration enables stellarators to control the plasma with no need for the current that tokamaks must induce in the gas to complete the magnetic field. Stellarator plasmas thus run little risk of disrupting, as can happen in tokamaks, causing the internal current to abruptly halt and fusion reactions to shut down.

PPPL has played key roles in the W7-X project. The Laboratory designed and delivered five barn ...Read More....

'Spooky' sightings in crystal point to extremely rare quantum spin liquid



A massive part of Oak Ridge National Laboratory's Spallation Neutron Source is shown during its construction phase in earlier years. The hole in the center is where the target crystal for neutron scattering is placed. Credit: Oak Ridge National Laboratory

Inside a new exotic crystal, physicist Martin Mourigal has observed strong indications of "spooky" action, and lots of it. The results of his experiments, if corroborated over time, would mean that the type of crystal is a rare new material that can house a quantum spin liquid.

Currently, only a small handful of materials are believed to possibly have these properties. This new crystal was synthesized for the first time only a year ago. Corroboration by other physicists of Mourigal's newly produced experimental data could take a decade or longer.

Confused? Meet quantum physics

A "liquid" found inside a solid object may sound confusing to many people.

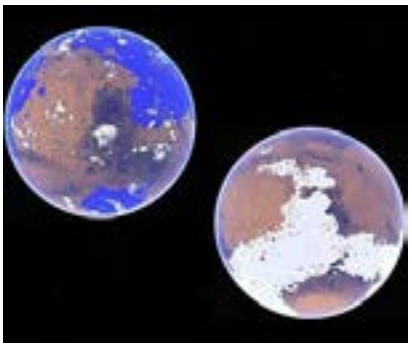
Welcome to quantum materials, part of the twilight zone called quantum physics, which scientists have been struggling for a century to grasp a nanometer at a time. Though much about it is yet undiscovered, quantum physics describes the underlying reality of matter.

The workings of computers, cell phones, superconductors and MRI machines are based on it. But its laws about the atomic realm defy human perception of what is real, and some sound so preposterous that they have become popular science brain teasers.

'Liquid' in 'spooky' entanglement

Take quantum entanglement, the core of Mourigal's research on the crystal: If two particles, electrons for example, become entangled, they can be physically separated by many miles, and still be intimately linked to one another. Actions applied to one particle then instantaneously effect the other. At first, this theory was too weird even for the father of relativity, Albert Einstein, who lampooned it as "spooky action at a distance." ...Read More...

Evidence suggests early Mars was warmer and wetter



Disclaimer: image is for illustration purposes only

Scientists are generally in agreement that water once flowed on Mars. The nature of those flows and the conditions that made them possible are less obvious, however.

New evidence may offer some clarity. Researchers in Italy have discovered a region of sedimentary rock southern hemisphere of Mars, just north of a massive impact crater known as Hellas Basin. Its presence suggests a warm, young Mars hosted water across an expanded geological timescale -- not simply during brief episodes of warming.

Until now, most researchers believed the smooth plains north of Hellas Basin featured rocks formed by volcanic activity. But astronomers from the University of Chieti-Pescara suggest the plains feature sedimentary rock.

The researchers are backed by evidence captured by Mars Express and the Mars Reconnaissance Orbiter. Images of small craters and instances of erosion on the plains have revealed layers of flat, light-colored rock.

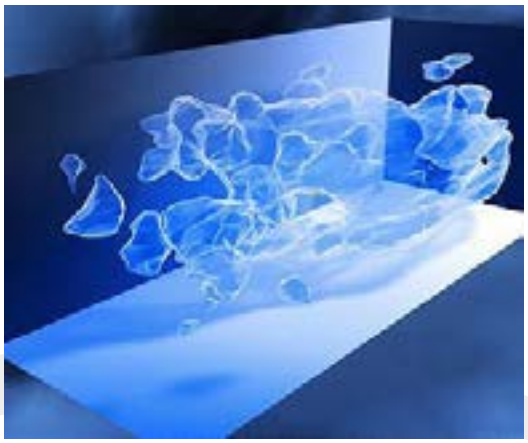
"To create the kind of sedimentary plains we found at Hellas, we believe that a generally aqueous environment was present in the region some 3.8 billion years ago," researcher Francesco Salese said in a news release. "Importantly, it must have lasted for a long period of time -- on the order of hundreds of millions of years."

The new images also revealed planar stratification and cross-bedding, characteristics of sedimentary rock. Furthermore, the probes identified the presence of significant amounts of clay.

"These characteristics suggest that the rock didn't form from lava flow deposits but rather from sedimentary processes, which implies that the region once experienced warm and wet conditions for a relatively long time," explained Salese. "When the layered rock was deposited -- during the Noachian period, around 3.8 billion years ago -- its surroundings must have been soaked in water, with intense liquid circulation.

The findings have significant implications for the search for evidence of life on Mars. The evidence suggests early Mars was a much more life-friendly place than previous studies. Clay-rich sedimentary rock is also an ideal medium in which to look for ancient signs of life. ...Read More...

Dark matter may be more smoothly distributed throughout cosmos



Disclaimer: Image is for illustration purposes only

New analysis of a phenomenon known as cosmic shear suggests dark matter is less dense and more evenly -- or smoothly -- distributed throughout space. The revelation was detailed this week in a new paper published in the Monthly Notices of the Royal Astronomical Society.

Cosmic shear is a type of gravitational lensing, the subtle warping of light waves emitted by distant galaxies as they travel past, around and through large clumps of cosmic matter, like galaxy clusters. Cosmic shear, specifically, isn't the warping effect caused by specific galactic clusters, but the distortions caused by large-scale cosmic structures.

A new computer model armed with image from the European Southern Observatory's Very Large Telescope helped astronomers conduct a survey of cosmic shear through the universe.

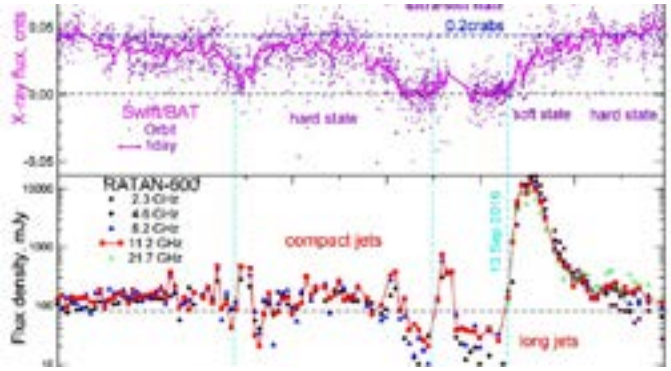
The new findings disagree with those made by a similar survey conducted using the European Space Agency's Planck satellite. The ESA Kilo Degree Survey characterized the universe's matter as clumpy, while the latest results suggest a smoother dispersal.

"This latest result indicates that dark matter in the cosmic web, which accounts for about one-quarter of the content of the Universe, is less clumpy than we previously believed," Massimo Viola, an astronomer at the Leiden Observatory in the Netherlands, said in a news release.

Because dark matter continues to escape direct observation, scientists' understanding of it and its role in the organization of the universe relies on surveys and analysis like the one led by Viola and his colleagues.

The latest findings aren't necessarily superior to those of ESA's survey, but reveal the necessity for further exploration of cosmic shear and the distribution of matter. The findings will also force astronomers to rethink a variety of cosmic models. ...Read More...

Giant radio flare of Cygnus X-3 detected by astronomers



Light curves before or during the flare at X-ray 15-50 KeV (top) and the multi-frequency data of the RATAN measurements (below). Characteristic X-ray states of the binary are marked. Credit: Trushkin et al., 2016.

Russian astronomers have recently observed a giant radio flare from a strong X-ray binary source known as Cygnus X-3 (Cyg X-3 for short). The flare occurred after more than five years of quiescence of this source. The discovery was presented in a paper published Dec. 2 on the arXiv preprint server.

Classified as a microquasar, Cygnus X-3 is a powerful X-ray source believed to be a compact object in a binary system. It was originally discovered in X-rays in 1967 and is observable in X-rays, gamma rays, infrared and radio. The source is located some 23,000 light years away in the constellation Cygnus and has an orbital periodicity of approximately 4.8 hours.

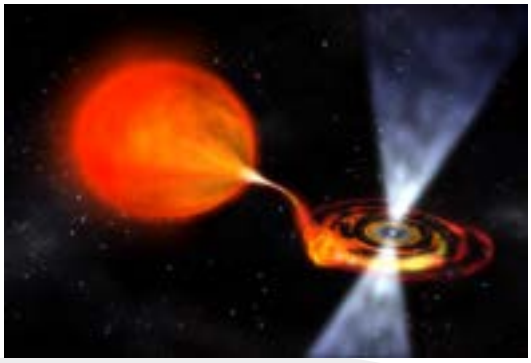
Cygnus X-3 experiences periodic radio outbursts. The first recorded significant flare took place in 1972 and increased the radio frequency emissions from this source a thousandfold. More recently, in March 2011, astronomers recorded a giant flare, and after this event, the source went into a state of dormancy.

The phase of quiescence was interrupted by the last giant radio outburst that took place in September 2016, and was predicted by a team of astronomers led by Sergei Trushkin of the Special Astrophysical Observatory (SAO) in Nizhnij Arkhys, Russia. The researchers observed Cygnus X-3 with SAO's RATAN-600 radio telescope as part of a long-term, multi-frequency monitoring campaign of microquasars.

"In the long-term multi-frequency monitoring program of the microquasars with RATAN-600, we discovered the giant flare from X-ray binary Cyg X-3 on September 13, 2016," the scientists wrote in the paper.

According to the research, Cygnus X-3's 2016 outburst interrupted a nearly five-and-a-half-year period of its quiescence. The flare of 2016 occurred after transition of the source to a 'hyper-soft' X-ray state, as in the case of the previous outburst in 2011. ...Read More...

Amateur astronomer helps uncover secrets of unique pulsar binary system



Artist's rendition of a typical millisecond pulsar binary system in which the shape of the companion star (l.) is deformed by the gravitational pull of the pulsar (r.) seen emitting beams of radiation. Credit: NASA

A professional astrophysicist and an amateur astronomer have teamed up to reveal surprising details about an unusual millisecond pulsar (MSP) binary system comprising one of the fastest-spinning pulsars in our Galaxy and its unique companion star.

Their observations, to be published in the Astrophysical Journal in December, are the first to identify "star spots" on an MSP's companion star. Plus, the observations show that the companion has a strong magnetic field, and provide clues into why pulsars in some MSP binaries switch on and off.

John Antoniadis, a Dunlap Fellow with the Dunlap Institute for Astronomy & Astrophysics, University of Toronto, and André van Staden, an amateur astronomer from South Africa, analyzed observations of the brightness of the companion star made by van Staden over a 15-month period, with his 30cm reflector telescope and CCD camera in his backyard observatory in Western Cape. The analysis revealed an unexpected rise and fall in the star's brightness.

In a typical MSP binary, the gravity of the pulsar distorts the shape of the companion star, pulling it into a teardrop-shape. As it circles the pulsar, we see a cyclical rise and fall in the companion's brightness. The companion is brightest at two points in its orbit, when we see its broad, tear-shaped profile; it is dimmest midway between those two points, when we see its smallest, circular profile. Naturally, the light curve measuring the brightness rises and falls in step with the companion's orbital period.

But Antoniadis and van Staden's observations revealed that the brightness of the companion wasn't in sync with its 15-hour orbital period; instead the star's peaks in brightness occur progressively later relative to the companion's orbital position. Antoniadis and van Staden concluded that this was caused by "starspots", the equivalent of our Sun's sunspots, and that the spots were lowering the brightness of the star. What's more ...Read More...

New telescope chip offers clear view of alien planets

Associate Professor Steve Madden

Scientists have developed a new optical chip for a telescope that enables astronomers to have a clear view of alien planets that may support life.

Seeing a planet outside the solar system which is close to its host sun, similar to Earth, is very difficult with today's standard astronomical instruments due to the brightness of the sun.

Associate Professor Steve Madden from The Australian National University (ANU) said the new chip removes light from the host sun, allowing astronomers for the first time to take a clear image of the planet.

"The ultimate aim of our work with astronomers is to be able to find a planet like Earth that could support life," said Dr Madden from the ANU Research School of Physics and Engineering.

"To do this we need to understand how and where planets form inside dust clouds, and then use this experience to search for planets with an atmosphere containing ozone, which is a strong indicator of life."

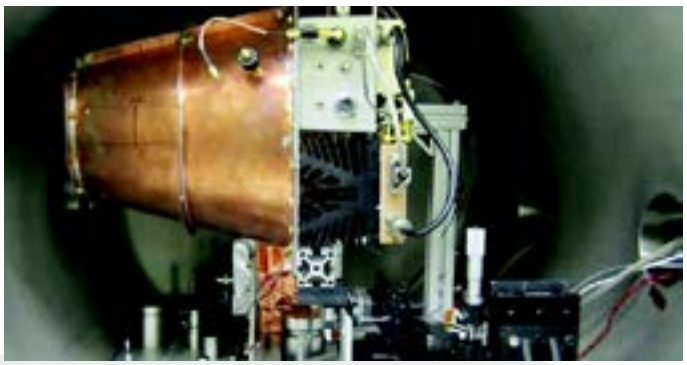
Physicists and astronomers at ANU worked on the optical chip with researchers at the University of Sydney and the Australian Astronomical Observatory.

Dr Madden said the optical chip worked in a similar way to noise cancelling headphones.

"This chip is an interferometer that adds equal but opposite light waves from a host sun which cancels out the light from the sun, allowing the much weaker planet light to be seen," he said.

PhD student Harry-Dean Kenchington Goldsmith, who built the chip at the ANU Laser Physics Centre, said the technology works like thermal imaging that fire fighters rely on to see through smoke. "The chip uses the heat emitted from the planet to peer through dust clouds and see planets forming. Ultimately the same technology ..Read More...

To Mars in 70 days: Expert discusses NASA's study of paradoxical EM propulsion drive



EM Drive in forward thrust configuration. Credit: NASA Photo

After months of speculation and rumor, NASA has finally released its long-awaited research paper on the controversial EM Drive propulsion system. The paper was recently published in the American Institute of Aeronautics and Astronautics' peer-reviewed Journal of Propulsion and Power. If the electromagnetic technology proves sound, it could radically change the way humans travel in space, opening up the possibility of journeys to Mars in just 70 days. But there is no shortage of skeptics who are adamant that the drive is more science fiction than science fact. Critics are quick to point out that the drive violates one of the fundamental laws of physics, namely: for every action, there is an equal and opposite reaction. With the science world abuzz in light of the recent developments, UConn Today called on engineering professor Brice Cassenti, an expert in advanced propulsion systems, to help us understand what's happening.

Q. What is the EM Drive propulsion system and what makes it so unique?

A. An EM Drive uses electromagnetic waves (e.g., radar) to produce thrust, which is obviously something that is needed for a rocket engine. The drive consists of a truncated conical copper shell with a plastic (polyethylene) disc covering the narrow end of the truncated cone. An electromagnetic wave is induced inside the copper shell in the same manner as a microwave oven. The propulsion system is unique because the device uses no traditional fuels or propellants. Instead, in the simplest of terms, the electromagnetic waves bounce around inside the cone in a way that some say causes propulsion. In the NASA tests, a thrust of 1.2 millinewtons per kilowatt was reported for an EM Drive activated in a vacuum, which is a very, very small – but noticeable – movement. By not relying on traditional fuels, the EM Drive would make spacecrafts lighter, and eliminate the need for massive amounts of fuel currently required to launch a spacecraft to far-off destinations.
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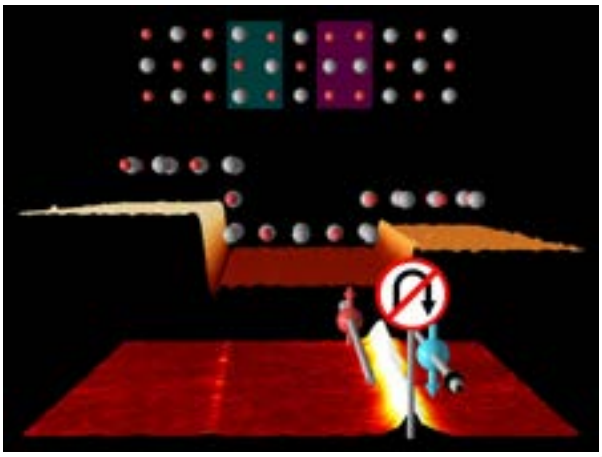
Electron highway inside crystal



Step edges on topological crystalline insulators may lead to electrically conducting pathways where electrons with opposite spin spin move in converse directions -- any U-turn is prohibited. Credit: Thomas Bathon/Paolo Sessi/Matthias Bode

Physicists of the University of Würzburg have made an astonishing discovery in a specific type of topological insulators. The effect is due to the structure of the materials used. The researchers have now published their work in the journal Science.

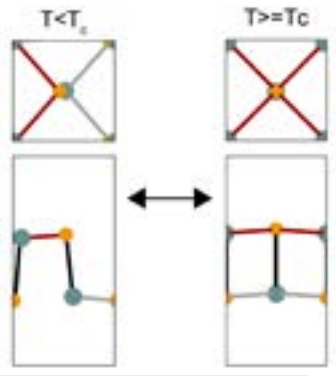
Topological insulators are currently the hot topic in physics according to the newspaper Neue Zürcher Zeitung. Only a few weeks ago, their importance was highlighted again as the Royal Swedish Academy of Sciences in Stockholm awarded this year's Nobel Prize in Physics to three British scientists for their research of so-called topological phase transitions and topological phases of matter.

Topological insulators are also being studied at the Departments for Experimental Physics II and Theoretical Physics I of the University of Würzburg. However, they focus on a special version of insulators called topological crystalline insulators (TCI). In cooperation with the Polish Academy of Sciences in Warsaw and the University of Zurich, Würzburg physicists have now achieved a major breakthrough. They were able to detect new electronic states of matter in these insulators. The results of their work are published in the latest issue of Science.

Step edges direct electrons

The central result: When crystalline materials are split, small atomically flat terraces emerge at the split off surfaces which are separated from each other by step edges. Inside these structures, conductive channels for electrical currents form which are extremely narrow at just about 10 nm and surprisingly robust against external disturbance. Electrons travel on these conductive channels with different spin in opposite directions - similar to a motorway with separate lanes for the two directions. This effect makes the materials interesting for technological applications in future electronic components such as ultra-fast and energy-efficient computers. ...Read More...

Physicists find structural phase transitions in 2-D atomic materials



Credit: Salvador Barraza-Lopez

An international team led by University of Arkansas physicists has discovered drastic changes in material properties occurring in a group of two-dimensional materials that are being investigated as candidates to power the next generation of opto-electronic devices.

The findings, published in the journal Physical Review Letters, reveal the rich properties of a new class of "phase-change" 2-D materials known as group-IV monochalcogenide monolayers and bilayers.

The U of A team consisted of Mehrshad Mehboudi, a doctoral student; Yurong Yang, a research assistant professor; Laurent Bellaiche, Distinguished Professor of physics; and assistant professors of physics Pradeep Kumar and Salvador Barraza-Lopez. Their collaborators were Benjamin Fregoso at the University of California-Berkeley, Wenjuan Zhu and Arend van der Zande, both at the University of Illinois; and Jaime Ferrer from Universidad de Oviedo in Spain.

"We are the first team to even realize the possibility of such two-dimensional structural transitions in 2-D atomic materials, and the first team to ever study the effect of such transitions on material properties," Barraza-Lopez said.

The transition is the change from a rectangle to a square unit cell occurring near room temperature. As a result of the transition, optical properties, charge transport, and intrinsic dipole moments in the case of monolayers are shown to change in an abrupt manner.

"These changes in properties make these materials an exciting platform for novel optoelectronic applications, and they also uncover fundamental physics of structural phase transitions in reduced dimensions," Barraza-Lopez said. "No such detailed analysis had been provided before this work." ...Read More...

This Week's Sky at a Glance - Dec. 10 - 16

Dec. 10	Saturn in Conjunction with Sun (15:00)
Dec. 11	Mercury at Greatest Elongation: 20.8°E (15:04)
Dec. 13	Moon at Perigee: 358463 km (03:27)
Dec. 14	Geminid Meteor Shower
Dec. 14	Full Moon (04:06)

SCASS ACTIVITIES

Saturday - Dec. 10, 2016

Lecture: **Interstellar Travel**
Speaker: **Dr. Ilias Fernini - UoS/SCASS**
Time: 18:00 - 19:00
Location: SCASS Auditorium

All 'Original Seven' American astronauts now dead

John Glenn's passing on Thursday means that the first seven American astronauts chosen to lead the fledging US space program in 1959 are now dead, ending a groundbreaking chapter in American history.

This crew of military aviators, known as the Original Seven, or "Mercury 7," proved that spaceflight was possible, and paved the way for the pioneering US trips to the moon. Their saga inspired the 1979 Tom Wolfe book "The Right Stuff," and the 1983 movie classic of the same name. Here are the feats the seven are best known for, and how they died:

Alan B. Shepard, Jr.

The first American to journey into space, Shepard launched on May 5, 1961, aboard the Freedom 7 spacecraft. His flight was suborbital, rising to an altitude of 116 statute miles (186 kilometers) before landing back on Earth. He later commanded the Apollo 14 in 1971—the third lunar landing—and became the fifth person to walk on the Moon. Shepard died in 1998 at the age of 74 from leukemia.

John H. Glenn, Jr.

The first American to orbit the Earth, Glenn is best known for making his three tours around the planet on February 20, 1962. He was also elected US senator in Ohio and served as a lawmaker from 1974 to 1999. In 1998, at the age of 77, Glenn became the oldest person to fly in space when he journeyed aboard the space shuttle Discovery.

Glenn died Thursday at the age of 95. He had been in declining health since undergoing heart valve surgery in 2014.
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