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Astronomy & Physics News

Department of Physics—United Arab Emirates University
Weekly news from around the world compiled by Dr. Ilias Fernini

100 Million Stars in the Andromeda galaxy.

Inside this issue:

Physics of food shows secrets of popcorn

To most people, it may be just a fun food to munch while watching a movie. But to a couple of French investigators, popcorn is a biomechanical enigma waiting to be explained.

In an unusual study published on Wednesday, engineers Emmanuel Virot and Alexandre Ponomarenko carried out experiments into what makes popcorn, well, pop.

Cameras recording at 2,900 frames per second helped show what happened when a kernel of corn strutted its stuff.

When the temperature reached 100 degrees Celsius (180 degrees Fahrenheit), some of the moisture inside the corn started to turn into steam, the researchers found.

As the temperature rose to around 180 C (356 F), pressure built to around 10 bar, or 10 times the atmosphere at sea level.

Unable to withstand the stress, the outer shell broke open, causing a dramatic drop in pressure that forced the kernel's starchy innards to expand and protrude.

"We found that the critical temperature is about 180 C (356 F), regardless of the size or shape of the grain," said Virot, an ...***Read More***...

Credit: Petr Kratochvil/public domain

Birth of a star quartet

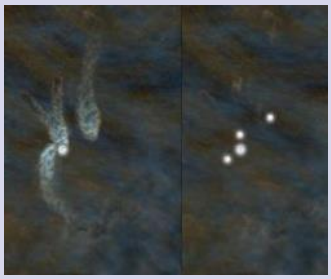
An international team of astrophysicists has witnessed a unique event: for the first time, researchers have discovered the formation of a quadruple star system from widely separated fragments of a filamentary gas cloud in the Perseus constellation.

The star system consists of a young star still in an early development phase and three gas clouds which are rapidly condensing by gravitational forces. According the astrophysicists' calculations, each gas cloud will develop into a star in 40,000 years. The stars may be relatively small and only reach around one-tenth the mass of our sun. The space between the individual stars amounts to more than a thousand times the average distance between the sun and the earth.

Unstable quadruple breaks apart

The experts calculated that the two stars which are the shortest distance apart form a stable double system, while the other two stars which are further apart will be catapulted into space after about half a million years.

"Star systems with more than three members are unstable and prone to interference," says Jaime Pineda, now at the Max Planck Institute for Extraterrestrial Physics, who is the first author of a study that has just been published ...***Read More***...



This is an artist's impression of the birth of a star quartet. The left panel shows the star and three dense gas condensations system. The right panel shows the system after the stars are formed out of the condensations. Image courtesy B. Saxton

Graphene displays clear prospects for flexible electronics

Published in the scientific journal Nature Materials, University of Manchester and University of Sheffield researchers show that new 2D 'designer materials' can be produced to create flexible, see-through and more efficient electronic devices.

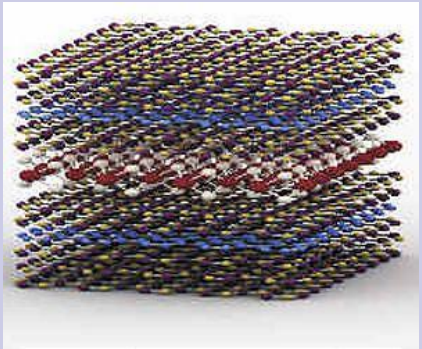
The team, led by Nobel Laureate Sir Kostya Novoselov, made the breakthrough by creating LEDs which were engineered on an atomic level.

The new research shows that graphene and related 2D materials could be utilized to create light emitting devices for the next-generation of mobile phones, tablets and televisions to make them incredibly thin, flexible, durable and even semi-transparent.

The LED device was constructed by combining different 2D crystals and emits light from across its whole surface. Being so thin, at only 10-40 atoms thick, these new components can form the basis for the first generation of semi-transparent smart devices.

One-atom thick graphene was first isolated and explored in 2004 at The University of Manchester. Its potential uses are vast but one of the first areas in which products are likely to be seen is in electronics. Other 2D materials, such as boron nitiride and molybdenum disulphide, have since been discovered opening up vast new areas of research and applications possibilities.

By building heterostructures - stacked layers of various 2D materials - to create ...***Read More***...



LED Heterostructure Schematic.

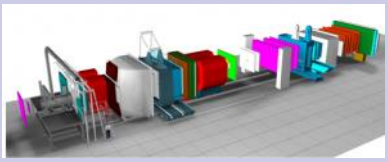
Experiment brings precision to a cornerstone of particle physics

In a paper published yesterday in the journal Physical Review Letters, the COMPASS experiment at CERN reports a key measurement on the strong interaction. The strong interaction binds quarks into protons and neutrons, and protons and neutrons into the nuclei of all the elements from which matter is built. Inside those nuclei, particles called pions made up of a quark and an antiquark mediate the interaction. Strong interaction theory makes a precise prediction on the polarisability of pions – the degree to which their shape can be stretched. This polarisability has baffled scientists since the 1980s, when the first measurements appeared to be at odds with the theory. Today's result is in close agreement with theory.

"The theory of the strong interaction is one of the cornerstones of our understanding of nature at the level of the fundamental particles," said Fabienne Kunne and Andrea Bressan, spokespersons of the COMPASS experiment, "so this result, in perfect agreement with the theory, is a very important one."

"Despite the high energies available at CERN, the experiment is a big challenge, as the pion polarisability is tiny and its effect hard to isolate," said Jan Friedrich, researcher at the Technische Universität München and leading scientist in the project.

Everything we see in the universe is made up of fundamental particles called quarks and leptons. Quarks are bound together in groups of three to make up the building blocks of the nuclei of elements – protons and neutrons...***Read More***….



Artistic view of the 60 m long COMPASS two-stage spectrometer. The two dipole magnets are indicated in red.

Novel high-power microwave generator

High-power microwaves are frequently used in civil applications, such as radar and communication systems, heating and current drive of plasmas in fusion devices, and acceleration in high-energy linear colliders. They can also be used for military purpose in directed-energy weapons or missile guidance systems.

In a new study published in the European Physical Journal D, scientists from Bangladesh demonstrate that their proposed novel method, which is capable of producing such microwaves, offers a viable alternative to traditional approaches. The solution was developed by Md. Ghulam Saber and colleagues from the Islamic University of Technology in Gazipur, Bangladesh.

To generate such high-power microwaves, researchers rely on devices referred to as backward wave oscillators, which are designed to transform the energy of an intense electron beam into electromagnetic radiation at microwave frequencies. The electron beam propagates axially through what is referred to as a slow electro-dynamic structure - SWS for short. The latter is designed to slow down the electromagnetic wave to phase velocities less than the speed of light.

Only then can the wave interact with the electron beam in a resonant manner. This interaction, in turn, leads to an instability, which is the prerequisite for energy transfer from the electron beam to the electromagnetic wave, and for turning it into high-power microwaves. Metallic cylinders with a sinusoidally shaped, periodically ...***Read More***...

VLA finds unexpected 'storm' at galaxy's core

Astronomers using the National Science Foundation's Very Large Array (VLA) found surprisingly energetic activity in what they otherwise considered a "boring" galaxy, and their discovery provides important insight on how supermassive black holes can have a catastrophic effect on the galaxies in which they reside.

"It appears that a supermassive black hole is explosively heating and blasting around the gas in this galaxy and, as a result, is transforming it from an actively star-forming galaxy into one devoid of gas that can no longer form stars," said Chris Harrison, the lead-author of the study, from The Centre for Extragalactic Astronomy at Durham University in the U.K.

Two major types of galaxies are spirals, rich in gas and actively forming stars, and ellipticals, gas-poor and with very little star formation. The massive ellipticals, astronomers think, started life as actively star-forming galaxies. Powerful jets and winds of material, powered by supermassive black holes at the galaxies' centers, are believed to remove or destroy the raw material needed for continued star formation.

"For many years, we've seen direct evidence of this happening in galaxies that are extremely bright when viewed through radio telescopes. These, rare, radio-bright galaxies harbor powerful jets, launched at the black hole, that plow into the surrounding gas," Harrison said.

"However, to understand how all of galaxies in our Universe formed, we needed to know if these same processes occur in less extreme galaxies that better represent the majority. This was the focus of our study," he added.

As part of an ongoing investigation, Harrison and his colleagues used the VLA to study a galaxy labelled J1430+1339, also known as the "Teacup," because of its appearance. About 1.1 billion light-years from Earth, the galaxy had ...***Read More***...

File image: Very Large Array (VLA).

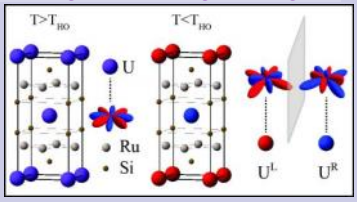
Team makes stride in explaining 30-year-old 'hidden order' physics mystery

A new explanation for a type of order, or symmetry, in an exotic material made with uranium may lead to enhanced computer displays and data storage systems, and more powerful superconducting magnets for medical imaging and levitating high-speed trains, according to a Rutgers-led team of research physicists.

The team's findings are a major step toward explaining a puzzle that physicists worldwide have been struggling with for 30 years, when scientists first noticed a change in the material's electrical and magnetic properties but were unable to describe it fully. This subtle change occurs when the material is cooled to 17.5 degrees above absolute zero or lower (a bone-chilling minus 428 degrees Fahrenheit).

"This 'hidden order' has been the subject of nearly a thousand scientific papers since it was first reported in 1985 at Leiden University in the Netherlands," said Girsh Blumberg, professor in the Department of Physics and Astronomy in the School of Arts and Sciences.

Collaborators from Rutgers University, the Los Alamos National Laboratory in New Mexico, and Leiden University, published their findings this week in the web-based journal Science Express, which ...***Read More***...



A Rutgers-led team of physicists discovered a new explanation for the 'hidden order' puzzle that has vexed physicists for 30 years. In an extremely pure crystalline sample of a uranium, ruthenium and silicon compound below the hidden order temperature of 17.5 degrees Kelvin, electron orbital patterns in uranium atoms in adjacent crystal layers become ...

Exotic states materialize with supercomputers

Scientists used supercomputers to find a new class of materials that possess an exotic state of matter known as the quantum spin Hall effect. The researchers published their results in the journal Science in December 2014, where they propose a new type of transistor made from these materials.

The science team included Ju Li, Liang Fu, Xiaofeng Qian, and Junwei Liu, experts in topological phases of matter and two-dimensional materials research at the Massachusetts Institute of Technology (MIT). They calculated the electronic structures of the materials using the Stampede and Lonestar supercomputers of the Texas Advanced Computing Center.

The computational allocation was made through XSEDE, the Extreme Science and Engineering Discovery Environment, a single virtual system funded by the National Science Foundation (NSF) that scientists use to interactively share computing resources, data and expertise. The study was funded by the U.S. Department of Energy and the NSF.

"To me, national computing resources like XSEDE, or specifically the Stampede and Lonestar supercomputers, are extremely helpful to computational scientists," Xiaofeng Qian said. In January 2015, Qian left MIT to join Texas A&M University as the first tenure-track assistant professor at its newly formed Department of Materials Science and Engineering.

What Qian and colleagues did was purely theoretical work, using Stampede for part of the calculations that modeled the interactions of atoms in the novel materials… ***Read More***...

Qian and colleagues found that the topological phases in the TMDC materials can be turned on and off by simply applying a vertical electric field that is perpendicular to the atomic plane of the material. That's shown here in calculations by the red crossing lines that conduct electricity along the ...

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The Physics Department cordially invites you to the seminar:

Optical Properties of ZnO Nanostructures and ZnO/polymer Composites

Dr. Ishaq Issa Musa
Physics Department, UAE University

Abstract

The presentation will include the synthesis, characterization and analysis of optical properties of ZnO nanostructures. In addition, composite thin films made by incorporating ZnO nanoparticles into conjugated polymer have also been fabricated and studied by optical characterization with special emphasis on photoluminescence (PL) measurements.

ZnO nanoparticles of various sizes (3 - 20 nm) were synthesized by different chemical routes without surface modification. The morphology and structure of the nanoparticles were characterized by transmission electron microscopy (TEM), X-ray diffraction (XRD), Raman spectroscopy, and time-resolved photoluminescence (PL). Surprisingly, the intensity of the defect-related emission band is found enhanced when the particle size is reduced. Meanwhile, the energies of near-band edge (NBE) UV emission and absorption onsets are found blue shifted. The dynamical behavior of exciton confinement is reflected by very short decay time of the NBE exciton, and by long-lived, multiexponential, intrinsic-defect emission in the green spectral range. This preliminary analysis of PL gives strong indication that a quantum confinement effect exists in the electronic structure of ZnO nanoparticles although sizes are above the exciton Bohr radius. The observed size dependence of the UV and green emission intensities opens up the possibility of tailoring exciton properties of ZnO nanocrystals for their applications in light emitting diodes or in photovoltaic devices. In the same context, the optical properties of ZnO coated multi wall carbon nanotubes (MWCNTs) have also been studied. Furthermore, the effects of size of ZnO nanoparticles and composition of hybrid MEH-PPV/ZnO and PF-oxe/ZnO composites on optical properties will be presented.

Thursday, February 19th 2015 @ 11:00 AM, Room F1-2119

All are Welcome!

Bionic leaf

Harvesting sunlight is a trick plants mastered more than a billion years ago, using solar energy to feed themselves from the air and water around them in the process we know as photosynthesis.

Scientists have also figured out how to harness solar energy, using electricity from photovoltaic cells to yield hydrogen that can be later used in fuel cells. But hydrogen has failed to catch on as a practical fuel for cars or for power generation in a world designed around liquid fuels.

Now scientists from a team spanning Harvard University's Faculty of Arts and Sciences, Harvard Medical School and the Wyss Institute for Biologically Inspired Engineering have created a system that uses bacteria to convert solar energy into a liquid fuel. Their work integrates an "artificial leaf," which uses a catalyst to make sunlight split water into hydrogen and oxygen, with a bacterium engineered to convert carbon dioxide plus hydrogen into the liquid fuel isopropanol.

The findings are published Feb. 9 in PNAS. The co-first authors are Joseph Torella, a recent PhD graduate from ...***Read More***…

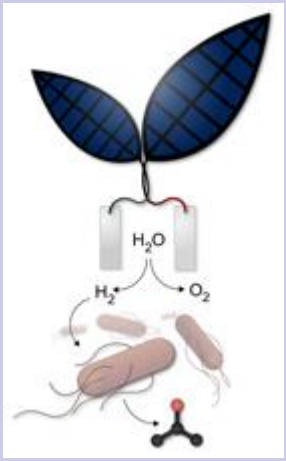

Image: Jessica Polka/HMS

The Most Unique Rocket Launch You'll Ever See

Have you ever heard of a girandola? I had not until we came across this video — which is pretty incredible! This might be one of the most unique things I've ever seen.

Girandolas are flying horizontal wheels and are a favorite of pyrotechnicians.

But as rudimentary as the setting looks in the video, girandolas are high precision, finely tuned instruments. According a group of fireworks professionals called the Pennsylvania Organization of Recreational Chaos (PORC), "you must have every driver (rocket motor) fire at the same time and be precisely tuned in order for the girandola to fly. There is very little room for error or it will not fly."

Check the link below:

https://www.youtube.com/watch?v=YVOevUSM8LQ