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Astronomy & Physics Weekly News

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

Top News

Tuesday's Lecture:

Deep Sky Objects
Nov. 15, 2016 (14:00 -15:00)

This Week's Sky at a Glance, Nov. 12 - 18

IT Support Issam Jami
Designed by Mohamed Bakir

There's an 'extra-super' Moon on the rise

Luna.

An unusually large and bright Moon will adorn the night sky next Monday - the closest "supermoon" to Earth in 68 years and a chance for dramatic photos and spectacular surf.

Weather permitting, the phenomenon should appear at its most impressive at 1352 GMT, when it will be at its fullest just as night falls over Asia, astronomers said.

Provided there are no clouds and not too much light pollution, people should be able to see Earth's satellite loom unusually large over the horizon shortly after sunset, irrespective of where in the world they are.

This happens when the Moon is full at the same time as, or very near, perigee - its closest point to Earth on an elliptical, monthly orbit. "On November 14, it becomes full within about two hours of perigee - arguably making it an extra-super Moon," NASA says on its website.

The orbit itself is changeable, meaning the distance from Earth differs from perigee to perigee - this time it will be the closest since 1948 at a distance of 356,509 kilometres (221,524 miles). The average is 384,400km.

On Monday, the full Moon's relative proximity should make it appear about 14 percent bigger and 30 percent brighter than at its furthest orbit point, according to the Irish Astronomical Association (IAA).

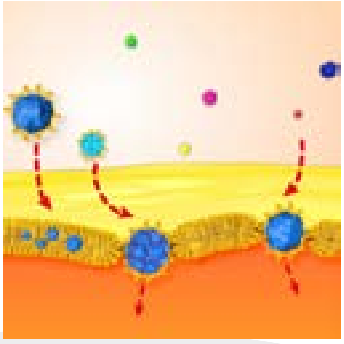
"Because the Earth/Moon system will be getting quite close to the time of year when it is closest to the Sun (January 4, 2017), the Moon will be receiving more sunlight than average, also boosting its apparent brightness."

Furthermore, the Moon's position in the sky will mean its southern hemisphere, the brighter of the two, will be turned towards Earth, said the IAA.

Illusion

Without foreknowledge, one might barely notice that the Moon appears brighter than usual, astronomers say. Once it is high in the sky, it would be hard to tell that the ...Read More...

First time physicists observed and quantified tiny nanoparticle crossing lipid membrane



Lipid-covered hydrophobic gold nanoparticles cross the membrane. Image courtesy URV.

Nanomaterials have invaded most of products used in our daily life. They are found everywhere: from cosmetics (creams, toothpastes, and shampoo), food components (sugar, or salt), clothes, buildings cement, paints, car tires, oil, electronic products (smartphones, screen), energy, pharmaceutics (drugs, medical imaging). The OECD recently reported that nanoparticles are present in more than 1300 commercial products where we ignore the potential toxicity for people, animals and environment.

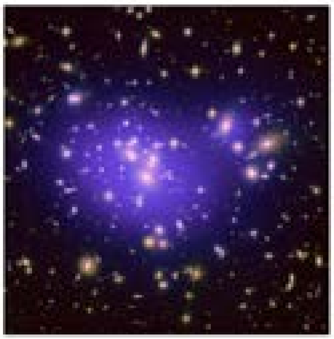
The absence of reliable tools to monitor nanoscale objects and tremendous number of mechanisms of possible toxicity leads to controversial regulations in nanotoxicity: for example, nanoparticles in creams are not crossing the human skin, but may enter through lungs or mucus layer. That is why the exact way how certain nanoparticle interact with human tissues and barriers, including cell membranes is still not well understood.

One of the reasons is the enormous difficulty to visualize individual nanoparticles. Indeed, nano-objects are below diffraction limit and thus below the capacities of optical microscopes. As a result, special and original techniques have to be designed to see the events in submicron world. Another difficulty related to tiny particles: they move fast and the processes associated with them last fractions of seconds: the measurement should be also fast.

Based on these concerns, the team of theoretical physics at Universitat Rovira i Virgili in Tarragona, led by Dr. Vladimir Baulin, the coordinator of European Network ITN SNAL, designed a research project to investigate the interaction between nanoparticles and lipid membranes.

In computer simulations, the researchers first created what they call a "perfect bilayer", in which all of the lipid tails stay in place within the membrane. Based on their calculations, the team of Dr. Baulin observed that small hydrophobic nanoparticles can insert into the lipid bilayer if their size is similar to the thickness of the membrane (around 5 nanometers). ...Read More...

Dark matter may be hiding in a hidden sector



This image shows the galaxy cluster Abell 1689, with the mass distribution of the dark matter in the gravitational lens overlaid (in purple). The mass in this lens is made up partly of normal (baryonic) matter and partly of dark matter. Credit: NASA, ESA, E. Jullo (JPL/LAM), P. Natarajan (Yale) and J-P. Kneib (LAM).

Currently, one of the strongest candidates for dark matter is weakly interacting massive particles, or WIMPS, although so far this hypothetical particle has not yet been directly detected. Now in a new study, physicists have proposed that dark matter is not a WIMP, and further, it is not any particle that is so far known or theorized to exist.

Instead, the physicists argue that dark matter is made of particles from one of the many "hidden sectors" that are thought to exist outside of the "visible sector" that encompasses our entire visible world. The team of researchers, Bobby Acharya, Sebastian Ellis, Gordon Kane, Brent Nelson, and Malcolm Perry, from institutions in the UK, Italy, and the US, has published their study in a recent issue of Physical Review Letters.

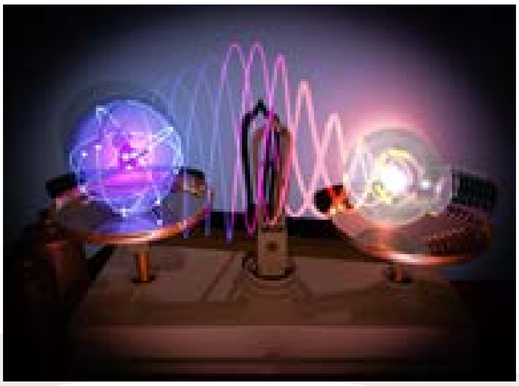
Hidden sectors are so-named because particles in these sectors don't feel the strong and electroweak forces like those in the visible sector do, which greatly reduces their interaction with the visible sector. So hidden sector particles could be all around us—we just currently have no way to detect them.

In the proposed scenario, dark matter consists of particles in the hidden sector that communicate through a portal from the hidden sector to the visible sector, and in this way exert the gravitational effects that scientists have long observed.

While such an idea may sound far-fetched, hidden sectors and portals have long been components of string theory and M-theory—two theories that seek to explain particle physics at its most fundamental level.

The main support for the new claim boils down to a question of stability. In general, heavier particles decay into lighter particles. So lighter particles, being more stable, are much more likely candidates for dark matter. This is where the long-standing support for WIMPs comes from, since WIMPs are the lightest supersymmetric particle, and therefore, until now, considered to be stable. ...Read More...

World's smallest magnifying glass makes it possible to see chemical bonds between atoms



Credit: NanoPhotonics Cambridge/Bart deNijs

For centuries, scientists believed that light, like all waves, couldn't be focused down smaller than its wavelength, just under a millionth of a metre. Now, researchers led by the University of Cambridge have created the world's smallest magnifying glass, which focuses light a billion times more tightly, down to the scale of single atoms.

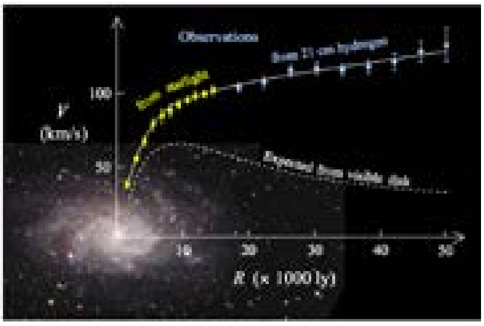
In collaboration with colleagues from Spain, the team used highly conductive gold nanoparticles to make the world's tiniest optical cavity, so small that only a single molecule can fit within it. The cavity—called a 'pico-cavity' by the researchers—consists of a bump in a gold nanostructure the size of a single atom, and confines light to less than a billionth of a metre. The results, reported in the journal Science, open up new ways to study the interaction of light and matter, including the possibility of making the molecules in the cavity undergo new sorts of chemical reactions, which could enable the development of entirely new types of sensors.

According to the researchers, building nanostructures with single atom control was extremely challenging. "We had to cool our samples to -260°C in order to freeze the scurrying gold atoms," said Felix Benz, lead author of the study. The researchers shone laser light on the sample to build the pico-cavities, allowing them to watch single atom movement in real time.

"Our models suggested that individual atoms sticking out might act as tiny lightning rods, but focusing light instead of electricity," said Professor Javier Aizpurua from the Center for Materials Physics in San Sebastian, who led the theoretical section of this work.

"Even single gold atoms behave just like tiny metallic ball bearings in our experiments, with conducting electrons roaming around, which is very different from their quantum life where electrons are bound to their nucleus," said Professor Jeremy Baumberg of the NanoPhotonics Centre at Cambridge's Cavendish Laboratory, who led the research. ...Read More...

No need for dark matter?



Wikepedia.

Theoretical physicist Erik Verlinde has a new theory of gravity, which describes gravity not a force but as an illusion. The theory says gravity is an emergent phenomenon, possible to be derived from the microscopic building blocks that make up our universe's entire existence. This week, he published the latest installment of his theory showing that – if he's correct – there's no need for dark matter to describe the motions of stars in galaxies.

Verlinde, who is at the University of Amsterdam, first released his new theory in 2010. According to a statement released this week (November 8, 2016):

> ... gravity is not a fundamental force of nature, but an emergent phenomenon. In the same way that temperature arises from the movement of microscopic particles, gravity emerges from the changes of fundamental bits of information, stored in the very structure of spacetime.

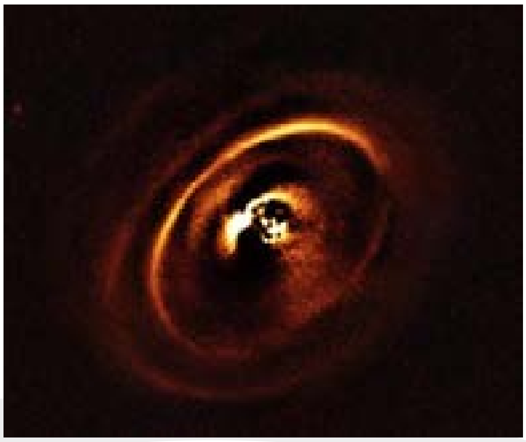
Dark matter – the invisible "something" that most modern physicists believe makes up a substantial fraction of our universe – came to be necessary when astronomers found in the mid-20th century they couldn't explain why stars in galaxies moved as they did. The outer parts of galaxies, including our own Milky Way, rotate much faster around their centers than they should, according to the theories of gravity as explained by Isaac Newton and Albert Einstein. According to these very accepted theories, there must be more mass in galaxies than that we can see, and thus scientists began speaking of invisible matter, which they called dark matter.

They've been speaking of it, and trying to understand it, ever since. Verlinde is now saying we don't need dark matter to explain what's happening in galaxies. He says his new theory of gravity accurately predicts star velocities in the Milky Way and other galaxies. In his statement, he said:

> We have evidence that this new view of gravity actually agrees with the observations. At large scales, it seems, gravity just doesn't behave the way Einstein's theory predicts.

If true, it's a revolution in science, since essentially all of modern cosmology – including the Big Bang theory that describes how our universe began – is based on Einstein's theory of gravity. In recent decades, dark ...Read More...

Protoplanetary Discs Being Shaped by Newborn Planets



Using the ESO's SPHERE instrument at the Very Large Telescope, a team of astronomer observed the planetary disc surrounding the star RX J1615 which lies in the constellation of Scorpius, 600 light-years from Earth. The observations show a complex system of concentric rings surrounding the young star, forming a shape resembling a titanic version of the rings that encircle Saturn. Such an intricate sculpting of rings in a protoplanetary disc has only been imaged a handful of times before. The central part of the image appears dark because SPHERE blocks out the light from the brilliant central star to reveal the much fainter structures surrounding it. Credit: ESO, J. de Boer et al.

Sharp new observations have revealed striking features in planet-forming discs around young stars. The SPHERE instrument, mounted on ESO's Very Large Telescope, has made it possible to observe the complex dynamics of young solar systems - including one seen developing in real-time.

The recently published results from three teams of astronomers showcase SPHERE's impressive capability to capture the way planets sculpt the discs that form them - exposing the complexities of the environment in which new worlds are formed.

Three teams of astronomers have made use of SPHERE, an advanced exoplanet-hunting instrument on the Very Large Telescope (VLT) at ESO's Paranal Observatory, in order to shed light on the enigmatic evolution of fledgling planetary systems. The explosion in the number of known exoplanets in recent years has made the study of them one of the most dynamic fields in modern astronomy.

Today it is known that planets form from vast discs of gas and dust encircling newborn stars, known as protoplanetary discs. These can extend for thousands of millions of kilometres. Over time, the particles in these protoplanetary discs collide, combine and eventually build up into planet-sized bodies. However, the finer details of the evolution of these planet-forming discs remain mysterious.

SPHERE is a recent addition to the VLT's array of instruments and with its combination of novel technologies, it provides a powerful method to directly image the fine details of protoplanetary discs. ...Read More...

Close to absolute zero, electrons exhibit their quantum nature

Researchers in the Nanoscale Science Department conduct their experiments in this instrument at lowest temperatures of a fifteen thousandth of a degree above absolute zero. The principle is always the same: A tunneling current (illustrated by the transparent bar) flows between an ultrafine tip and the sample, providing information about the properties of the sample. At these low temperatures the tunneling current reveals all of its quantum properties. Credit: MPI for Solid State Research

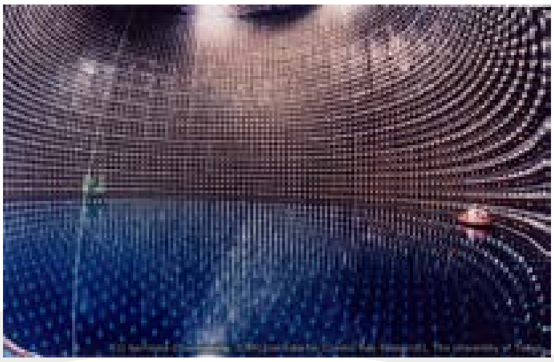
What would happen if an electric current no longer flowed, but trickled instead? This was the question investigated by researchers working with Christian Ast at the Max Planck Institute for Solid State Research. Their investigation involved cooling their scanning tunnelling microscope down to a fifteen thousandth of a degree above absolute zero. At these extremely low temperatures, the electrons reveal their quantum nature. The electric current is therefore a granular medium, consisting of individual particles. The electrons trickle through a conductor like grains of sand in an hourglass, a phenomenon that can be explained with the aid of quantum electrodynamics.

Flowing water from a tap feels like a homogeneous medium - it is impossible to distinguish between the individual water molecules. Exactly the same thing is true about electric current. So many electrons flow in a conventional cable that the current appears to be homogeneous. Although it is not possible to distinguish individual electrons, quantum mechanics says they should exist. So how do they behave? Under which conditions does the current not flow like water through a tap, but rather trickles like sand in an hourglass?

The hourglass analogy is very appropriate for the scanning tunnelling microscope, where a thin, pointed tip scans across the surface of a sample without actually touching it. A tiny current flows nevertheless, as there is a slight probability that electrons "tunnel" from the pointed tip into the sample. This tunnelling current is an exponential function of the separation, which is why the pointed tip is located only a few Ångström (a ten millionth of a millimetre) above the sample.

Minute variations in the tunnelling current thus allow researchers to resolve individual atoms and atomic structures on surfaces and investigate their electronic structure. Scanning tunnelling microscopes are therefore some of the most versatile and sensitive detectors in the whole of solid state physics. Even under these extreme conditions – a tiny current of less than one ...Read More...

Solar physicists unlock easier way to observe peculiar particles that reveal the inner workings of the sun



Workers maintain the Super-Kamiokande neutrino detector in Hida, Japan. Credit: Kamioka Observatory, Institute for Cosmic Ray Research, University of Tokyo

In 2009, applied physicist Peter Sturrock was visiting the National Solar Observatory in Tucson, Arizona, when the deputy director of the observatory told him he should read a controversial article about radioactive decay. Although the subject was outside Sturrock's field, it inspired a thought so intriguing that the next day he phoned the author of the study, Purdue University physicist Ephraim Fischbach, to suggest a collaboration.

Fischbach replied, "We were about to phone you."

More than seven years later, that collaboration could result in an inexpensive tabletop device to detect elusive neutrinos more efficiently and inexpensively than is currently possible, and could simplify scientists' ability to study the inner workings of the sun. The work was published in the Nov. 7 issue of Solar Physics.

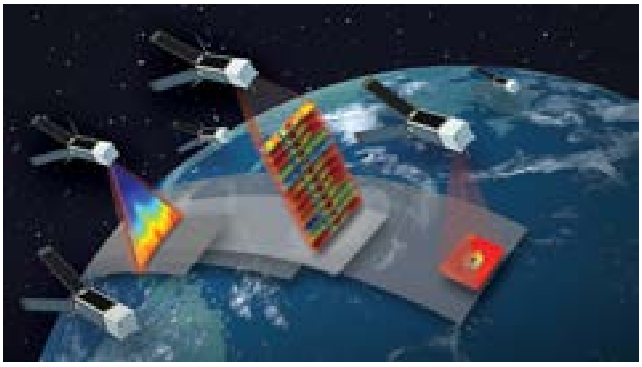
"If we're correct, it means that neutrinos are far easier to detect than people have thought," said Sturrock, professor emeritus of applied physics. "Everyone thought that it would be necessary to have huge experiments, with thousands of tons of water or other material, that may involve huge consortia and huge expense, and you might get a few thousand counts a year. But we may get similar or even better data from an experiment involving only micrograms of radioactive material."

Why, how we study neutrinos

For twenty years, Sturrock and his colleague Jeff Scargle, astrophysicist and data scientist at NASA Ames Research Center, have studied neutrinos, subatomic particles with no electric charge and nearly zero mass, which can be used to learn about the inside of the sun.

Nuclear reactions in the sun's core produce neutrinos. A unique feature of neutrinos is that they rarely interact with other particles and so can escape ...Read More...

NASA small satellites will take a fresh look at Earth



Artist's concept of the TROPICS mission, which will study hurricanes with a constellation of 12 CubeSats flying in formation. Image courtesy MIT Lincoln Laboratory.

Beginning this month, NASA is launching a suite of six next-generation, Earth-observing small satellite missions to demonstrate innovative new approaches for studying our changing planet. These small satellites range in size from a loaf of bread to a small washing machine and weigh from a few to 400 pounds (180 kilograms).

Their small size keeps development and launch costs down as they often hitch a ride to space as a "secondary payload" on another mission's rocket - providing an economical avenue for testing new technologies and conducting science.

"NASA is increasingly using small satellites to tackle important science problems across our mission portfolio," said Thomas Zurbuchen, associate administrator of NASA's Science Mission Directorate in Washington. "They also give us the opportunity to test new technological innovations in space and broaden the involvement of students and researchers to get hands-on experience with space systems."

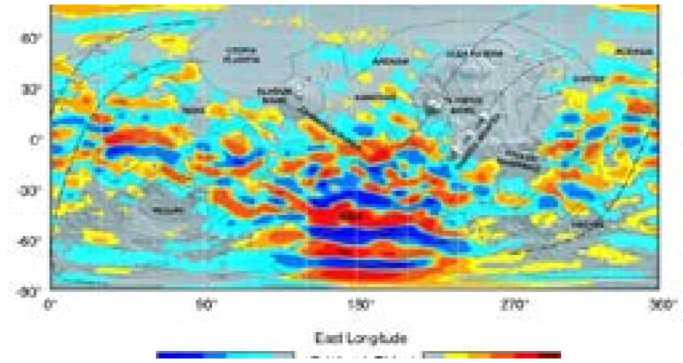
Small-satellite technology has led to innovations in how scientists approach Earth observations from space. These new missions, five of which are scheduled to launch during the next several months, will debut new methods to measure hurricanes, Earth's energy budget, aerosols and weather.

"NASA is expanding small satellite technologies and using low-cost, small satellites, miniaturized instruments, and robust constellations to advance Earth science and provide societal benefit through applications," said Michael Freilich, director of NASA's Earth Science Division in Washington.

Four CubeSats in Three Launches

Scheduled to launch this month, RAVAN, the Radiometer Assessment using Vertically Aligned Nanotubes, is a CubeSat that will demonstrate new technology for detecting slight changes in Earth's energy budget at the top of the atmosphere - essential measurements for understanding greenhouse gas effects on climate. RAVAN is led by Bill Swartz at the Johns Hopkins Applied Physics Laboratory in ..Read More...

Mars' ionosphere shaped by crustal magnetic fields



Magnetic map of Mars. Image courtesy NASA

Scattered pockets of magnetism across the surface of Mars have a significant influence on the planet's upper atmosphere, according to observations from ESA's Mars Express. Understanding these effects may be crucial for ensuring safe radio communications between Mars and Earth and, eventually, between explorers on the surface of the planet.

Earth's magnetic field is dominated by a single, strong source: the dynamo deep below the planet's surface. However, the same cannot be said for Mars. Rather than possessing a single source of magnetic field, Mars has many.

The Red Planet has numerous pockets of strong magnetism locked up within its crust, remnants from its earliest days. Modern-day Mars may be known for its relative lack of magnetism but young Mars was likely a different world; it was probably warmer and wetter, with a denser atmosphere and a hotter core. Scientists believe the young planet also had a sizeable magnetic field, driven by the circulating motion of molten material within its core (known as a planetary dynamo).

This global field switched off long ago - likely as the core cooled and solidified, freezing the dynamo in place - but the planet still boasts anomalous patches of strong remnant magnetism spread across its surface, known as 'crustal fields'.

Magnetic memories of early Mars

Parts of Mars' crust and rock remain magnetised today due to a phenomenon known as 'ferro-magnetism', which lasts even when the external magnetic field is no longer present (as is the case with Mars).

Mars' crust cooled to below a specific temperature - known as the Curie temperature [1] - when the planet's core dynamo, and thus its magnetic field, was still active and present, causing residual magnetism to become permanently locked within ferrous (iron-containing) material in the crust. Similar crustal magnetic fields are ...Read More...

How the 18th-century steam engine helped physicists make a quantum breakthrough

Who knew the steam engine would prove so useful? Credit: Jorge Royan/wikimedia, CC BY-SA

The hissing sound you hear in the background when you turn up the volume of your music player is called "noise". Most of this hiss is due to the thermal motion of electrons in the music-player circuitry. Just like molecules in a hot gas, electrons in the circuitry are constantly jiggling about in a random fashion, and this motion this gives rise to an unwanted noise signal.

But there is another type of noise that only comes into play when we have an electrical current flowing. This noise is known as shot noise. Obstacles that generate shot noise in this way are found in many electronic components, such as diodes and some transistors, and electronic engineers take great efforts to try to get rid of the effects of all sources of noise, including shot noise, in their designs. Now a new study has shown that shot noise can be eliminated at its microscopic origin. And to do so, they have borrowed an idea from an unlikely source – the early days of the steam engine.

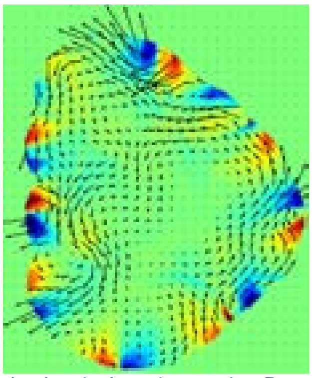
Quantum weirdness

Shot noise has its origins in the fact that electrical current is composed of a stream of individual particles – electrons – and that the behaviour of these particles is governed by the strange laws of quantum mechanics.

When an electron encounters an obstacle that you'd think would block its path, quantum mechanics offers the possibility that it can pass through it unhindered. This is called quantum tunnelling, and it makes the seemingly impossible possible. The important thing about quantum tunnelling is that it is a random process—quantum mechanics can tell us with what probability an electron might tunnel, but it can't tell us whether any particular electron will tunnel or not.

Thus, if a stream of electrons hits an obstacle, some will tunnel and some will not, and this happens in a ...Read More...

Simulations show swirling rings, whirlpool-like structure in subatomic 'soup'



This hydrodynamic simulation shows the flow patterns, or 'vorticity distribution,' from a smoke ring-like swirling fluid around the beam direction of two colliding heavy ions. The simulation provides new insights about the properties of a superhot fluid known as the quark-gluon plasma. Credit: Berkeley Lab

At its start, the universe was a superhot melting pot that very briefly served up a particle soup resembling a "perfect," frictionless fluid. Scientists have recreated this "soup," known as quark-gluon plasma, in high-energy nuclear collisions to better understand our universe's origins and the nature of matter itself. The physics can also be relevant to neutron stars, which are the extraordinarily dense cores of collapsed stars.

Now, powerful supercomputer simulations of colliding atomic nuclei, conducted by an international team of researchers including a Berkeley Lab physicist, provide new insights about the twisting, whirlpool-like structure of this soup and what's at work inside of it, and also lights a path to how experiments could confirm these characteristics. The work is published in the Nov. 1 edition of Physical Review Letters.

Matter, deconstructed

This soup contains the deconstructed ingredients of matter, namely fundamental particles known as quarks and other particles called gluons that typically bind quarks to form other particles, such as the protons and neutrons found at the cores of atoms. In this exotic plasma state—which can reach trillions of degrees Fahrenheit, hundreds of thousands of times hotter than the sun's core—protons and neutrons melt, freeing quarks and gluons from their usual confines at the center of atoms.

These record-high temperatures have been achieved by colliding gold nuclei at Brookhaven National Laboratory's RHIC (Relativistic Heavy Ion Collider), for example, and lead nuclei at CERN's LHC (Large Hadron Collider). Experiments at RHIC discovered in 2005 that quark-gluon plasma behaves like a fluid. In addition to gold nuclei, RHIC has also been used to collide protons, copper and uranium. The LHC began conducting heavy-ion experiments in 2014, and has confirmed that the quark-gluon plasma behaves like a fluid. ...Read More...

This Week's Sky at a Glance
Nov. 12 - 18

Nov 14	Moon at perigee: 356512 km (15:23)
Nov 14	Full Moon (17:52) - Supermoon
Nov 15	Aldebaran 0.4°S of Moon (20:50)
Nov 17	Leonid meteor shower

SCASS ACTIVITIES

Monday - Nov. 14, 2016

Event: Students Astronomy Observation (Female Students)
Time: 18:00 - 20:00
Location: SCASS Observatory

Tuesday - Nov. 15, 2016

Event: Tuesday's Lecture
Title: Deep Sky Objects
Lecture: Mr. Mohamed Rihan - Planetarium Supervisor
Time: 14:00 - 15:00
Location: SCASS Auditorium

Tuesday - Nov. 15, 2016

Event: Students Astronomy Observation (Male Students)
Time: 18:00 - 20:00
Location: SCASS Observatory

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