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Astronomy & Physics Weekly News

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

Top News

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Abu-Dhabi
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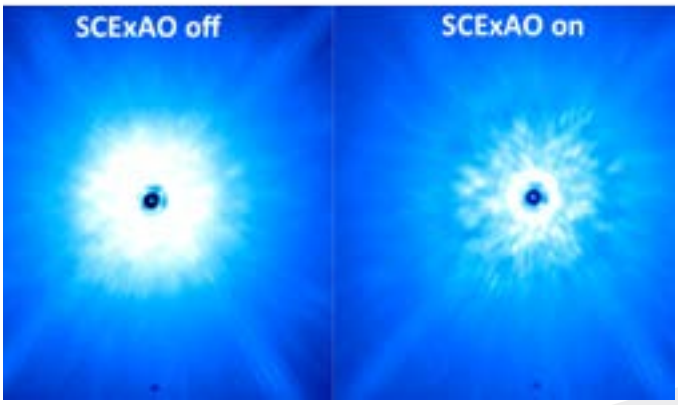
Designed by Mohamed Bakir

Dedicated Planet Imager Opens Its Eyes to Other Worlds



Comparison of images taken from existing, facility instrument (AO 188 + HiCIAO, left) and the newly commissioned instrument (AO 188 + SCExAO, right). Image courtesy NAOJ.

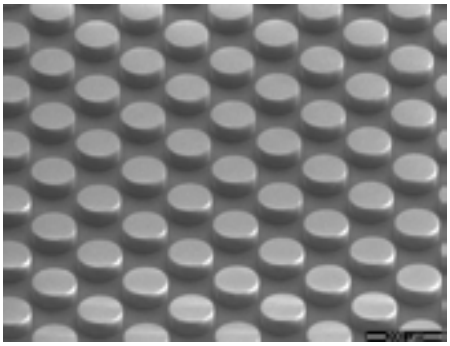
An astronomical instrument on Maunakea specifically designed to see planets around other stars has been successfully commissioned and has started to reveal stunning images of other worlds after almost a decade of painstaking work. "Maunakea is the best place on this planet to see planets in other stellar systems. Now, we finally have an instrument designed to utilize this mountain's special gifts and the results are breathtaking," exclaims Dr. Thayne Currie, who authored the first science result paper.

While the first planets ever seen around another star were imaged from Maunakea, these discoveries were made with general-purpose instruments. With the commissioning of a new instrument at the Subaru Telescope called SCExAO (Subaru Coronagraphic Extreme Adaptive Optics), specifically designed and optimized for imaging planets by employing experimental technology, joins recently commissioned extreme AO instruments in Chile and Arizona.

With SCExAO, Maunakea reaffirms its leading role in the direct detection and exploration of other worlds, eventually those that may resemble that of the Earth. So far, about a dozen planets have been directly discovered by imaging techniques using current AO systems. The list includes two from the Subaru Telescope (kappa And b and GJ 504 b. These planets are 4 to 13 times more massive than Jupiter and located further from their host star than Neptune is from our Sun.

Being an extreme AO system, SCExAO allows us to image planets with masses and orbital separations much more like those in our own solar system by better compensating for the blurring of images due to turbulent air at the telescope site. Compared to the facility, multi-purpose AO system (AO188) at the Subaru Telescope, SCExAO is able to compensate more precisely for how the atmosphere blurs images of stars and does so at a faster rate. As a result, SCExAO now delivers far, far sharper images: with a reduced glare from the star, imaging fainter, more solar system-like planets becomes possible. ...Read More...

Absorbing electromagnetic energy while avoiding the heat



Each cylinder of this new non-metal metamaterial is made of boron-doped silicon and precisely tailored to absorb electromagnetic waves. Credit: Willie Padilla, Duke University

Electrical engineers at Duke University have created the world's first electromagnetic metamaterial made without any metal. The device's ability to absorb electromagnetic energy without heating up has direct applications in imaging, sensing and lighting.

Metamaterials are synthetic materials composed of many individual, engineered features that together produce properties not found in nature. Imagine an electromagnetic wave moving through a flat surface made of thousands of tiny electrical cells. If researchers can tune each cell to manipulate the wave in a specific way, they can dictate exactly how the wave behaves as a whole.

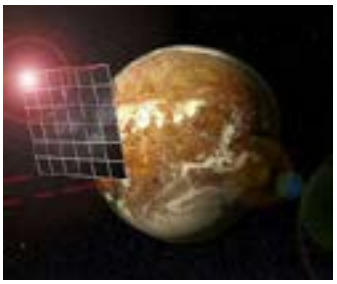
For researchers to manipulate electromagnetic waves, however, they've typically had to use electrically conducting metals. That approach, however, brings with it a fundamental problem of metals—the higher the electrical conductivity, the better the material also conducts heat. This limits their usefulness in temperature-dependent applications.

In a new paper, electrical engineers at Duke University demonstrate the first completely dielectric (non-metal) electromagnetic metamaterial—a surface dimpled with cylinders like the face of a Lego brick that is designed to absorb terahertz waves. While this specific frequency range sits between infrared waves and microwaves, the approach should be applicable for almost any frequency of the electromagnetic spectrum.

The results appeared online on Jan. 9 in the journal Optics Express.

"People have created these types of devices before, but previous attempts with dielectrics have always been paired with at least some metal," said Willie Padilla, professor of electrical and computer engineering at Duke University. "We still need to optimize the technology, but the path forward to several applications is much easier than with metal-based approaches." ...Read More...

Full Braking at Alpha Centauri



Interstellar journey: The aim of the Starshot project is to send a tiny spacecraft propelled by an enormous rectangular photon sail to the Alpha Centauri star system, where it would fly past the Earth-like planet Proxima Centauri b. The four red beams emitted from the corners of the sail depict laser pulses for communication with the Earth. Image courtesy Planetary Habitability Laboratory, Univesity of Puerto Rico at Arecibo.

In April last year, billionaire Yuri Milner announced the Breakthrough Starshot Initiative. He plans to invest 100 million US dollars in the development of an ultra-light light sail that can be accelerated to 20 percent of the speed of light to reach the Alpha Centauri star system within 20 years.

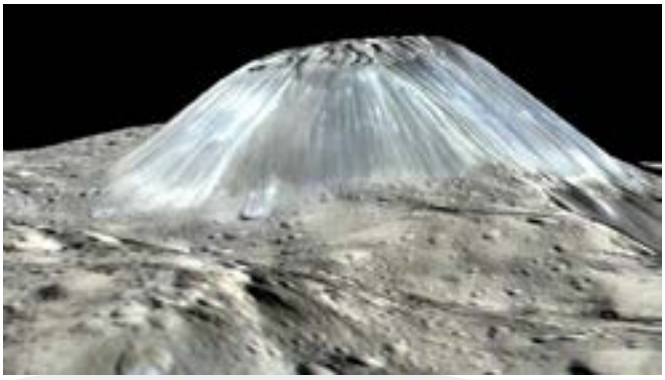
The problem of how to slow down this projectile once it reaches its target remains a challenge. Rene Heller of the Max Planck Institute for Solar System Research in Gottingen and his colleague Michael Hippke propose to use the radiation and gravity of the Alpha Centauri stars to decelerate the craft. It could then even be rerouted to the red dwarf star Proxima Centauri and its Earth-like planet Proxima b.

In the recent science fiction film Passengers, a huge spaceship flies at half the speed of light on a 120-year-long journey toward the distant planet Homestead II, where its 5000 passengers are to set up a new home. This dream is impossible to realize at the current state of technology. "With today's technology, even a small probe would have to travel nearly 100,000 years to reach its destination," Rene Heller says.

Notwithstanding the technical challenges, Heller and his colleague Michael Hippke wondered, "How could you optimize the scientific yield of this type of a mission?" Such a fast probe would cover the distance from the Earth to the Moon in just six seconds. It would therefore hurtle past the stars and planets of the Alpha Centauri system in a flash.

The solution is for the probe's sail to be redeployed upon arrival so that the spacecraft would be optimally decelerated by the incoming radiation from the stars in the Alpha Centauri system. Rene Heller, an astrophysicist working on preparations for the upcoming Exoplanet mission PLATO, found a congenial spirit in IT specialist Michael Hippke, who set up the computer simulations. The two scientists based their calculations on a space probe weighing less than 100 grams in ...Read More...

New research shows Ceres may have vanishing ice volcanoes



This is Ahuna Mons seen in a simulated perspective view. The elevation has been exaggerated by a factor of two. The view was made using enhanced-color images from NASA's Dawn mission. Image courtesy NASA.

A recently discovered solitary ice volcano on the dwarf planet Ceres may have some hidden older siblings, say scientists who have tested a likely way such mountains of icy rock - called cryovolcanoes - might disappear over millions of years.

NASA's Dawn spacecraft discovered Ceres's 4-kilometer (2.5-mile) tall Ahuna Mons cryovolcano in 2015. Other icy worlds in our solar system, like Pluto, Europa, Triton, Charon and Titan, may also have cryovolcanoes, but Ahuna Mons is conspicuously alone on Ceres. The dwarf planet, with an orbit between Mars and Jupiter, also lies far closer to the sun than other planetary bodies where cryovolcanoes have been found.

Now, scientists show there may have been cryovolcanoes other than Ahuna Mons on Ceres millions or billions of years ago, but these cryovolcanoes may have flattened out over time and become indistinguishable from the planet's surface. They report their findings in a new paper accepted for publication in Geophysical Research Letters, a journal of the American Geophysical Union.

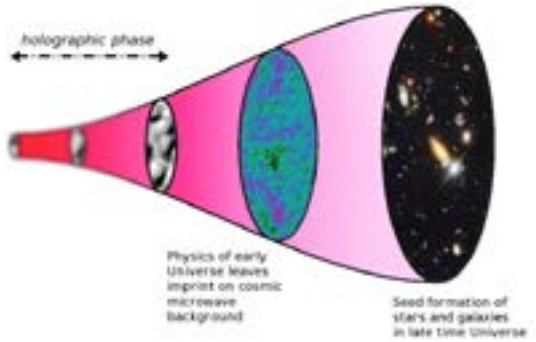
"We think we have a very good case that there have been lots of cryovolcanoes on Ceres but they have deformed," said Michael Sori of the Lunar and Planetary Laboratory at the University of Arizona in Tucson, and lead author of the new paper.

Ahuna Mons is a prominent feature on Ceres, rising to about half the height of Mount Everest. Its solitary existence has puzzled scientists since they spied it.

"Imagine if there was just one volcano on all of Earth," Sori said. "That would be puzzling."

Adding to the puzzle are the steep sides and well-defined features of Ahuna Mons - usually signs of geologic youth, Sori said. That leads to two possibilities: Ahuna Mons is just as it appears, inexplicably alone after ...Read More...

Study reveals substantial evidence of holographic universe



A sketch of the timeline of the holographic Universe. Time runs from left to right. The far left denotes the holographic phase and the image is blurry because space and time are not yet well defined. At the end of this phase (denoted by the black fluctuating ellipse) the Universe enters a geometric phase, which can now be described by Einstein's equations. The cosmic microwave background was emitted about 375,000 years later. Patterns imprinted in it carry information about the very early Universe and seed the development of structures of stars and galaxies in the late time Universe (far right). Credit: Paul McFadden

A UK, Canadian and Italian study has provided what researchers believe is the first observational evidence that our universe could be a vast and complex hologram.

Theoretical physicists and astrophysicists, investigating irregularities in the cosmic microwave background (the 'afterglow' of the Big Bang), have found there is substantial evidence supporting a holographic explanation of the universe—in fact, as much as there is for the traditional explanation of these irregularities using the theory of cosmic inflation.

The researchers, from the University of Southampton (UK), University of Waterloo (Canada), Perimeter Institute (Canada), INFN, Lecce (Italy) and the University of Salento (Italy), have published findings in the journal Physical Review Letters.

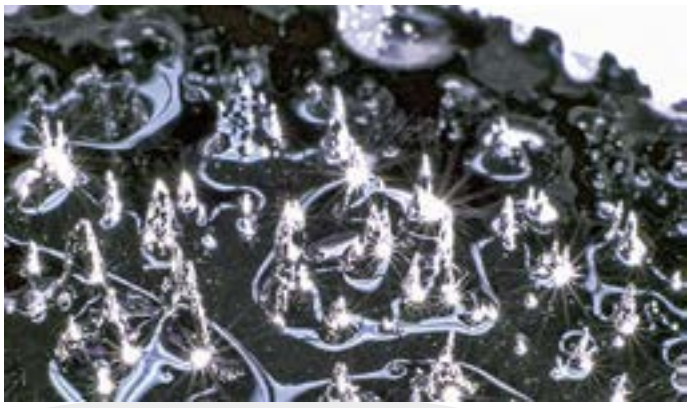
A holographic universe, an idea first suggested in the 1990s, is one where all the information that makes up our 3-D 'reality' (plus time) is contained in a 2-D surface on its boundaries.

Professor Kostas Skenderis of Mathematical Sciences at the University of Southampton explains: "Imagine that everything you see, feel and hear in three dimensions (and your perception of time) in fact emanates from a flat two-dimensional field. The idea is similar to that of ordinary holograms where a three-dimensional image is encoded in a two-dimensional surface, such as in the hologram on a credit card. However, this time, the entire universe is encoded."

Although not an example with holographic properties, it could be thought of as rather like watching a 3-D film in a cinema. We see the pictures as having height, width and crucially, depth—when in fact it all originates from a flat 2-D screen. The difference, in our 3-D universe, is that we can touch objects and the 'projection' is 'real' from our perspective.

In recent decades, advances in telescopes and sensing equipment have allowed scientists to detect a vast amount of data hidden in the 'white noise' or ...Read More...

A new material to unearth mysteries of magnetic fields



Credit: Yale University

Journeying to the center of the Earth, a la Jules Verne, won't be happening anytime soon. A new material made from a liquid metal and magnetic particles, however, could make it much easier for researchers to recreate the powerful forces at the planet's core.

"We can potentially reproduce some of the phenomena seen in planets and stars with this material," said Eric Brown, assistant professor of mechanical engineering and materials science at Yale and senior author of a study published Jan. 30 in the journal Physical Review Fluids.

The new material is made from an alloy of indium and gallium (eGaln) with various particles suspended within it. When flowing, its ability to generate or modify magnetic fields is up to five times greater than that of pure liquid metal. That, along with a significant increase in electrical conductivity, means researchers can use the material to study the effects of magnetohydrodynamics (MHD)—the magnetic properties of conductive fluids usually only observable in the cores of planets and stars.

One challenge of suspending particles in liquid metals is that the air oxidizes the skin of the metals, keeping particles on the surface. The researchers got around this by submerging the liquid metal in an acid solution, which removes and prevents oxidation.

"We managed to suspend almost anything we wanted—steel, zinc, nickel, iron—basically anything with a conductivity higher than that of the eGaln," said Florian Carle, a postdoctoral associate in Yale's Department of Mechanical Engineering & Materials Science, and lead author of the paper.

The discovery could hold benefits for geophysics, astrophysics, and other fields that explore the dynamics of the Earth's magnetic field, which is generated by the liquid metal flowing in the core. This magnetic field creates an electrical current inside the Earth and blocks radiation from space. Considering the wide range of the material's potential applications, the researchers ...Read More...

Celestial cat meets cosmic lobster

This spectacular image from the VLT Survey Telescope shows the Cat's Paw Nebula (NGC 6334, upper right) and the Lobster Nebula (NGC 6357, lower left). These dramatic objects are regions of active star formation where the hot young stars are causing the surrounding hydrogen gas to glow red. The very rich field of view also includes dark clouds of dust. With around two billion pixels this is one of the largest images ever released by ESO. Image courtesy ESO.

NGC 6334 is located about 5500 light-years away from Earth, while NGC 6357 is more remote, at a distance of 8000 light-years. Both are in the constellation of Scorpius (The Scorpion), near the tip of its stinging tail.

The British scientist John Herschel first saw traces of the two objects, on consecutive nights in June 1837, during his three-year expedition to the Cape of Good Hope in South Africa. At the time, the limited telescopic power available to Herschel, who was observing visually, only allowed him to document the brightest "toepad" of the Cat's Paw Nebula. It was to be many decades before the true shapes of the nebulae became apparent in photographs - and their popular names coined.

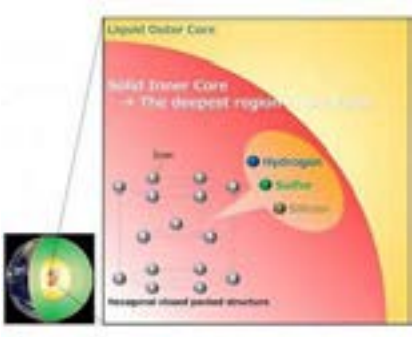
The three toepads visible to modern telescopes, as well as the claw-like regions in the nearby Lobster Nebula, are actually regions of gas - predominantly hydrogen - energised by the light of brilliant newborn stars. With masses around 10 times that of the Sun, these hot stars radiate intense ultraviolet light.

When this light encounters hydrogen atoms still lingering in the stellar nursery that produced the stars, the atoms become ionised. Accordingly, the vast, cloud-like objects that glow with this light from hydrogen (and other) atoms are known as emission nebulae.

Thanks to the power of the 256-megapixel OmegaCAM camera, this new Very Large Telescope Survey Telescope (VST) image reveals tendrils of light-obscuring dust rippling throughout the two nebulae. At 49511 x 39136 pixels this is one of the largest images ever released by ESO.

OmegaCAM is a successor to ESO's celebrated Wide Field Imager (WFI), currently installed at the MPG/ESO 2.2-metre telescope on La Silla. The WFI was used to photograph the Cat's Paw Nebula in 2010, also in ..Read More...

Research journey to the center of the Earth



The solid inner core of the Earth and its possible light elements are shown. Image courtesy Tatsuya Sakamaki.

Researchers in Japan say they may be one step closer to solving the mystery at the core of the Earth.

It has long been established that approximately 85 percent of the Earth's core is made of iron, while nickel makes up an additional 10 percent. Details of the final 5 percent - believed to be some amount of light elements - has, until now, eluded scientists.

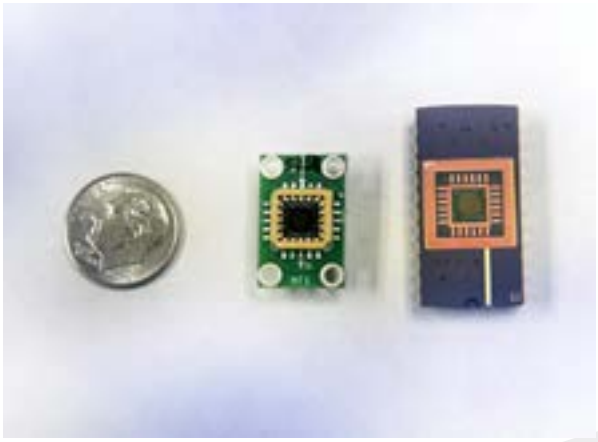
According to the Japanese research team, which includes Dr. Tatsuya Sakamaki and Prof. Eiji Ohtani from Tohoku University's Graduate School of Science, new experiments show that possible candidates for the light elements are hydrogen, silicon and sulfur.

Experiments have consisted of building model cores containing different materials, and subjecting them to heat of up to 6,000C and pressure 3.6 million times that at the surface of the planet. The researchers then measured the density and sound velocity, and concluded that the physical properties of the iron-alloy with those three elements are consistent with seismological observations in the real core.

The core, which is the deepest region of the Earth, is composed of a liquid outer core (2900~5100 km in depth) and solid inner core (5100~6400 km in depth). The core is one of the most important "final frontiers" for scientists looking to understand the history of Earth, and the conditions during its formation 4.5 billion years ago.

This study was initially published in "Science Advances" by the American Association for the Advancement of Science (AAAS) on Feb. 26, 2016. More recently, the team gave a presentation at a meeting of the American Geophysical Union in San Francisco in Dec. 2016. ...Read More...

Infrared links could simplify data center communications



Two different Microelectromechanical devices containing micro mirrors used to position an infrared laser beam to target a receiver and send information. Credit: Patrick Mansell, Penn State

Data centers are the central point of many, if not most, information systems today, but the masses of wires interconnecting the servers and piled high on racks begins to resemble last year's tangled Christmas-tree lights disaster. Now a team of engineers is proposing to eliminate most of the wires and substitute infrared free-space optics for communications.

"We and others tried radio frequency signaling, but the beams become wide over short distances," said Mohsen Kavehrad, W. L. Weiss Chair Professor of Electrical Engineering, Penn State. "The buildings could be a mile long and every rack should be able to communicate."

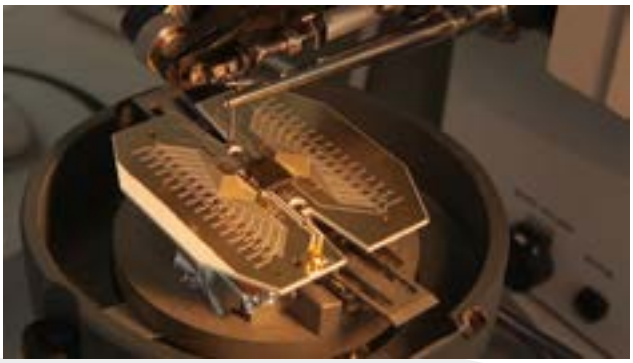
In an experiment conducted by Microsoft engineers, researchers found that radio-frequency signaling resulted in high interference, limited active links and limited throughput—the amount of data that can go through a system.

"We use a free space optical link," Kavehrad told attendees today (Jan. 31) at Photonics West 2017 in San Francisco. "It uses a very inexpensive lens, we get a very narrow infrared beam with zero interference and no limit to the number of connections with high throughput."

The Free-space optical Inter-Rack nEtwork with high FLexibilitY—or Firefly—architecture is a joint project of Penn State, Stony Brook University and Carnegie Mellon University. It would use infrared lasers and receivers mounted on top of data center racks to transmit information. The laser modules are rapidly reconfigurable to acquire a target on any rack. Human interference is minimal because the racks are more than 6.5 feet high so most workers can walk between the rows of racks without breaking the laser beams.

According to Kavehrad, data centers may house 400,000 servers on racks filling a mile-long room. Data centers typically build for peak traffic, which means that most of the time about 30 percent of servers are offline. However, because they are still on, they continue to ...Read More...

First ever blueprint unveiled to construct a large scale quantum computer



Prototype of the core of a trapped ion quantum computer. Credit: Ion Quantum Technology Group, University of Sussex

An international team, led by a scientist from the University of Sussex, have today unveiled the first practical blueprint for how to build a quantum computer, the most powerful computer on Earth.

This huge leap forward towards creating a universal quantum computer is published today (1 February 2017) in the influential journal Science Advances (1). It has long been known that such a computer would revolutionise industry, science and commerce on a similar scale as the invention of ordinary computers. But this new work features the actual industrial blueprint to construct such a large-scale machine, more powerful in solving certain problems than any computer ever constructed before.

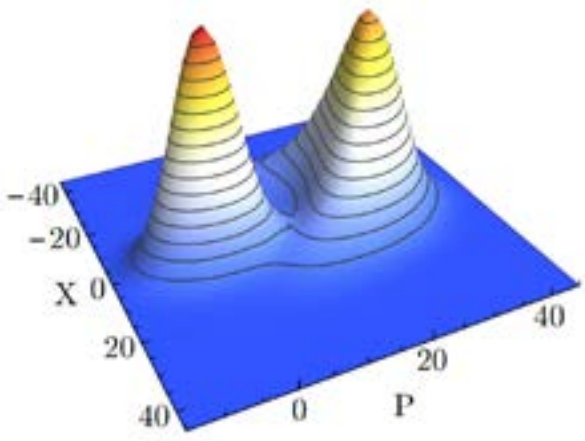
Once built, the computer's capabilities mean it would have the potential to answer many questions in science; create new, lifesaving medicines; solve the most mind-boggling scientific problems; unravel the yet unknown mysteries of the furthest reaches of deepest space; and solve some problems that an ordinary computer would take billions of years to compute.

The work features a new invention permitting actual quantum bits to be transmitted between individual quantum computing modules in order to obtain a fully modular large-scale machine capable of reaching nearly arbitrary large computational processing powers.

Previously, scientists had proposed using fibre optic connections to connect individual computer modules. The new invention introduces connections created by electric fields that allow charged atoms (ions) to be transported from one module to another. This new approach allows 100,000 times faster connection speeds between individual quantum computing modules compared to current state-of-the-art fibre link technology.

The new blueprint is the work of an international team of scientists from the University of Sussex (UK), Google (USA), Aarhus University (Denmark), RIKEN (Japan) and Siegen University (Germany). ..Read More...

Quantum phase transition observed for the first time



Probability distribution showing the equal likelihood for the cavity being transparent and opaque at the critical point. Credit: J. Fink

A group of scientists led by Johannes Fink from the Institute of Science and Technology Austria (IST Austria) reported the first experimental observation of a first-order phase transition in a dissipative quantum system. Phase transitions include such phenomena as the freezing of water at the critical temperature of 0 degrees Celsius. However, phase transitions also occur at the quantum mechanical level, where they are still relatively unexplored by researchers.

One example of a phase transition at the quantum level is the photon-blockade breakdown, which was only discovered two years ago. During photon blockade, a photon fills a cavity in an optical system and prevents other photons from entering the same cavity until it leaves, hence blocking the flow of photons. But if the photon flux increases to a critical level, a quantum phase transition is predicted: The photon blockade breaks down, and the state of the system changes from opaque to transparent. This specific phase transition has now been experimentally observed by researchers who, for the first time, met the very specific conditions necessary to study this effect.

During a phase transition, the continuous tuning of an external parameter, for example temperature, leads to a transition between two robust steady states with different attributes. First-order phase transitions are characterized by a coexistence of the two stable phases when the control parameter is within a certain range close to the critical value. The two phases form a mixed phase in which some parts have completed the transition and others have not, as in a glass containing ice water. The experimental results that Fink and his collaborators will publish in the journal Physical Review X give insight into the quantum mechanical basis of this effect in a microscopic, zero-dimensional system.

Their setup consisted of a microchip with a superconducting microwave resonator acting as the cavity and a few superconducting qubits acting as the atoms. ..Read More...

Change in astronaut's gut bacteria attributed to spaceflight

Credit: NASA

Northwestern University researchers studying the gut bacteria of Scott and Mark Kelly, NASA astronauts and identical twin brothers, as part of a unique human study have found that changes to certain gut "bugs" occur in space.

The Northwestern team is one of 10 NASA-funded research groups studying the Kelly twins to learn how living in space for a long period of time—such as a mission to Mars—affects the human body. While Scott spent nearly a year in space, his brother, Mark, remained on Earth, as a ground-based control.

"We are seeing changes associated with spaceflight, and they go away upon return to Earth," said Fred W. Turek, the Charles E. and Emma H. Morrison Professor of Biology in the Weinberg College of Arts and Sciences. He is a co-leader of the study.

"It's early in our analysis, so we don't know yet what these changes mean," said Martha H. Vitaterna, study co-leader and research associate professor of neurobiology at Northwestern. "We don't know what it is about spaceflight that is driving the changes in gut microbes."

The research team includes collaborators from Rush University Medical School and the University of Illinois at Chicago.

"We will be working closely with the other Twins Study teams to piece together a more complete picture of the effects of long space missions," Turek said. "What we learn will help us safeguard the health of astronauts, and it will also help us improve human health on Earth."

Turek reported his team's preliminary research results at NASA's Human Research Program's annual Investigators' Workshop, held last week in Galveston, Texas. This was the first meeting where the researchers with the 10 Twins Study teams, which are looking at different aspects of the twins' physiology, could share their data with each other. ...Read More...

This Week's Sky at a Glance, Feb. 04 - 10

Feb. 04	First Quarter Moon 08:18
Feb. 06	Aldebaran 0.2o S Moon 01:14
Feb. 06	Moon at Perigee 17:59 (368817 km)
Feb. 07	Mercury at Aphelion 18:00
Feb. 10	Beehive 3.9o N of Moon 03:46

Global Space Congress

Abu-Dhabi (Jan. 31 - Feb. 01, 2017)

The University of Sharjah and the Sharjah Center for Astronomy and Space Sciences have attended during two days the "Global Space Congress" meeting in Abu-Dhabi. The GSC 2017 main objective was to bring together key public and private stakeholders to evaluate the biggest opportunities in the space sector and to get exposure to the world's most vibrant and energetic new space programmes.

The Global Space Congress is where space policies are defined and strategies developed; where new applications for space technology are showcased and the development of highly skilled technical workforces to support national development are promoted. It hosted discussions and initiatives that will have a practical and lasting impact on the overall development of the space sector in the Middle East and globally.

The Congress has gathered 600 experts from across the world, including Heads of Space Agencies, C-Level executives from leading space and aerospace companies, government ministries, top researchers and academics. The Congress enables collaborative development and the implementation of core space and satellite technology strategies, bringing global and regional economic benefits.

Five representatives from the Sharjah Center for Astronomy and Space Sciences (Dr. Ilias Fernini, Ibrahim Al-jarwan, Mohamed Talafha, Mohamed Bakir, and Mohamed Rihan) and ten students from the University of Sharjah (Huda Abdullah, Ruhi Ahmed Moazzam Misbahulhaq, Rashed Abdulla Saeed, Yumna Adel Mohamed, Eman Yousif Mohamed, Ali Al Hammadi, Salwa Haitham, Amal Mohamed Abdallah Musbah Al Qaydi, Abduallah Abou Hewelle, and Yousuf Mohamed Faroukh) have attended the two days meeting.

The ten students presented their two DemoSat CubeSat systems and demonstrated the practical use of all the eight sensors in front of the GSC delegates. Live experiments done by the UoS students were done to see how each sensor (Luminosity Sensor, Temperature Sensor, Accelerometer, Gyroscope, Magnetometer, Barometer, Ultra Violet Light Sensor, Infrared Thermopile) works as part of a unique to see how the different components of a CubeSat work. The delegates were very pleased and amuzed to see in front of them how could such a tiny instrument (10cm x 10 cm x 10 cm) could perform all of these experimentts. A CubeSat is just a minitiarization of a large satellite with a specific task to accomplish.