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Astronomy & Physics Weekly News

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

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

Top News

SCASS ACTIVITIES:

- Tuesday's Monthly Lecture (09/20 - 14:00 - 15:00)
- Friday's Open House (9/23)

This Week's Sky at a Glance, Sep. 17-23

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IT Support Issam Jami

Design by Mohamed Bakir

Astronomers discover 63 new quasars in early universe

File Image.

Astronomers have identified 63 new quasars -- the largest number reported in a single scientific study.

Led by Eduardo Bañados, an astronomer at the Carnegie Institution for Science, the survey almost doubles the number of known quasars in the early universe.

All of the newly identified quasars reveal the universe as it was when it was no more than 1 billion years old.

Quasars are like lighthouses, their beams hailing from far away in the ancient universe. Quasars are active supermassive black holes at the center of galaxies, and they are some of the brightest objects in the universe.

"They literally illuminate our knowledge of the early universe," Bañados said in a news release.

Their insatiable consumption of matter -- and the concentration of that matter in the accretion disk -- produces intense X-ray emissions, powerful enough to be seen 13 billion light-years away.

Researchers are hopeful that further analysis of the 63 quasars will offer new insights into the evolution of the early universe, particularly the transition from a dark, black universe to one with light -- a period about which astronomers remain mostly in the dark.

In the wake of the Big Bang, after the matter exploded by the birth of the universe began to cool, light was absent. It wasn't until gravity slowly condensed the plethora of hydrogen atoms that the universe's first sources of light came into existence. Astronomers believe quasars may have been some of the first sources. "The formation and evolution of the earliest light sources and structures in the universe is one of the greatest mysteries in astronomy," Bañados said. "Very bright quasars such ...Read More...

Time crystals might exist after all

Credit: CC0 Public Domain

Are time crystals just a mathematical curiosity, or could they actually physically exist? Physicists have been debating this question since 2012, when Nobel laureate Frank Wilczek first proposed the idea of time crystals. He argued that these hypothetical objects can exhibit periodic motion, such as moving in a circular orbit, in their state of lowest energy, or their "ground state." Theoretically, objects in their ground states don't have enough energy to move at all.

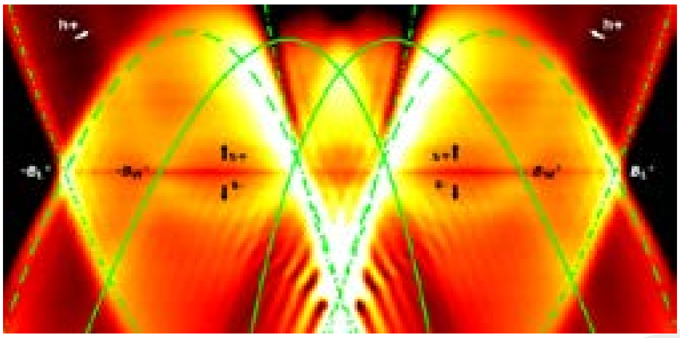
In the years since, other physicists have proposed various arguments for why the physical existence of time crystals is impossible—and most physicists do seem to think that time crystals are physically impossible because of their odd properties. Even though time crystals couldn't be used to generate useful energy (since disturbing them makes them stop moving), and don't violate the second law of thermodynamics, they do violate a fundamental symmetry of the laws of physics.

However, now in a new paper published in Physical Review Letters, physicists from the University of California, Santa Barbara (UCSB) and Microsoft Station Q (a Microsoft research lab located on the UCSB campus) have demonstrated that it may be possible for time crystals to physically exist.

The physicists have focused on the implication of time crystals that seems most surprising, which is that time crystals are predicted to spontaneously break a fundamental symmetry called "time-translation symmetry." To understand what this means, the researchers explain what spontaneous symmetry breaking is.

"The crucial difference here is between explicit symmetry breaking and spontaneous symmetry breaking," coauthor Dominic Else, a physicist at UCSB, told Phys.org. "If a symmetry is broken explicitly, then the laws of nature do not have the symmetry anymore; spontaneous symmetry breaking means that the laws of nature have a symmetry, but nature chooses a state that doesn't." If time crystals really do spontaneously break time-translation symmetry, then the laws of nature that govern time ...Read More...

A tight squeeze for electrons – quantum effects observed in 'one-dimensional' wires



Regime of a single 1D wire subband filled. Credit: Dr Maria Moreno

Researchers have observed quantum effects in electrons by squeezing them into one-dimensional 'quantum wires' and observing the interactions between them. The results could be used to aid in the development of quantum technologies, including quantum computing.

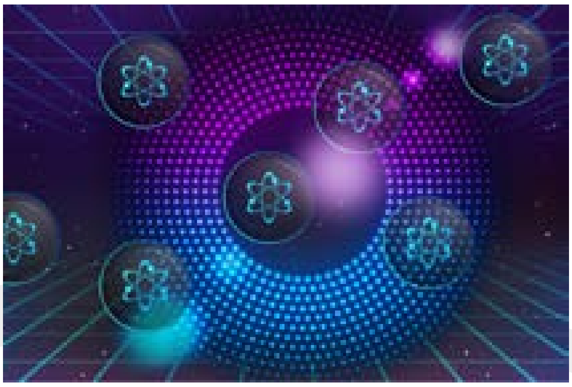
Scientists have controlled electrons by packing them so tightly that they start to display quantum effects, using an extension of the technology currently used to make computer processors. The technique, reported in the journal Nature Communications, has uncovered properties of quantum matter that could pave a way to new quantum technologies.

The ability to control electrons in this way may lay the groundwork for many technological advances, including quantum computers that can solve problems fundamentally intractable by modern electronics. Before such technologies become practical however, researchers need to better understand quantum, or wave-like, particles, and more importantly, the interactions between them.

Squeezing electrons into a one-dimensional 'quantum wire' amplifies their quantum nature to the point that it can be seen, by measuring at what energy and wavelength (or momentum) electrons can be injected into the wire.

"Think of a crowded train carriage, with people standing tightly packed all the way down the centre of the carriage," said Professor Christopher Ford of the University of Cambridge's Cavendish Laboratory, one of the paper's co-authors. "If someone tries to get in a door, they have to push the people closest to them along a bit to make room. In turn, those people push slightly on their neighbours, and so on. A wave of compression passes down the carriage, at some speed related to how people interact with their neighbours, and that speed probably depends on how hard they were shoved by the person getting on the train. By measuring this speed, one could learn about the interactions." ...Read More...

For first time, researchers see individual atoms keep away from each other or bunch up as pairs



"Learning from this model, we can understand what's really going on in these superconductors, and what one should do to make higher-temperature superconductors, approaching hopefully room temperature," says Martin Zwierlein, professor of physics and principal investigator in MIT's Research Laboratory of Electronics. Credit: Christine Daniloff/MIT

If you bottle up a gas and try to image its atoms using today's most powerful microscopes, you will see little more than a shadowy blur. Atoms zip around at lightning speeds and are difficult to pin down at ambient temperatures.

If, however, these atoms are plunged to ultracold temperatures, they slow to a crawl, and scientists can start to study how they can form exotic states of matter, such as superfluids, superconductors, and quantum magnets.

Physicists at MIT have now cooled a gas of potassium atoms to several nanokelvins—just a hair above absolute zero—and trapped the atoms within a two-dimensional sheet of an optical lattice created by crisscrossing lasers. Using a high-resolution microscope, the researchers took images of the cooled atoms residing in the lattice.

By looking at correlations between the atoms' positions in hundreds of such images, the team observed individual atoms interacting in some rather peculiar ways, based on their position in the lattice. Some atoms exhibited "antisocial" behavior and kept away from each other, while some bunched together with alternating magnetic orientations. Others appeared to piggyback on each other, creating pairs of atoms next to empty spaces, or holes.

The team believes that these spatial correlations may shed light on the origins of superconducting behavior. Superconductors are remarkable materials in which electrons pair up and travel without friction, meaning that no energy is lost in the journey. If superconductors can be designed to exist at room temperature, they could initiate an entirely new, incredibly efficient era for anything that relies on electrical power. ...Read More...

Black hole hidden within its own exhaust

Artist impression of the heart of galaxy NGC 1068, which harbors an actively feeding supermassive black hole. Arising from the black hole's outer accretion disk, ALMA discovered clouds of cold molecular gas and dust. This material is being accelerated by magnetic fields in the disk, reaching speeds of about 400 to 800 kilometers per second. This material gets expelled from the disk and goes on to hide the region around the black hole from optical telescopes on Earth. Essentially, the black hole is cloaking itself behind a veil of its own exhaust. Credit: NRAO/AUI/NSF; D. Berry / Skyworks

Supermassive black holes, millions to billions of times the mass of our Sun, are found at the centers of galaxies. Many of these galactic behemoths are hidden within a thick doughnut-shape ring of dust and gas known as a torus. Previous observations suggest these cloaking, tire-like structures are formed from the native material found near the center of a galaxy.

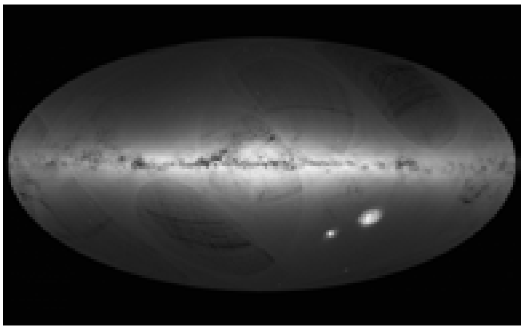
New data from the Atacama Large Millimeter/submillimeter Array (ALMA), however, reveal that the black hole at the center of a galaxy named NGC 1068 is actually the source of its own dusty torus of dust and gas, forged from material flung out of the black hole's accretion disk.

This newly discovered cosmic fountain of cold gas and dust could reshape our understanding of how black holes impact their host galaxy and potentially the intergalactic medium.

"Think of a black hole as an engine. It's fueled by material falling in on it from a flattened disk of dust and gas," said Jack Gallimore, an astronomer at Bucknell University in Lewisburg, Pennsylvania, and lead author on a paper published in Astrophysical Journal Letters. "But like any engine, a black hole can also emit exhaust." That exhaust, astronomers discovered, is the likely source of the torus of material that effectively obscures the region around the galaxy's supermassive black hole from optical telescopes.

NGC 1068 (also known as Messier 77) is a barred spiral galaxy approximately 47 million light-years from Earth in the direction of the constellation Cetus. At its center is an active galactic nucleus, a supermassive black hole that is being fed by a thin, rotating disk of gas ...Read More...

One billion stars in 3-D: Gaia's billion-star map hints at treasures to come



An all-sky view of stars in our Galaxy – the Milky Way – and neighbouring galaxies, based on the first year of observations from ESA's Gaia satellite, from July 2014 to September 2015. Credit: ESA/Gaia/DPAC

The first catalogue of more than a billion stars from ESA's Gaia satellite was published today – the largest all-sky survey of celestial objects to date.

On its way to assembling the most detailed 3-D map ever made of our Milky Way galaxy, Gaia has pinned down the precise position on the sky and the brightness of 1142 million stars.

As a taster of the richer catalogue to come in the near future, today's release also features the distances and the motions across the sky for more than two million stars.

"Gaia is at the forefront of astrometry, charting the sky at precisions that have never been achieved before," says Alvaro Giménez, ESA's Director of Science.

"Today's release gives us a first impression of the extraordinary data that await us and that will revolutionise our understanding of how stars are distributed and move across our Galaxy."

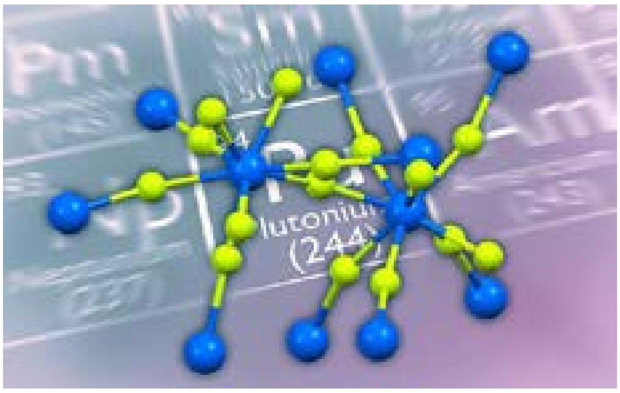
Launched 1000 days ago, Gaia started its scientific work in July 2014. This first release is based on data collected during its first 14 months of scanning the sky, up to September 2015.

"The beautiful map we are publishing today shows the density of stars measured by Gaia across the entire sky, and confirms that it collected superb data during its first year of operations," says Timo Prusti, Gaia project scientist at ESA.

The stripes and other artefacts in the image reflect how Gaia scans the sky, and will gradually fade as more scans are made during the five-year mission.

"The satellite is working well and we have demonstrated that it is possible to handle the analysis of a billion stars. Although the current data are preliminary ...Read More...

Plutonium keeps its electrons close to home



Plutonium is formidably complex element that does not always act as expected. New research shows that plutonium does not share electrons when it bonds with fluoride atoms. Understanding how plutonium bonds and forms molecules offers insights for nuclear power, security, and environmental remediation. Credit: PNNL

Found in nuclear fuel and nuclear weapons, plutonium is an incredibly complex element that has far-ranging energy, security, and environmental effects. To understand plutonium, scientists at Pacific Northwest National Laboratory and Washington State University delved into a plutonium compound with a relatively simple composition: plutonium tetrafluoride (PuF4). While the formula is simple, the four bonds proved to be more complex. The electrons stay relatively close to each atom, creating ionic bonds—not the expected electron-sharing covalent bonds. Even though the plutonium and fluorine atoms are tied together in a lattice, they act as isolated atoms and form ionic bonds.

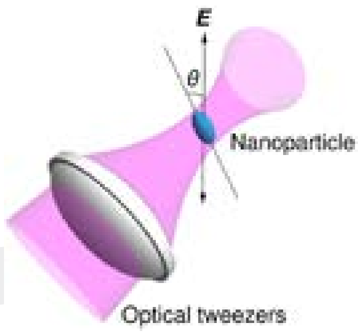
"Bonding is one of the big questions for plutonium and its actinide neighbors on the Periodic Chart," said Dr. Herman Cho at PNNL, who led the research. "Answering this question is of huge importance because plutonium's chemistry depends on how it bonds. PuF4 leans toward electrostatic attraction. This work provides a clearer picture of why that is."

Plutonium is formidably complex because of the large cloud of electrons that surrounds its nucleus. It doesn't always act as expected. Adding to the complexity of the element is the limited number of institutions that can safely handle and study the radioactive element. The team's research sheds new light on plutonium's true nature. It could provide insights about key molecules involved in nuclear power, national security, and environmental cleanup.

"Plutonium doesn't fit within the simple pictures that apply to lighter elements," said Cho. "This work answers tough questions as to why plutonium acts the way it does."

The researchers began with highly radioactive PuF4 from the long-shuttered Plutonium Finishing Plant in Washington State. At the plant, scientists created ...Read More...

Levitating nanoparticle improves 'torque sensing,' might bring new research into fundamentals of quantum theory



This graphic represents a new experiment where levitating a nanodiamond with a laser in a vacuum chamber for the first time was used to detect and measure its "torsional vibration," an advance that could bring new types of sensors and studies in quantum mechanics. Credit: Purdue University image/ Thai M. Hoang

Researchers have levitated a tiny nanodiamond particle with a laser in a vacuum chamber, using the technique for the first time to detect and measure its "torsional vibration," an advance that could bring new types of sensors and studies in quantum mechanics.

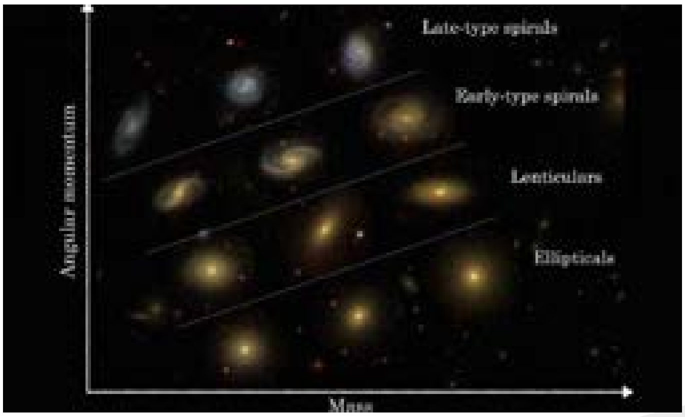
The experiment represents a nanoscale version of the torsion balance used in the classic Cavendish experiment, performed in 1798 by British scientist Henry Cavendish, which determined Newton's gravitational constant. A bar balancing two lead spheres at either end was suspended on a thin metal wire. Gravity acting on the two weights caused the wire and bar to twist, and this twisting – or torsion - was measured to calculate the gravitational force.

In the new experiment, an oblong-shaped nanodiamond levitated by a laser beam in a vacuum chamber served the same role as the bar, and the laser beam served the same role as the wire in Cavendish's experiment.

"A change of the orientation of the nanodiamond caused the polarization of the laser beam to twist," said Tongcang Li, an assistant professor of physics and astronomy and electrical and computer engineering at Purdue University. "Torsion balances have played historic roles in the development of modern physics. Now, an optically levitated ellipsoidal nanodiamond in a vacuum provides a new nanoscale torsion balance that will be many times more sensitive." Findings are detailed in a paper that appeared on Thursday (Sept. 15) in the journal Physical Review Letters.

"This is the first experimental observation of torsional motion of a nanoparticle levitated in a vacuum and represents a very sensitive torque detector," Li said. "In principle, we could detect the torque on a single electron or a single proton." ...Read More...

Astronomers shed light on different galaxy types



Classification of several of the 488 galaxies observed in this study using the Hubble Sequence and the proposed Angular Momentum based system. Credit: L. Cortese (ICRAR/UWA) and Sloan Digital Sky Survey

In research published today, Australian scientists have taken a critical step towards understanding why different types of galaxies exist throughout the Universe.

he research, made possible by cutting-edge AAO instrumentation, means that astronomers can now classify galaxies according to their physical properties rather than human interpretation of a galaxy's appearance.

For the past 200 years, telescopes have been capable of observing galaxies beyond our own galaxy, the Milky Way.

Only a few were visible to begin with but as telescopes became more powerful, more galaxies were discovered, making it crucial for astronomers to come up with a way to consistently group different types of galaxies together.

In 1926, the famous American astronomer Edwin Hubble refined a system that classified galaxies into categories of spiral, elliptical, lenticular or irregular shape. This system, known as the Hubble sequence, is the most common way of classifying galaxies to this day.

Despite its success, the criteria on which the Hubble scheme is based are subjective, and only indirectly related to the physical properties of galaxies. This has significantly hampered attempts to identify the evolutionary pathways followed by different types of galaxies as they slowly change over billions of years.

Dr Luca Cortese, from The University of Western Australia node of the International Centre for Radio Astronomy Research (ICRAR), said the world's premier astronomical facilities are now producing surveys consisting of hundreds of thousands of galaxies rather than the hundreds that Hubble and his contemporaries were working with. "We really need a way to classify galaxies consistently using instruments that measure physical properties ...Read More...

Did meteorites bring life's phosphorus to Earth?

An artist's impression of meteors crashing into water on the young Earth. Did they bring phosphorous with them? Image courtesy David A Aguilar (CfA).

Meteorites that crashed onto Earth billions of years ago may have provided the phosphorous essential to the biological systems of terrestrial life. The meteorites are believed to have contained a phosphorus-bearing mineral called schreibersite, and scientists have recently developed a synthetic version that reacts chemically with organic molecules, showing its potential as a nutrient for life.

Phosphorus is one of life's most vital components, but often goes unheralded. It helps form the backbone of the long chains of nucleotides that create RNA and DNA; it is part of the phospholipids in cell membranes; and is a building block of the coenzyme used as an energy carrier in cells, adenosine triphosphate (ATP).

Yet the majority of phosphorus on Earth is found in the form of inert phosphates that are insoluble in water and are generally unable to react with organic molecules. This appears at odds with phosphorus' ubiquity in biochemistry, so how did phosphorus end up being critical to life?

In 2004, Matthew Pasek, an astrobiologist and geochemist from the University of South Florida, developed the idea that schreibersite [(Fe, Ni)3P], which is found in a range of meteorites from chondrites to stony-iron pallasites, could be the original source of life's phosphorus. Because the phosphorus within schreibersite is a phosphide, which is a compound containing a phosphorus ion bonded to a metal, it behaves in a more reactive fashion than the phosphate typically found on Earth.

Finding naturally-formed schreibersite to use in laboratory experiments can be time consuming when harvesting from newly-fallen meteorites and expensive when buying from private collectors. Instead, it has become easier to produce schreibersite synthetically for use in the laboratory.

Natural schreibersite is an alloy of iron, phosphorous and nickel, but the common form of synthetic schreibersite that has typically been used in experiments is ...Read More...

Chemistry says Moon is proto-Earth's mantle, relocated

File Image.

Measurements of an element in Earth and Moon rocks have just disproved the leading hypotheses for the origin of the Moon. Tiny differences in the segregation of the isotopes of potassium between the Moon and Earth were hidden below the detection limits of analytical techniques until recently.

But in 2015, Washington University in St. Louis geochemist Kun Wang, then the Harvard Origins of Life Initiative Prize postdoctoral fellow, and Stein Jacobsen, professor of geochemistry at Harvard University, developed a technique for analyzing these isotopes that can hit precisions 10 times better than the best previous method .

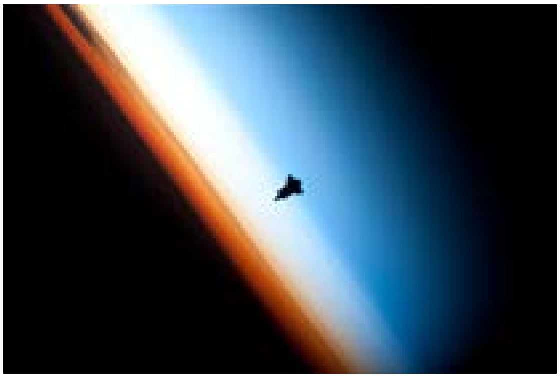
Wang and Jacobsen now report isotopic differences between lunar and terrestrial rocks that provide the first experimental evidence that can discriminate between the two leading models for the Moon's origin. In one model, a low-energy impact leaves the proto-Earth and Moon shrouded in a silicate atmosphere; in the other, a much more violent impact vaporizes the impactor and most of the proto-Earth, expanding to form an enormous superfluid disk out of which the Moon eventually crystallizes.

The isotopic study, which supports the high-energy model, is published in the advance online edition of Nature Sep.12, 2016. "Our results provide the first hard evidence that the impact really did (largely) vaporize Earth," said Wang, assistant professor in Earth and Planetary Sciences in Arts and Sciences.

An isotopic crisis

In the mid-1970s, two groups of astrophysicists independently proposed that the Moon was formed by a grazing collision between a Mars-sized body and the proto-Earth. The giant impact hypothesis, which explains many observations, such as the large size of the Moon relative to the Earth and the rotation rates of the Earth and Moon, eventually became the leading hypothesis for the Moon's origin. ...Read More...

How High is Space?



Space Shuttle Endeavor silhouetted against Earth's atmosphere. The orange layer is the troposphere, the white layer is the stratosphere and the blue layer the mesosphere. Credit: NASA

Look up at the night sky, and what do you see? Space, glittering and gleaming in all its glory. Astronomically speaking, space is really quite close, lingering just on the other side of that thin layer we call an atmosphere. And if you think about it, Earth is little more than a tiny island in a sea of space. So it is quite literally all around us.

By definition, space is defined as being the point at which the Earth's atmosphere ends, and the vacuum of space begins. But exactly how far away is that? How high do you need to travel before you can actually touch space? As you can probably imagine, with such a subjective definition, people tend to disagree on exactly where space begins.

Definition:

The first official definition of space came from the National Advisory Committee for Aeronautics (the predecessor to NASA), who decided on the point where atmospheric pressure was less than one pound per square foot. This was the altitude that airplane control surfaces could no longer be used, and corresponded to roughly 81 kilometers (50 miles) above the Earth's surface.

Any NASA test pilot or astronaut who crosses this altitude is awarded their astronaut wings. Shortly after that definition was passed, the aerospace engineer Theodore von Kármán calculated that above an altitude of 100 km, the atmosphere would be so thin that an aircraft would need to be traveling at orbital velocity to derive any lift.

This altitude was later adopted as the Karman Line by the World Air Sports Federation (Fédération Aéronautique Internationale, FAI). And in 2012, when Felix Baumgartner broke the record for the highest freefall, he jumped from an altitude of 39 kilometers (24.23 mi), less than halfway to space (according to NASA's definition).

By the same token, space is often defined as beginning at the lowest altitude at which satellites ...Read More...

This Week's Sky at a Glance, Sep. 17-23

Sep 18	Venus 2.2° North of Spica (Local Time: 19:15)
Sep 18	Moon at perigee: 361894 km (Local Time: 21:00)
Sep 22	Aldebaran 0.1° South of moon (Local Time: 01:23)
Sep 22	Autumnal equinox (Local Time: 18:20)
Sep 23	Last Quarter Moon (Local Time: 13:55)

SCASS Tuesday Monthly Lecture - Sep. 20, 2016

Lecture:	Astronomy Sites Testing
Speaker:	Mr. Mohamed Talafha - SCASS Observatory Assistant
Date:	Sep. 20, 2016
Time:	14:00 - 15:00
Location:	SCASS Auditorium

SCASS Observatory Open House - Sep. 23, 2016

Date:	Friday - Sep. 23, 2016
Time:	19:00 - 21:00
Location:	SCASS Observatory - Sharjah
Target Objects:	Venus - Mars - Saturn - Star Clusters - Galaxies

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