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Astronomy & Physics Weekly News

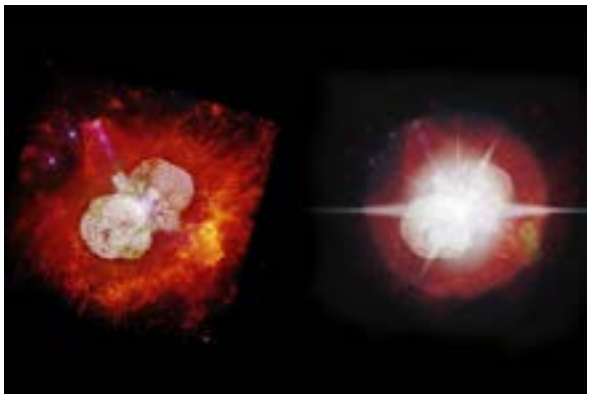
Dept. of Applied Physics & Astronomy - University of Sharjah
Compiled by Dr. Ilias Fernini

Top News

IT Support Issam Jami

Design by Mohamed Bakir

Goodbye to a beauty in the night sky



(L) A view of Eta Carinae by NASA's Hubble Space Telescope in 2000. (R) What the star could look like in 2032, when it overshadows its nebula.

For over a century and a half, Eta Carinae has been one of the most luminous – and most enigmatic – stars of the southern Milky Way.

Part of its nature was revealed in 1847, when, in a giant eruption, it ejected a nebula called the Homunculus ("little man"). The event made Eta Carinae the second-brightest star in the sky after Sirius, visible even in broad daylight and (later) easily distinguishable from other, similarly unstable stars called Luminous Blue Variables, whose nebulae are not so clearly visible.

Aside from making Eta Carinae one of the most beautiful and frequently photographed objects in the night sky, the giant Homunculus contains information about its parent star, ranging from the energy of its expansion to its bipolar outflow and chemical composition.

In as little as a decade from now, however, we will no longer be able to see the nebula clearly.

A recent study indicates that the Homunculus will be obfuscated by the increasing brightness of Eta Carinae itself. So rapidly is it growing, in fact, that in 2036 the star will be 10 times brighter than its nebula, which in the end will make it indistinguishable from other LBVs.

Good news

But there's an upside.

A team of 17 researchers led by Brazilian astronomer Augusto Damineli, with input from Université de Montréal's Anthony Moffatt, believe that the increasing brightness of Eta Carinae is not intrinsic to the star itself, as is commonly believed. In fact, it is likely caused by the dissipation of a dust cloud positioned exactly in front of it as seen from the Earth.

This cloud, the researchers posit in a new study in the Monthly Notices of the Royal Astronomical Society, completely shrouds the star and its winds, blotting out much of its light emanating towards Earth. The surrounding Homunculus, by contrast, can be seen ...Read More...

How does a quantum particle see the world?

Quantum features, such as quantum superposition, are only defined relative to an observer. When we look at the train from the point of view of an observer standing on the platform, the train looks in a quantum superposition of different positions. Credit: Christian Murzek/IQOQI-Vienna

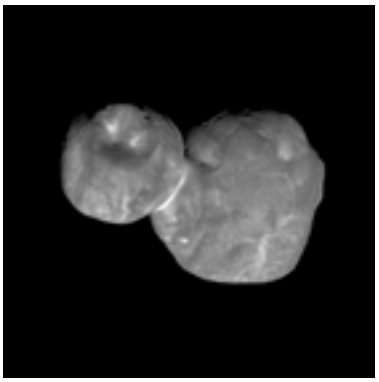
Researchers at the University of Vienna study the relevance of quantum reference frames for the symmetries of the world.

According to one of the most fundamental principles in physics, an observer on a moving train uses the same laws to describe a ball on the platform as an observer standing on the platform – physical laws are independent on the choice of a reference frame. Reference frames such as the train and the platform are physical systems and ultimately follow quantum-mechanical rules. They can be, for example, in a quantum state of superposition of different positions at once. So, what would the description of the ball look like for an observer on such a "quantum platform"? Researchers at the University of Vienna and the Austrian Academy of Sciences proved that whether an object (in our example, the ball) shows quantum features depends on the reference frame. The physical laws, however, are still independent of it. The results are published in Nature Communications.

Physical systems are always described relative to a reference frame. For example, a ball bouncing on a railway platform can be observed either from the platform itself or from a passing train. A fundamental principle of physics, the principle of General Covariance, states that the laws of physics which describe the motion of the ball do not depend on the reference frame of the observer. This principle has been crucial in the description of motion since Galileo and central to the development of Einstein's theory of relativity. It entails information about symmetries of the laws of physics as seen from different reference frames.

Reference frames are physical systems, which ultimately follow quantum-mechanical rules. A group of researchers led by Časlav Brukner at the University of Vienna and the Institute for Quantum Optics and Quantum Information (IQOQI-Vienna) of the Austrian Academy of Sciences have asked themselves whether it is possible to formulate the laws of physics from the point of view of an observer "attached" to a quantum particle and to introduce a quantum reference frame. They were able to ...Read More...

New Horizons' latest images from Ultima Thule reveal new details



The latest image of Kuiper Belt Object 2014 MU69. (Credit: NASA/JHUAPL/SwRI)

The latest image of 2014 MU69 shows new details on the Kuiper Belt Object's icy surface.

Just after midnight on New Year's Day, NASA's New Horizon's spacecraft flew past the Kuiper Belt object, 2014 MU69, more commonly known as Ultima Thule. Now, the best image of the object to-date has reached Earth, revealing previously unseen details on the peanut-shaped space rock.

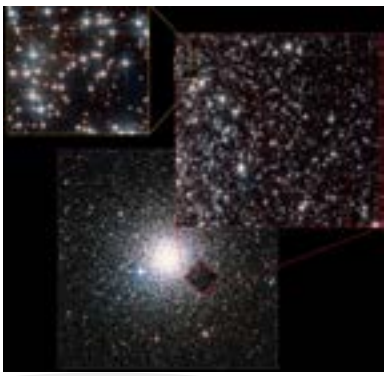
This latest image was taken with the wide-angle Multicolor Visible Imaging Camera (MVIC) component of the spacecraft's Ralph instrument. The camera snapped the shot when the spacecraft was just 4,200 miles (6,700 km) from the object, at 12:26 a.m. EST, just seven minutes before the craft reached closest approach on Jan 1.

This newest image had an original resolution of 440 feet (135 m) per pixel. After beaming back to Earth between around Jan. 18, scientists enhanced the details of the image to make it as clear and sharp as possible. Though, this process (known as deconvolution) will make the image look a bit grainier at high contrast.

The new image shows Ultima Thule's surface along the day/night boundary near the top of the object. You can also make out a number of small pits on the surface, which stretch nearly half a mile across. You might notice a large, circular feature on the space rock's smaller half. Using this image, it appears as though this feature, which stretches about 4 miles (7 km) across, is a depression.

It is too early to definitively say whether these features are impact craters or created from internal processes. Both halves, or lobes, of the object also have light and dark patterns. The most obvious of these is the light band that separates the object's two lobes. Scientists don't yet know where these patterns came from, but according to a statement from Johns Hopkins Applied Physics Laboratory, they could help researchers to decipher the object's origins and how it formed. ...Read More...

Tiny 'oddball' galaxy discovered lurking in our cosmic backyard



This composite image shows the location of the accidentally discovered dwarf galaxy Bedin 1 behind the globular cluster NGC 6752. The lower image, depicting the complete cluster, is a ground-based observation. The upper right image shows the full field of view of the Hubble Space Telescope. The upper left one highlights the part containing the galaxy Bedin 1.ESA/Hubble, NASA, Bedin et al.,

Astronomers using the Hubble Space Telescope just made an unexpected discovery: a group of stars thought to be part of our own Milky Way galaxy actually belongs to a previously unknown galaxy that lies 30 million light-years away in an unusually isolated region of space.

The international team was studying a cluster of stars known as NGC 6752, which lies about 13,000 light-years away at the edge of the Milky Way. But after analyzing the brightnesses and temperatures of the stars under observation, the scientists realized they weren't in the cluster at all but were roughly 2,300 times more distant.

"This was a truly serendipitous find," Luigi "Rolly" Bedin, an astronomer at the Astronomical Observatory of Padova in Italy, told NBC News MACH in an email. Bedin is the leader of the team and the lead author of a paper describing the discovery, which was published Thursday in the journal Monthly Notices of the Royal Astronomical Society.

The newfound galaxy, dubbed Bedin 1 in an acknowledgment of the scientist's singular role in its discovery, looks tiny and faint even under Hubble's powerful magnification. And no wonder: It's about 30 times smaller than the Milky Way and a thousand times dimmer.

Unlike the Milky Way, which is a type of spiral galaxy, Bedin 1 is roughly spherical — what astronomers call a dwarf spheroidal galaxy. It's one of 36 such galaxies known to exist in the so-called Local Group of Galaxies, which includes the Milky Way and the neighboring Andromeda Galaxy.

The galaxy is believed to be roughly 13 billion years old, making it a "living fossil from the early universe."

The universe itself is believed to be about 13.8 billion years old. ...Read More...

Hubble Spies Doomed Spiral Galaxy Plunging Into Coma Cluster (and Losing Gas, Too)

A glowing red stream of hydrogen gas emanates from the spiral galaxy D100 as it plunges toward the center of the giant Coma galaxy cluster. Glowing blue clumps of young stars can be seen near the middle of the tail, where there is still enough hydrogen gas to fuel star formation. Credit: Hubble image: NASA, ESA, M. Sun (University of Alabama) and W. Cramer and J. Kenney (Yale University); Subaru image: M. Yagi (National Astronomical Observatory of Japan)

NASA's Hubble Space Telescope captured a stunning new view of a spiral galaxy that wandered too close to the massive Coma galaxy cluster and is being stripped of its gas.

The spiral galaxy, named D100, is being pulled by gravity toward the dense center of the Coma cluster, located approximately 330 million light-years from Earth. As the galaxy plunges toward the cluster, it is stripped of its gas, creating a long, thin tail that stretches about 200,000 light-years — nearly the width of two Milky Way galaxies, according to a statement from NASA.

The galaxy's tail consists of dust and hydrogen gas. As the galaxy wades through intergalactic material surrounding the cluster, gas and dust is expelled from the galaxy. Eventually, D100 will run out of hydrogen gas, which the galaxy needs in order to form new stars, and become a dead relic, according to the statement.

"This galaxy stands out as a particularly extreme example of processes common in massive clusters, where a galaxy goes from being a healthy spiral full of star formation to a red and dead galaxy," William Cramer, lead author of the study and a researcher at Yale University in Connecticut, said in the statement. "The spiral arms disappear, and the galaxy is left with no gas and only old stars. This phenomenon has been known about for several decades, but Hubble provides the best imagery of galaxies undergoing this process."

Researchers estimate that D100 has been enduring the process, also known as ram-pressure stripping, for roughly 300 million years.

While D100 is one of many galaxies in this situation, one factor distinguishes it from others that astronomers have seen and modeled: D100's tail is much more smooth and well-defined than most such galaxies, ..Read More...

Earth's core may have hardened just in time to save its magnetic field

SOLAR SHIELD Earth's magnetic field (illustrated) is powered by circulation of iron-rich fluid in the core. New research suggests Earth's solid inner core formed about 565 million years ago, saving a weakening magnetic field from collapse

This shift both prevented the protective magnetic field from collapsing and recharged it.

Earth's inner core solidified around 565 million years ago — just in time to not only save the planet's protective magnetic field from imminent collapse, but also to kick-start it into its current, powerful phase, a new study suggests.

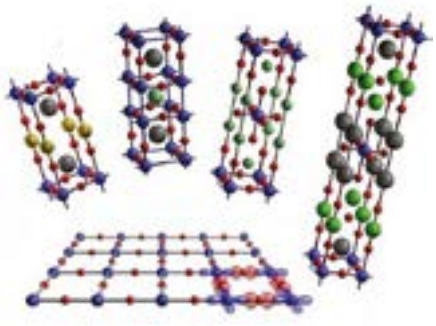
The finding, reported online January 28 in Nature Geoscience, supports an idea previously proposed by simulations that Earth's inner core is relatively young. It also provides insight into how, and how quickly, Earth has been losing heat since its formation 4.54 billion years ago —key to understanding not only the generation of the planet's magnetic shield but also convection within the mantle and plate tectonics.

"We don't have many real benchmarks for the thermal history of our planet," says Peter Olson, a geophysicist at Johns Hopkins University who was not involved in the new study. "We know the interior was hotter than today, because all planets lose heat. But we don't know what the average temperature was a billion years ago, compared with today." Pinning down when iron in the inner core began to crystallize could offer a window into how hot the interior of the planet was at the time, Olson says.

The planet's iron-nickel core is made up of two layers: a solid inner core and a molten outer core. When that solid inner core formed is a long-standing mystery. "Proposed ages have been anywhere from 500 million years ago to older than 2.5 billion years," says coauthor John Tarduno, a geophysicist at the University of Rochester in New York.

The interplay of the two layers drives the geodynamo, the circulation of iron-rich fluid that powers the magnetic field. That field, surrounding the planet, protects Earth from being battered by the solar wind, a constant flow of charged particles ejected by the sun. As the inner core cools and crystallizes, the composition of the remaining fluid changes; more buoyant liquid rises like a plume while the cooling crystals sink. That self-sustaining, density-...Read More...

Superconductors: Resistance is futile



These are different cuprates which are being studied at TU Wien.

Every standard cable, every wire, every electronic device has some electric resistance. There are, however, superconducting materials with the ability to conduct electrical current with a resistance of exactly zero - at least at very low temperatures. Finding a material which behaves as a superconductor at room temperature would be a scientific breakthrough of incredible conceptual and technological importance. It could lead to a wide range of new applications, from levitating trains to new imaging technologies for medicine.

The search for high-temperature superconductors is extremely difficult, because many of the quantum effects related to superconductivity are not yet well understood. Professor Neven Barisi, professor for solid state physics at TU Wien (Vienna) is performing experiments with cuprates, a class of materials which behave as a superconductor at record temperatures as high as 140K at ambient pressure. Barisi and his colleagues have now come up with a remarkable set of results and new insights that could profoundly change the way we think about these complex materials and high-temperature superconductivity in general.

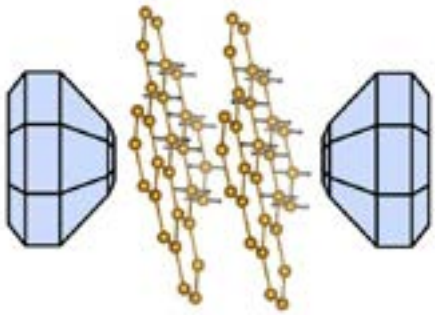
The Quest for the Holy Grail

"The phenomenon of high-temperature superconductivity has been thoroughly investigated for decades, but nobody has cracked the problem yet", says Neven Barisi. "Quite a few materials show superconducting behaviour at temperatures close to absolute zero, and we understand why this happens in some of them. But the real challenge is to understand superconductivity in cuprates, where this states persists at much higher temperatures. A material which behaves as a superconductor at room temperature would be the Holy Grail of solid state physics - and we are getting closer and closer."

Barisi and his colleagues have shown that there are two fundamentally different kinds of charge carriers in cuprates, and suggested that superconductivity crucially depends on the subtle interplay between them.

Some of the electrical charge is localized - each of these charge carriers sits at particular set of atoms and can only move away if the material is heated. ..Read More...

Magnetic graphene switches between insulator and conductor



Credit: University of Cambridge

Researchers have found that certain ultra-thin magnetic materials can switch from insulator to conductor under high pressure, a phenomenon that could be used in the development of next-generation electronics and memory storage devices.

The international team of researchers, led by the University of Cambridge, say that their results, reported in the journal Physical Review Letters, will aid in understanding the dynamic relationship between the electronic and structural properties of the material, sometimes referred to as magnetic graphene, and may represent a new way to produce two-dimensional materials.

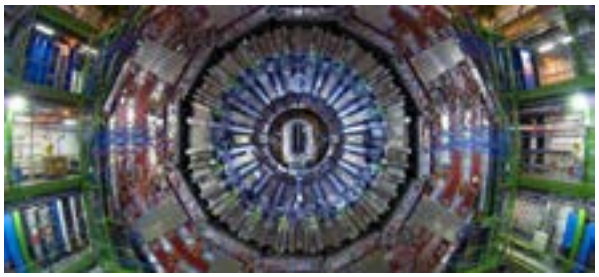
Magnetic graphene, or iron trithiohypophosphate (FePS3), is from a family of materials known as van der Waals materials, and was first synthesised in the 1960s. In the past decade however, researchers have started looking at FePS3 with fresh eyes. Similar to graphene, a two-dimensional form of carbon, FePS3 can be exfoliated into ultra-thin layers. Unlike graphene however, FePS3 is magnetic.

The expression for electrons' intrinsic source of magnetism is known as spin. Spin makes electrons behave a bit like tiny bar magnets and point a certain way. Magnetism from the arrangement of electron spins is used in most memory devices, and is important for developing new technologies such as spintronics, which could transform the way in which computers process information.

Despite graphene's extraordinary strength and conductivity, the fact that it is not magnetic limits its application in areas such as magnetic storage and spintronics, and so researchers have been searching for magnetic materials which could be incorporated with graphene-based devices.

For their study, the Cambridge researchers squashed layers of FePS3 together under high pressure (about 10 Gigapascals), they found that it switched between an insulator and conductor, a phenomenon known as a Mott transition. The conductivity could also be tuned by changing the pressure. ...Read More...

International team of physicists continues search for new physics



The Compact Muon Solenoid detector is a general-purpose detector at the Large Hadron Collider (LHC) in Switzerland, designed to observe any new physics phenomena that the LHC might reveal. Credit: CERN

Dark matter, which is thought to account for nearly a quarter of matter in the universe (but has yet to be observed), has perplexed physicists for decades. They're constantly looking for something surprising to show up in experiments—results that deviate from the standard model that defines elementary physics.

It's no wonder the scientific community was abuzz when an experiment at CERN, known as ATLAS, detected a slight deviation in an experiment in July 2018. Researchers thought they might have finally uncovered evidence of new physics, which could be a sign of dark matter particles. But a recent improvement of the measurement by the CMS collaboration produced results that are nearly consistent with the expectations of the standard model. The findings were published in the January issue of the CERN Courier.

"We wanted to produce a more accurate result than ATLAS had, so we improved the way we reconstruct quantities by using a better correction algorithm, and our results indicate there might not actually have been a deviation there," said Andreas Jung, an assistant professor of physics and astronomy at Purdue University. "This doesn't mean there isn't anything interesting going on here, it just means we don't have the data to prove it right now."

The standard model explains how the basic building blocks of matter interact. It explains chemical reactions, radioactive decays, electrodynamics and more—but not gravity or dark matter. It's the best description of the subatomic world, but it doesn't tell the whole story.

It's what is yet to be included in the standard model, or anything that might contradict it, that physicists are searching for. They primarily use particle accelerators, playfully referred to as "atom smashers" by some, in these experiments.

The Compact Muon Solenoid (CMS) is one of four detectors at the world's largest and most powerful particle accelerator, the Large Hadron Collider. The collider uses electromagnetic fields to propel charged particles to relativistic speeds and high energies, contains them in beams and sends them smashing into one another. ...Read More...

All-photonic quantum repeaters could lead to a faster, more secure global quantum internet

Professor Hoi-Kwong Lo (ECE) and his collaborators have performed a proof-of-principle experiment on a key aspect of all-photonic quantum repeaters. Credit: Jessica MacInnis

Engineering researchers have demonstrated proof-of-principle for a device that could serve as the backbone of a future quantum Internet. University of Toronto Engineering professor Hoi-Kwong Lo and his collaborators have developed a prototype for a key element for all-photonic quantum repeaters, a critical step in long-distance quantum communication.

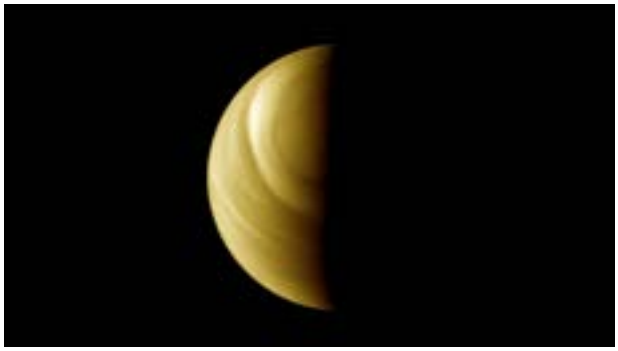
A quantum Internet is the 'Holy Grail' of quantum information processing, enabling many novel applications including information-theoretic secure communication. Today's Internet was not specifically designed for security, and it shows: hacking, break-ins and computer espionage are common challenges. Nefarious hackers are constantly poking holes in sophisticated layers of defence erected by individuals, corporations and governments.

In light of this, researchers have proposed other ways of transmitting data that would leverage key features of quantum physics to provide virtually unbreakable encryption. One of the most promising technologies involves a technique known as quantum key distribution (QKD). QKD exploits the fact that the simple act of sensing or measuring the state of a quantum system disturbs that system. Because of this, any third-party eavesdropping would leave behind a clearly detectable trace, and the communication can be aborted before any sensitive information is lost.

Until now, this type of quantum security has been demonstrated in small-scale systems. Lo and his team are among a group of researchers around the world who are laying the groundwork for a future quantum Internet by working to address some of the challenges in transmitting quantum information over great distances, using optical fibre communication.

Because light signals lose potency as they travel long distances through fibre-optic cables, devices called repeaters are inserted at regular intervals along the line. These repeaters boost and amplify the signals to help transmit the information along the line. ...Read More...

How a high-flying balloon could search for life on hellishly hot Venus



Venus's extremely hot surface makes it difficult to study, but scientists want to fly a balloon high in the planet's atmosphere, where conditions are much more tolerable.ESA/MPS/DLR/IDA

Venus may be our closest neighbor in the solar system, but we still have a lot to learn about the second rock from the sun.

Now, a group of NASA scientists is pushing hard for a new expedition to Venus — an unmanned mission that would use a huge, instrument-laden helium balloon floating in the superheated Venusian atmosphere to study the planet and possibly search for alien life.

The mission, which has been proposed before but was recently bolstered by a 2018 study that assessed the technologies available to support it, would be the space agency's first to visit the planet since 1989.

"We think Venus' time has come," said Jim Cutts, a program manager in the Solar System Exploration Directorate at the Jet Propulsion Laboratory in Pasadena, California and leader of the 2018 study. "Venus is partly forgotten because it's difficult to explore, but the key thing that has happened to turn things around is the development of these new technologies."

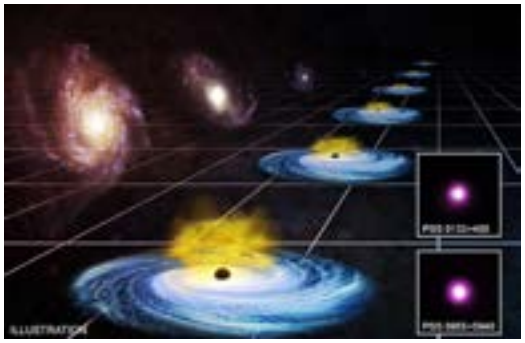
Venus lies farther from the sun than Mercury, the innermost planet, but its heat-trapping atmosphere makes it the hottest of all planets. Temperatures on the Venusian surface can reach 880 degrees Fahrenheit, meaning it's all but impossible for conventional spacecraft to explore it.

Conditions are more hospitable 30 miles above the surface. In fact, temperatures in this region of the atmosphere are much like those on Earth — "similar conditions to Miami, Florida in summertime," said Kevin Baines, a planetary scientist at the JPL and the University of Wisconsin-Madison.

It's in this part of Venus' atmosphere that Baines and his colleagues want to unleash the helium balloon. "You can do a world tour of the planet without using any propellers or fuel to power it," Baines said. "The winds are so powerful on Venus that the whole atmosphere is a giant jetstream."

Under the plan, the mission spacecraft would reach Venus after a six-month journey. Upon arrival, Baines said, the spacecraft would use an onboard helium tank to inflate the 25-foot-diameter balloon and then release it. ..Read More...

Dark Energy Gets Weirder: Mysterious Force May Vary Over Time



Artist's illustration of quasars, along with observations of two of these superbright objects by NASA's Chandra X-ray Observatory (insets). Credit: G.Risaliti & E.Lusso/Illustration: NASA/CXC/M.Weiss; X-ray: NASA/CXC/Univ. of Florence

Dark energy is apparently even more mysterious than astronomers had thought.

Scientists first proposed the existence of this invisible force two decades ago, to explain the surprising discovery that the universe's expansion is accelerating. (Surprising and incredibly important; the find netted three researchers the Nobel Prize in physics in 2011.)

The most-used astrophysical model of the universe's structure and evolution regards dark energy as a constant. Indeed, many astronomers believe it to be the cosmological constant, which Einstein posited in 1917 as part of his theory of general relativity.

But a new study of enormous, superbright black holes known as quasars suggests that dark energy could be miscast as the cosmological constant, or any kind of constant; the force may have varied since the universe's birth 13.8 billion years ago, research team members said.

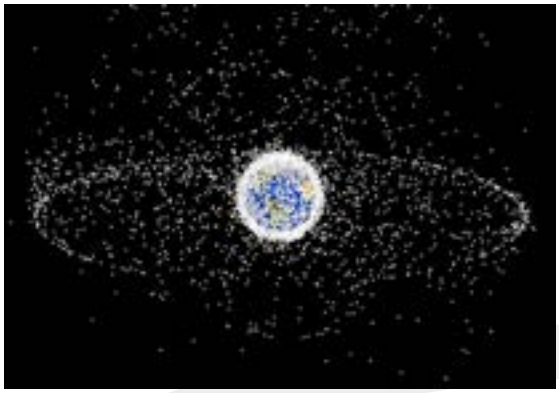
"We observed quasars back to just a billion years after the Big Bang, and found that the universe's expansion rate up to the present day was faster than we expected," study lead author Guido Risaliti, of the University of Florence in Italy, said in a statement. "This could mean dark energy is getting stronger as the cosmos grows older."

Quasars are fast-growing supermassive black holes at the hearts of galaxies. Quasars' incredible luminosity — they're the brightest objects in the universe — originates in the disks of material that swirl around the black holes. These fast-spinning disks generate huge amounts of ultraviolet (UV) light, some of which slams into electrons in nearby clouds of hot gas. Such interactions can ramp up the UV radiation to X-ray levels, producing a powerful glow across multiple wavelengths of high-energy light.

The correlation between these two types of light can reveal the distance to a quasar, Risaliti and co-author Elisabetta Lusso, of Durham University in England, determined. In the new study, the duo ...Read More...

Special Read:

This 'Empty Trash Bag' Is Orbiting Earth in a Very Strange Way



Lots of space debris is orbiting Earth, including non-functional satellites. Credit: NASA

A bizarre object orbiting Earth is reminding astronomers of an empty trash bag.

The unusual satellite is trekking around the planet in an almost absurd ellipse, dipping as close as 372.8 miles (600 kilometers) from the surface and then swinging out to a distance of 334,460 miles (538,261 km), or 1.4 times the average distance of the Earth to the moon.

According to Northolt Branch Observatories in London, the object is a light piece of material left over from a rocket launch. What it will do next is anyone's guess.

Unusual orbiting object

According to the observatories, the Haleakala (ATLAS-HKO) Observatory in Hawaii was the first to detect the object. The observatory is tasked with detecting near-Earth objects to warn of dangerous chunks that might impact the planet. This particular object is not dangerous, but it is weird.

Scientists dubbed it A10bMLz. According to the Northolt Branch Observatories, it's what is known as an "empty trash bag object." That means it is large enough to be spotted, but very light. Scientists at the London observatory calculated that A10bMLz is several meters in width, but weighs less than 2.2 pounds (1 kilogram).

Most likely, they wrote on the observatory Facebook page, the object is a bit of metallic foil flung into space during a rocket launch. It's not clear when A10bMLz entered orbit or what rocket took it spaceward.

Earth, surrounded

This is not the first empty trash bag object found in orbit, Northolt Branch Observatories reported, but it is possibly the strangest. No other "empty trash bag" has been seen orbiting so far out. Its current weird orbit is not likely to be permanent. The object has such a small mass, Northolt Branch reported, that photons emanating from the sun can easily push it around. For that reason, its orbit will likely change frequently, in unpredictable ways. It could even re-enter Earth's atmosphere and burn up in the coming months.

Earth's orbit is full of space junk. About 500,000 individual pieces of debris circulate around the planet, according to NASA, and about 50,000 of the largest of those are tracked by the space agency and the U.S. Department of Defense. , Between 200 and 400 pieces of space debris reenter the atmosphere each year, according to the National Oceanic and Atmospheric Administration's National Environmental Satellite, Data and Information Service. Most of that junk burns up before hitting the surface of the planet.

Two clouds of space dust called Kordylewski clouds may also be orbiting Earth, researchers reported last year.
..Read More...

This Week's Sky at a Glance - Feb. 02-08, 2019

Feb. 02	Sa	04:48	Moon South Dec.: 21.5° S
		11:18	Moon-Saturn: 0.7° S
Feb. 03	Su	10:35	Moon Descending Node
Feb. 05	Tu	01:04	New Moon
		13:26	Moon Apogee: 406600 km

Space changes your brain in bigger ways than we thought

We are already aware of many of the dangers that spaceflight can inflict on the human body. Loss of bone and muscle mass, distortions on eyeball size and function, and radiation are just a few in the long list of health consequences that can result from spending time in zero G. But one area of study that's increasingly concerning is how space environments might damage the brain, and how microgravity itself can induce unique irregularities in brain shape and structure. A new study published in JAMA Neurology this week provides more concerning details on how spaceflight changes the brain. The findings inadvertently underscore just how little we know about the effects of space on brain health and safety, creating a worrisome specter that's sure to grow larger as we start sending astronauts into space for years at a time.

"These brain changes were in the same direction as what you would see with aging, but they occurred at a faster speed," says Rachael Seidler, a professor of applied physiology and kinesiology at the University of Florida, and a co-author of the new JAMA paper. "They were greater with longer spaceflight mission durations, and larger brain changes were correlated with greater balance declines."

The study's findings center around the movement of intracranial fluids within the skull, as well as—for the first time—an examination of how spaceflight affects the brain's white matter. As opposed to gray matter, which is composed largely of neuronal cell bodies and plays a significant role in muscle control and sensory perception, white matter is mostly made of fat-covered nerve fibers, passing along messages between different parts of the brain and the nervous system.

While gray matter development peaks in a person's 20s, white matter continues to develop long after and won't peak until middle age, creating larger concerns that spaceflight could effectively stunt or warp parts of the brain's development in young astronauts normally thought to be fit for space missions.

It's been well-documented that astronauts often come back to Earth feeling disoriented, experiencing and showing impairments in motor control, balance, and functional mobility and cognition. And it was already known that the brain shifts upward within the skull during spaceflight, and that the somatosensory cortex (which processes sensory information for the brain) also increases in gray matter volume. However, it's never been completely clear how these various disturbances relate to one-another. More importantly, it's never been understood what effect spaceflight has on white matter.

Seidler and her team developed a new technique that would allow them to quantify the fluid shifts occurring within astronaut brains using diffusion MRI (dMRI) scans that could track the movement of water molecules in the brain. Water molecule motion is limited by white matter fiber tracts in the brain, enabling the researchers to get a better sense of how white matter structure changes as a result of spaceflight.

NASA made available preflight and postflight dMRI scans of 15 astronauts taken from 2010 to 2015—seven of whom took part in a Space Shuttle mission lasting less than 30 days, and eight of whom completed a long-duration mission to the International Space Station lasting less than 200 days. The median age was 47.2, with 12 men and 3 women.

The findings weren't all that surprising: Spaceflight decreased fluid around the top of the brain, and significantly increased fluid around the base of the brain, indicating that fluid distributions are altered by the upward shift of the brain within the skull. Moreover, the team found changes to white matter around pathways in the brain that process visual and spatial information, balance, vertical perception, and movement control. Astronauts with the most white matter changes experienced the most significant disturbances in these processes. ...Read More...