June 02, 2018 Ramadhan 17, 1439 AH Volume 8, Issue 22

Astronomy & Physics Weekly News

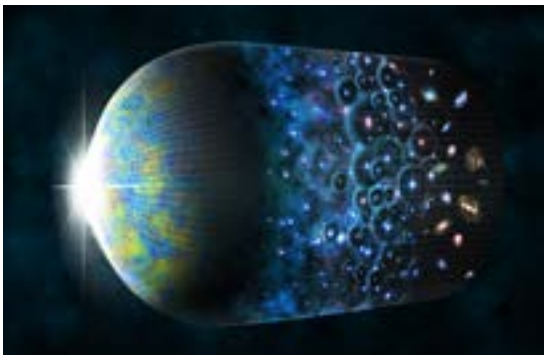
Dept. of Applied Physics & Astronomy - University of Sharjah
Compiled by Dr. Ilias Fernini

Top News

IT Support Issam Jami

Designed by Mohamed Bakir

Does some dark matter carry an electric charge?



This artist's impression shows the evolution of the Universe beginning with the Big Bang on the left followed by the appearance of the cosmic microwave background. The formation of the first stars ends the cosmic dark ages, followed by the formation of galaxies. Credit: CfA/M. Weiss

Astronomers have proposed a new model for the invisible material that makes up most of the matter in the Universe. They have studied whether a fraction of dark matter particles may have a tiny electrical charge.

"You've heard of electric cars and e-books, but now we are talking about electric dark matter," said Julian Munoz of Harvard University in Cambridge, Mass., who led the study that has been published in the journal Nature. "However, this electric charge is on the very smallest of scales."

Munoz and his collaborator, Avi Loeb of the Harvard-Smithsonian Center for Astrophysics (CfA) in Cambridge, Mass., explore the possibility that these charged dark matter particles interact with normal matter by the electromagnetic force.

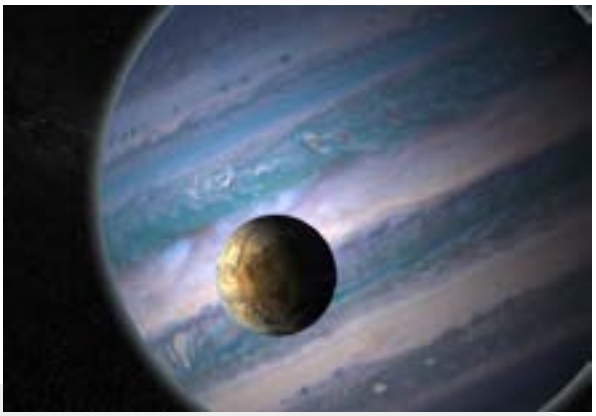
Their new work dovetails with a recently announced result from the Experiment to Detect the Global EoR (Epoch of Reionization) Signature (EDGES) collaboration. In February, scientists from this project said they had detected the radio signature from the first generation of stars, and possible evidence for interaction between dark matter and normal matter. Some astronomers quickly challenged the EDGES claim. Meanwhile, Munoz and Loeb were already looking at the theoretical basis underlying it.

"We're able to tell a fundamental physics story with our research no matter how you interpret the EDGES result," said Loeb, who is the chair of the Harvard astronomy department. "The nature of dark matter is one of the biggest mysteries in science and we need to use any related new data to tackle it."

The story begins with the first stars, which emitted ultraviolet (UV) light. According to the commonly accepted scenario, this UV light interacted with cold hydrogen atoms in gas lying between the stars and enabled them to absorb the cosmic microwave background (CMB) radiation, the leftover radiation from the Big Bang.

This absorption should have led to a drop in intensity of the CMB during this period, which ..Read More...

Researchers have identified 121 giant planets that may have habitable moons



An artist's illustration of a potentially habitable exomoon orbiting a giant planet in a distant solar system. Credit: NASA GSFC: JAY FRIEDLANDER AND BRITT GRISWOLD

We've all heard about the search for life on other planets, but what about looking on other moons?

In a paper forthcoming in The Astrophysical Journal, researchers at the University of California, Riverside and the University of Southern Queensland have identified more than 100 giant planets that potentially host moons capable of supporting life. Their work will guide the design of future telescopes that can detect these potential moons and look for tell-tale signs of life, called biosignatures, in their atmospheres.

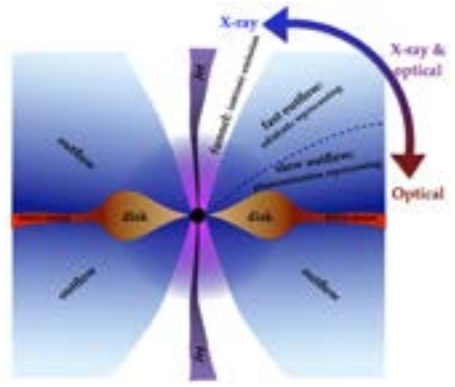
Since the 2009 launch of NASA's Kepler telescope, scientists have identified thousands of planets outside our solar system, which are called exoplanets. A primary goal of the Kepler mission is to identify planets that are in the habitable zones of their stars, meaning it's neither too hot nor too cold for liquid water—and potentially life—to exist.

Terrestrial (rocky) planets are prime targets in the quest to find life because some of them might be geologically and atmospherically similar to Earth. Another place to look is the many gas giants identified during the Kepler mission. While not a candidate for life themselves, Jupiter-like planets in the habitable zone may harbor rocky moons, called exomoons, that could sustain life.

"There are currently 175 known moons orbiting the eight planets in our solar system. While most of these moons orbit Saturn and Jupiter, which are outside the Sun's habitable zone, that may not be the case in other solar systems," said Stephen Kane, an associate professor of planetary astrophysics and a member of the UCR's Alternative Earths Astrobiology Center. "Including rocky exomoons in our search for life in space will greatly expand the places we can look."

The researchers identified 121 giant planets that have orbits within the habitable zones of their ...Read More...

New model explains what we see when a massive black hole devours a star



In the figure we see a cross section of what happens when the material from the disrupted star is devoured by the black hole. An accretion disk is formed (disk) by the material. There is too much material for it to pass into the black hole at once. It is heated up in the process and emits vast amounts of light and radiation, visible from Earth (Double arrow). Dr. Jane Dai's computer model takes the difference in viewing angle from Earth into account, which means we are now able to categorize the variations in observations correctly. This means we can study the properties of the black hole, and learn about a celestial body we would otherwise not be able to see. Credit: Niels Bohr Institute

A star that wanders too close to the supermassive black hole in the center of its galaxy will be torn apart by the black hole's gravity in a violent cataclysm called a tidal disruption event (TDE), producing a bright flare of radiation. A new study led by theoretical astrophysicists at the University of Copenhagen's Niels Bohr Institute and UC Santa Cruz provides a unified model that explains recent observations of these extreme events.

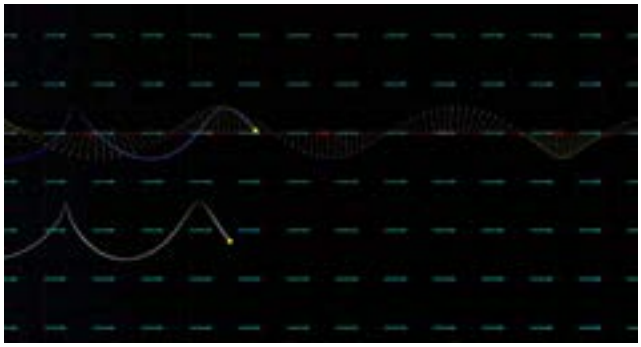
The breakthrough study, published in Astrophysical Journal Letters, provides a new theoretical perspective for a fast-growing research field.

"Only in the last decade or so have we been able to distinguish TDEs from other galactic phenomena, and the new model will provide us with the basic framework for understanding these rare events," said coauthor Enrico Ramirez-Ruiz, professor and chair of astronomy and astrophysics at UC Santa Cruz and Niels Bohr Professor at the University of Copenhagen.

In most galaxies, the central black hole is quiescent, not actively consuming any material and therefore not emitting any light. Tidal disruption events are rare, only happening about once every 10,000 years in a typical galaxy. When an unlucky star gets torn apart, however, the black hole is "overfed" with stellar debris for a while and emits intense radiation.

"It is interesting to see how materials get their way into the black hole under such extreme conditions," said first author Jane Lixin Dai, assistant professor at the University of Copenhagen, who led the study. "As the black hole is eating the stellar gas, a vast amount of ...Read More...

The case of the relativistic particles solved with NASA missions



In a background magnetic field, represented by the cyan arrows, two electrons are propagating to the right, executing identical gyromotion. A circularly polarized electromagnetic wave approaches the upper electron from the left. Credit: NASA

Encircling Earth are two enormous rings—called the Van Allen radiation belts—of highly energized ions and electrons. Various processes can accelerate these particles to relativistic speeds, which endanger spacecraft unlucky enough to enter these giant bands of damaging radiation. Scientists had previously identified certain factors that might cause particles in the belts to become highly energized, but they had not known which cause dominates.

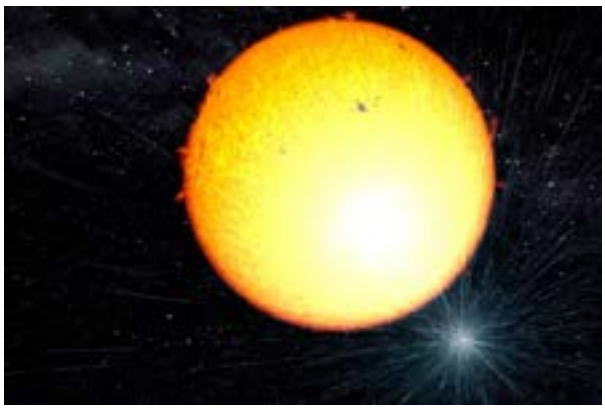
Now, with new research from NASA's Van Allen Probes and Time History of Events and Macroscale Interactions during Substorms—THEMIS—missions, published in Geophysical Research Letters, the verdict is in. The main culprit is a process known as local acceleration, caused by electromagnetic waves called chorus waves. Named after their characteristic rising tones, reminiscent of chirping birds, chorus waves speed up the particles pushing them along like a steady hand repeatedly pushing a swing. This process wasn't a widely accepted theory before the Van Allen Probes mission.

Establishing the main cause of the radiation belt enhancements provides key information for models that forecast space weather—and thus protect our technology in space.

"We've had studies in the past that look at individual events, so we knew local acceleration was going to be important for some of the events, but I think it was a surprise just how important local acceleration was," said Alex Boyd, lead author and researcher at New Mexico Consortium, Los Alamos, New Mexico. "The results finally address this main controversy we've been having about the radiation belts for a number of years."

There are two main causes of particle energization in the Van Allen belts: radial diffusion and local acceleration. Radial diffusion, which often occurs during solar storms—giant influxes of particles, energy and magnetic fields from the Sun, which can alter our space environment—slowly and repeatedly nudges particles closer to Earth, where they gain energy from the magnetic fields they encounter. Many scientists had long thought this ...Read More...

Researchers discover one of the most massive neutron stars



The massive pulsar in the binary system PSR J2215+5135, illustrated in the figure, heats up the inner face of its companion star. Credit: G. Pérez-Díaz/IAC

Using a pioneering method, researchers from the Astronomy and Astrophysics Group of the UPC and the Canary Islands Institute of Astrophysics (IAC) have found a neutron star of about 2.3 solar masses—one of the most massive ever detected. The study was published on the 23rd of May in the Astrophysical Journal and opens a new path of knowledge in many fields of astrophysics and nuclear physics.

Neutron stars (often called pulsars) are stellar remnants that have reached the end of their evolutionary life: they result from the death of a star of between 10 and 30 solar masses. Despite their small size (about 20 kilometres in diameter), neutron stars have more mass than the sun, so they are extremely dense.

Researchers from the Universitat Politècnica de Catalunya (UPC) and the Canary Islands Institute of Astrophysics (IAC) used an innovative method to measure the mass of one of the heaviest neutron stars known to date. Discovered in 2011 and called PSR J2215+5135, with about 2.3 solar masses it is one of the most massive of the more than 2,000 neutron stars known to date. Although a study published in 2011 reported evidence of a neutron star with 2.4 solar masses, the most massive neutron stars that had previously achieved a consensus among scientists, reported in 2010 and 2013, have 2 solar masses.

The study was led by Manuel Linares, Marie-Curie researcher of the Astronomy and Astrophysics Group (GAA), linked to the UPC's Department of Physics, in collaboration with the astronomers Tariq Shahbaz and Jorge Casares of the IAC. The researchers used data obtained from the Gran Telescopio Canarias (GTC), the largest optical and infrared telescope in the world, the William Herschel Telescope (WHT), the Isaac Newton Telescope Group (ING) and the IAC-80 telescope, in combination with dynamical models of binary stars with irradiation. An article reporting on the results of the study, entitled "Peering into the dark side: magnesium lines establish a massive neutron star in PSR J2215+5135", was published in the ...Read More...

Very Large Telescope: Powerful Eyes on the Sky

The entire arc of the Milky Way can be seen in the southern sky in this view from the European Southern Observatory's Very Large Telescope at the Paranal Observatory in Chile's Atacama Desert. Credit: Miguel Claro

Seated in the Atacama Desert of Chile, the European Southern Observatory (ESO)'s Very Large Telescope (VLT) consists of four main telescopes and four smaller telescopes that can be used separately or combined into a single larger instrument powerful enough to distinguish two car headlights at the distance of the moon.

World's most advanced optical instrument

The VLT is located at Paranal Observatory in the Atacama Desert. The four Unit Telescopes boast 8.2-meter (27 feet) mirrors. Just one of these instruments can spot objects that are 4 billion times fainter than what can be seen with the unaided eye. According to the ESO's website, the VLT is "the world's most advanced optical telescope."

The first of the four instruments, Unit Telescope 1 (UT1), saw first light on May 25, 1998, and went into scientific operations on April 1, 1999. UT2 saw first light only four days before the observatory's March 5, 1999, inauguration.

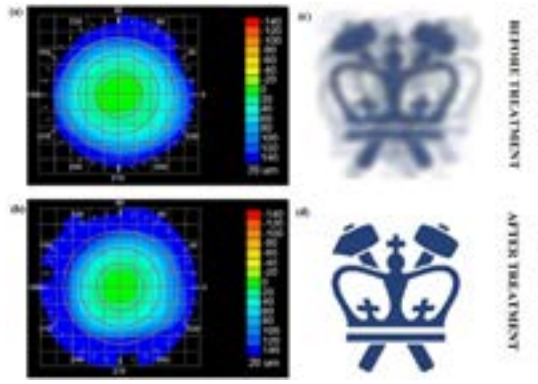
The four Unit Telescopes sit in compact, thermally controlled buildings that rotate with the instruments. These buildings minimize adverse effects, such as turbulence in the telescope tube, on observations.

At the inauguration, the four Unit telescopes were given names in the Mapuche language, from an indigenous people living in the area south of Santiago de Chile. Chile's schoolchildren participated in the naming, with an essay by then-17-year-old Jorssy Albanez Castilla unanimously selected by the committee.

UT1 is known as Antu (an-too), which means the sun.
UT2 is Kueyen (quay-yen), or the moon.
UT3 is Melipal (me-li-pal), or the Southern Cross).
UT4 is Yepun (ye-poon), or the evening star (Venus).

The VLT also contains four moveable 1.8-meter Auxiliary Telescopes. All eight telescopes are ...Read More...

Engineers invent a noninvasive technique to correct vision



Corneal topography before and after the treatment, paired with virtual vision that simulates effects of induced refractive power change. Credit: Sinisa Vukelic/Columbia Engineering

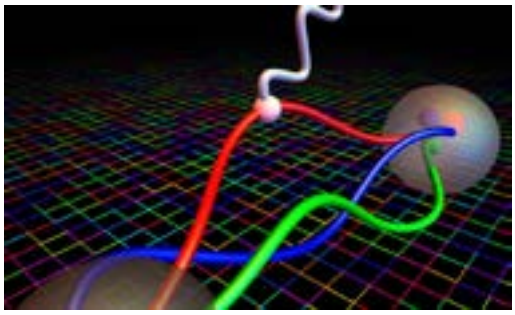
Nearsightedness, or myopia, is an increasing problem around the world. There are now twice as many people in the US and Europe with this condition as there were 50 years ago. In East Asia, 70 to 90 percent of teenagers and young adults are nearsighted. By some estimates, about 2.5 billion of people across the globe may be affected by myopia by 2020.

Eye glasses and contact lenses are simple solutions; a more permanent one is corneal refractive surgery. But, while vision correction surgery has a relatively high success rate, it is an invasive procedure, subject to post-surgical complications, and in rare cases permanent vision loss. In addition, laser-assisted vision correction surgeries such as laser in situ keratomileusis (LASIK) and photorefractive keratectomy (PRK) still use ablative technology, which can thin and in some cases weaken the cornea.

Columbia Engineering researcher Sinisa Vukelic has developed a new non-invasive approach to permanently correct vision that shows great promise in preclinical models. His method uses a femtosecond oscillator, an ultrafast laser that delivers pulses of very low energy at high repetition rate, for selective and localized alteration of the biochemical and biomechanical properties of corneal tissue. The technique, which changes the tissue's macroscopic geometry, is non-surgical and has fewer side effects and limitations than those seen in refractive surgeries. For instance, patients with thin corneas, dry eyes, and other abnormalities cannot undergo refractive surgery. The study, which could lead to treatment for myopia, hyperopia, astigmatism, and irregular astigmatism, was published May 14 in Nature Photonics.

"We think our study is the first to use this laser output regimen for noninvasive change of corneal curvature or treatment of other clinical problems," says Vukelic, who is a lecturer in discipline in the department of mechanical engineering. His method uses a femtosecond oscillator to alter biochemical and biomechanical properties of collagenous tissue without causing cellular ...Read More...

Nuclear scientists calculate value of key property that drives neutron decay



ScIn this illustration, the grid in the background represents the computational lattice that theoretical physicists used to calculate a particle property known as nucleon axial coupling. This property determines how a W boson (white wavy line) interacts with one of the quarks in a neutron (large transparent sphere in foreground), emitting an electron (large arrow) and antineutrino (dotted arrow) in a process called beta decay. This process transforms the neutron into a proton (distant transparent sphere). Credit: Evan Berkowitz/ Jülich Research Center, Lawrence Livermore National Laboratory

Using some of the world's most powerful supercomputers, an international team including scientists from several U.S. Department of Energy (DOE) national laboratories has released the highest-precision calculation of a fundamental property of protons and neutrons known as nucleon axial coupling. This quantity determines the strength of the interaction that triggers neutrons to decay into protons—and can therefore be used to more accurately predict how long neutrons are expected to "live." The results appear in Nature.

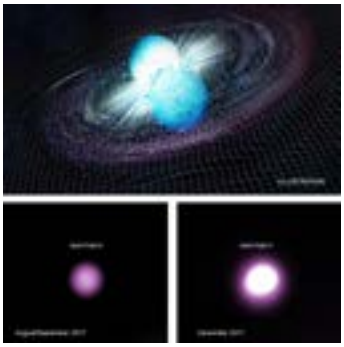
"The fact that neutrons decay into protons is a very, very important fact in the universe," said Enrico Rinaldi, a special postdoctoral researcher at the RIKEN BNL Research Center at DOE's Brookhaven National Laboratory, who was involved in developing simulations essential to the new calculation. "It basically tells you how atomic nuclei—made of protons and neutrons—were created after the Big Bang."

Neutron lifetime also has bearing on the relative abundance of atoms like hydrogen and helium in the universe today, and how that balance will affect the formation of future stars.

The new calculation could also help scientists determine which of two approaches to experimentally measure neutron lifetime is more accurate—and whether the several-second discrepancy between the two could potentially point to the existence of yet-to-be discovered particles.

The effort to calculate the axial coupling, led by André Walker-Loud of DOE's Lawrence Berkeley National Laboratory (Berkeley Lab), used computing resources at Lawrence Livermore National Laboratory and the Oak Ridge Leadership Computing Facility (OLCF), a DOE ...Read More..

Gravitational wave event likely signaled creation of a black hole



Credit: NASA/CXC/Trinity University/D. Pooley et al. Illustration: NASA/CXC/M.Weiss

The spectacular merger of two neutron stars that generated gravitational waves announced last fall likely did something else: birthed a black hole. This newly spawned black hole would be the lowest mass black hole ever found.

A new study analyzed data from NASA's Chandra X-ray Observatory taken in the days, weeks, and months after the detection of gravitational waves by the Laser Interferometer Gravitational Wave Observatory (LIGO) and gamma rays by NASA's Fermi mission on August 17, 2017.

While nearly every telescope at professional astronomers' disposal observed this source, known officially as GW170817, X-rays from Chandra are critical for understanding what happened after the two neutron stars collided.

From the LIGO data astronomers have a good estimate that the mass of the object resulting from the neutron star merger is about 2.7 times the mass of the Sun. This puts it on a tightrope of identity, implying it is either the most massive neutron star ever found or the lowest mass black hole ever found. The previous record holders for the latter are no less than about four or five times the Sun's mass.

"While neutron stars and black holes are mysterious, we have studied many of them throughout the universe using telescopes like Chandra," said Dave Pooley of Trinity University in San Antonio, Texas, who led the study. "That means we have both data and theories on how we expect such objects to behave in X-rays."

The Chandra observations are telling, not only for what they revealed, but also for what they did not. If the neutron stars merged and formed a heavier neutron star, then astronomers would expect it to spin rapidly and generate a very strong magnetic field. This, in turn, would have created an expanding bubble of high-energy particles that would result in bright X-ray emission. Instead, the Chandra data show levels of X-rays that are a factor of a few to several hundred times lower than expected for a rapidly spinning, merged neutron star and the associated bubble of high-energy particles, implying a black hole likely formed instead. ...Read More...

Physicists invent flux capacitor, break time-reversal symmetry

An electronic circulator keeps information moving in a certain direction, much like a roundabout. (But in a circulator, 'traffic' must always take the next exit after they enter.)

In the popular movie franchise "Back to the Future", an eccentric scientist creates a time machine that runs on a flux capacitor.

Now a group of actual physicists from Australia and Switzerland have proposed a device which uses the quantum tunneling of magnetic flux around a capacitor, breaking time-reversal symmetry.

The research, published this week in Physical Review Letters, proposes a new generation of electronic circulators, which are devices that control the direction in which microwave signals move.

It represents a collaboration between two Australian Research Council Centres of Excellence: the Centre for Engineered Quantum Systems (EQUS) and the Centre for Future Low-Energy Electronics Technologies (FLEET).

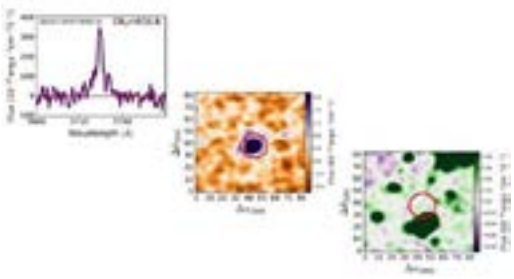
FLEET Associate Investigator Professor Jared Cole (working at RMIT University) said the proposed device is built from a superconductor, in which electricity can flow without electrical resistance.

Professor Cole added, "We propose two different possible circuits, one of which resembles the iconic three-pointed-star design of the cinematic flux capacitor. (See images.)

"In it, quantum 'tubes' of magnetic flux can move around a central capacitor by a process known as quantum tunneling, where they overcome classically insurmountable obstacles." The combination of magnetic fields and electric charges leads to what the physicists call broken time-reversal symmetry.

"Unfortunately this effect does not allow us to actually travel back in time," Professor Tom Stace (University of Queensland) said. ...Read More...

Lightening up dark galaxies



One of the new dark-galaxy candidates, identified through a combination of spectral information (left) and images reflecting the emission of gas (middle) and stars (right). The position of the dark-galaxy candidate is marked by the red circle.

Despite substantial progress over the past half a century in understanding of how galaxies form, important open questions remain regarding how precisely the diffuse gas known as the 'intergalactic medium' is converted into stars.

One possibility, suggested in recent theoretical models, is that the early phase of galaxy formation involves an epoch when galaxies contain a great amount of gas but are still inefficient at forming stars.

Direct proof of such a 'Dark Phase' has been so far elusive, however - - after all, dark galaxies do not emit much visible light. The observational discovery of such galaxies would therefore fill an important gap in our understanding of galaxy evolution.

There are ways to bring dark galaxies to lighten up though. An international team led by Dr. Raffaella Anna Marino and Prof. Sebastiano Cantalupo from the Department of Physics at ETH Zurich has now done just that and thus was able to search the sky for potential dark galaxies with unprecedented efficiency.

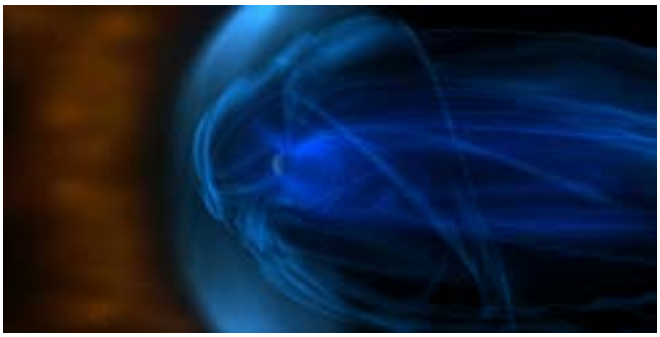
And successfully so, as they report in a paper published in The Astrophysical Journal: they have identified at least six strong candidates for dark galaxies.

To overcome the obstacle that their target objects are dark, the team used a flashlight of sorts, which came in the form of quasars. These emit intense ultraviolet light, which in turn induces fluorescent emission in hydrogen atoms known as the Lyman-alpha line. As a result, the signal from any dark galaxies in the vicinity of the quasar gets a boost, making them visible.

Such 'fluorescent illumination' has been used before in searches for dark galaxies, but Marino et al. now looked at the neighbourhood of quasars at greater distances than has been possible in earlier observations.

Also, they acquired the full spectral information for each of the dark-galaxy candidates. Deep observations - - 10 hours for each of the six quasar fields they ...Read More...

Study shows how Earth slows the solar wind to a gentle breeze



A giant magnetic field (swirling blue lines) surrounds Earth. As Earth travels through solar wind (orange area), its magnetic field creates a bow shock in front of itself (pale blue area). Credit: NASA/Goddard Space Flight Center

As Earth orbits the sun at supersonic speed, it cuts a path through the solar wind. This fast stream of charged particles, or plasma, launched from the sun's outer layers would bombard Earth's atmosphere if not for the protection of Earth's magnetic field.

Just as a motorboat creates a bow-shaped wave ahead of itself as the hull pushes through the water, Earth creates a similar effect—called a bow shock—as it pushes through the solar wind. Scientists have sought to explain how Earth's magnetic field can shove aside the powerful solar wind without unleashing calamity. They have known part of the answer for a long time: the bow shock converts energy from the solar wind to heat stored in electrons and ions. But now, researchers have important new clues about how this process occurs.

A University of Maryland-led study describes the first observations of the process of electron heating in Earth's bow shock. The researchers found that when the electrons in the solar wind encounter the bow shock, they momentarily accelerate to such a high speed that the electron stream becomes unstable and breaks down. This breakdown process robs the electrons of their high speed and converts the energy to heat.

The results add an important new dimension to scientists' understanding of Earth's magnetic field and its ability to protect the planet from harmful particles and radiation. The research paper was published in the journal Physical Review Letters on May 31, 2018.

"If you were to stand on a mountaintop, you might get knocked over by a fast wind," explained Li-Jen Chen, lead author of the study and an associate research scientist in the UMD Department of Astronomy. "Fortunately, as the solar wind crashes into Earth's magnetic field, the bow shock protects us by slowing down this wind and changing it to a nice, warm breeze. We now have a better idea how this happens." ...Read More...

Special Read:

Could alien life exist in parallel universes?

The idea that other universes might exist arises from the realization that the Big Bang might not have been a unique event but a common one.Victor De Schwanberg / Science Photo Library via Getty Images

It's one thing to look for life elsewhere in the universe. But why stop there? What about life in all those parallel universes that theoretical physicists like to talk about? A recent paper in the Monthly Notices of the Royal Astronomical Society suggests that some of that real estate might be home to aliens who aren't just out of this world — they're out of this cosmos.

The idea that other universes might exist arises from the realization that the Big Bang might not have been a unique event but a common one. How common? Stanford University physicists Andrei Linde and Vitaly Vanchurin have estimated that the number of unique parallel universes — ones that are independent of the cosmos you know and adore — could be written as a one followed by 10 thousand trillion zeroes. That's not a number that has a name, and certainly not one you will ever encounter in the real world. I figure it would require 10 billion notebooks just to write this number down.

So, to paraphrase Jodie Foster's character in the movie "Contact," if our cosmos is the only one with life, then that's an awful waste of universes.

But despite their possible plentitude, not all those parallel universes are likely to be blessed with biology. As many scientists have pointed out, our universe — known by the catchy name "the universe" — seems pretty special. Its physical properties are remarkably suitable for the existence of life. If the forces that hold atoms together were even a bit different, the atomic reactions that power the stars wouldn't work, and our cosmos would consist of nothing but hydrogen. Tweak those constants another way, and stars would burn themselves out so quickly that there would have been no time for the evolution of microbes, dinosaurs, or you. If the strength of gravity were just slightly altered, our universe would have either expanded too rapidly after the Big Bang for stars and galaxies to form — or would have collapsed in a Big Crunch. ...Read More...

This Week's Sky at a Glance
June 02-08, 2018

Jun 02	Sa	20:34	Moon Apogee: 405300 km
Jun 03	Su	15:58	Moon-Mars : 3.5° S
		16:39	Moon Descending Node
Jun 06	We	05:53	Mercury Superior Conj.
		22:32	Last Quarter
Jun 08	Fr	07:37	Venus-Pollux: 4.7° S