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Astronomy & Physics Weekly News

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Top News

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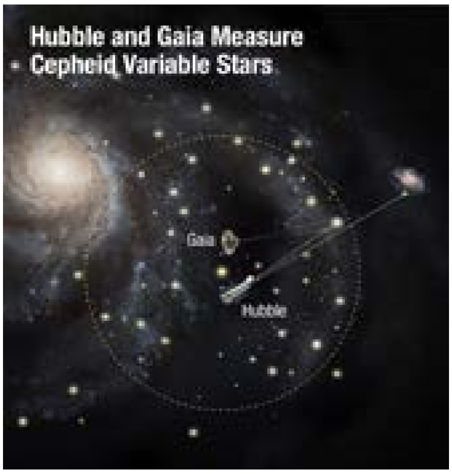
Hubble and Gaia team up to fuel cosmic conundrum



Using two of the world's most powerful space telescopes -- NASA's Hubble and ESA's Gaia -- astronomers have made the most precise measurements to date of the universe's expansion rate. This is calculated by gauging the distances between nearby galaxies using special types of stars called Cepheid variables as cosmic yardsticks. By comparing their intrinsic brightness as measured by Hubble, with their apparent brightness as seen from Earth, scientists can calculate their distances. Gaia further refines this yardstick by geometrically measuring the distances to Cepheid variables within our Milky Way galaxy. This allowed astronomers to more precisely calibrate the distances to Cepheids that are seen in outside galaxies. Credit: NASA, ESA, and A. Feild (STScI)

Using the power and synergy of two space telescopes, astronomers have made the most precise measurement to date of the universe's expansion rate. The results further fuel the mismatch between measurements for the expansion rate of the nearby universe, and those of the distant, primeval universe—before stars and galaxies even existed.

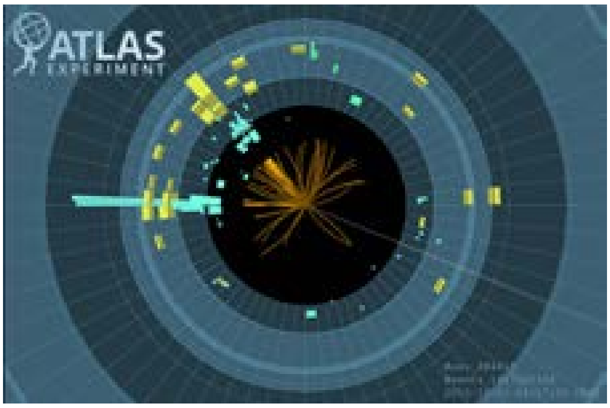
This so-called "tension" implies that there could be new physics underlying the foundations of the universe. Possibilities include the interaction strength of dark matter, dark energy being even more exotic than previously thought, or an unknown new particle in the tapestry of space.

Combining observations from NASA's Hubble Space Telescope and the European Space Agency's (ESA) Gaia space observatory, astronomers further refined the previous value for the Hubble constant, the rate at which the universe is expanding from the big bang 13.8 billion years ago.

But as the measurements have become more precise, the team's determination of the Hubble constant has become more and more at odds with the measurements from another space observatory, ESA's Planck mission, which is coming up with a different predicted value for the Hubble constant.

Planck mapped the primeval universe as it appeared only 360,000 years after the big bang. The entire sky is imprinted with the signature of the big bang encoded in microwaves. Planck measured the sizes of the ripples in this Cosmic Microwave Background (CMB) that were produced by slight irregularities in the big bang ..Read More...

Higgs boson observed decaying to b quarks



Event display for the H→bb decay analysis with the ATLAS detector. Credit: ATLAS Collaboration/CERN

On 9 July, at the 2018 International Conference on High Energy Physics (ICHEP) in Seoul (South Korea), the ATLAS experiment reported a preliminary result establishing the observation of the Higgs boson decaying into pairs of b quarks, furthermore at a rate consistent with the Standard Model prediction.

The Brout-Englert-Higgs mechanism solves the apparent theoretical impossibility of weak vector bosons (W and Z) to have mass. The discovery of the Higgs boson in 2012 was a triumph of the Standard Model. The Higgs field can also be used in an elegant way to provide mass to charged fermions (quarks and leptons) through interactions involving Yukawa couplings with strength proportional to the particle mass. The observation of the Higgs boson decaying into pairs of →leptons provided the first direct evidence of this type of interaction.

Six years after its discovery, the ATLAS experiment at CERN observed about 30 percent of the Higgs boson decays predicted in the Standard Model. However, the favoured decay of the Higgs boson into a pair of b quarks (H→bb), which is expected to account for almost 60 percent of all possible decays, has remained elusive up to now. Observing this decay mode and measuring its rate is a mandatory step to confirm or disconfirm the mass generation for fermions via Yukawa interactions, as predicted in the Standard Model.

At the 2018 International Conference on High Energy Physics (ICHEP) in Seoul (South Korea), the ATLAS experiment reported a preliminary result establishing the observation of the Higgs boson decaying into pairs of b quarks at a rate consistent with the Standard Model prediction. It is necessary to exclude at a level of one in 3 million the probability that the decay detection arises from a fluctuation of the background that could mimic the process. When such a probability is at the level of only one in 1000, the detection is qualified as "evidence." Evidence of the H→bb decay was first provided at the Tevatron in 2012, and a year ago by the ATLAS and CMS Collaborations, independently. ...Read More...

Researchers interpret new experimental data aimed at showing dark matter interacts with ordinary matter

Photo shows PandaX, a xenon-based detector in China. Credit: PandaX.

An international team of scientists that includes University of California, Riverside, physicist Hai-Bo Yu has imposed conditions on how dark matter may interact with ordinary matter—constraints that can help identify the elusive dark matter particle and detect it on Earth.

Dark matter—nonluminous material in space—is understood to constitute 85 percent of the matter in the universe. Unlike normal matter, it does not absorb, reflect, or emit light, making it difficult to detect.

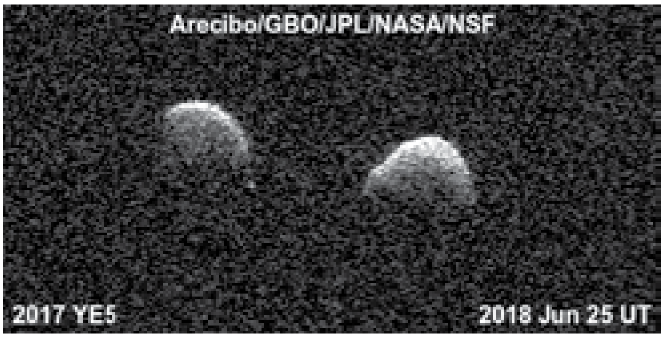
Physicists are certain dark matter exists, having inferred this existence from the gravitational effect dark matter has on visible matter. What they are less certain of is how dark matter interacts with ordinary matter—or even if it does.

In the search for direct detection of dark matter, the experimental focus has been on WIMPs, or weakly interacting massive particles, the hypothetical particles thought to make up dark matter.

But Yu's international research team invokes a different theory to challenge the WIMP paradigm: the self-interacting dark matter model, or SIDM, a well-motivated framework that can explain the full range of diversity observed in the galactic rotation curves. First proposed in 2000 by a pair of eminent astrophysicists, SIDM has regained popularity in both the particle physics and the astrophysics communities since around 2009, aided, in part, by work Yu and his collaborators did.

Yu, a theorist in the Department of Physics and Astronomy at UCR, and Yong Yang, an experimentalist at Shanghai Jiaotong University in China, co-led the team analyzing and interpreting the latest data collected in 2016 and 2017 at PandaX-II, a xenon-based dark matter direct detection experiment in China (PandaX refers to Particle and Astrophysical Xenon Detector; PandaX-II refers ..Read More...

Cosmic Double Take: Rare Binary Asteroid Discovered Near Earth



Bi-static radar images of the binary asteroid 2017 YE5 from the Arecibo Observatory and the Green Bank Observatory on June 25. The observations show that the asteroid consists of two separate objects in orbit around each other. Credit: Jet Propulsion Laboratory

New observations by three of the world's largest radio telescopes have revealed that an asteroid discovered last year is actually two objects, each about 3,000 feet (900 meters) in size, orbiting each other.

Near-Earth asteroid 2017 YE5 was discovered with observations provided by the Morocco Oukaimeden Sky Survey on Dec. 21, 2017, but no details about the asteroid's physical properties were known until the end of June. This is only the fourth "equal mass" binary near-Earth asteroid ever detected, consisting of two objects nearly identical in size, orbiting each other. The new observations provide the most detailed images ever obtained of this type of binary asteroid.

On June 21, the asteroid 2017 YE5 made its closest approach to Earth for at least the next 170 years, coming to within 3.7 million miles (6 million kilometers) of Earth, or about 16 times the distance between Earth and the Moon. On June 21 and 22, observations by NASA's Goldstone Solar System Radar (GSSR) in California showed the first signs that 2017 YE5 could be a binary system. The observations revealed two distinct lobes, but the asteroid's orientation was such that scientists could not see if the two bodies were separate or joined. Eventually, the two objects rotated to expose a distinct gap between them.

Scientists at the Arecibo Observatory in Puerto Rico had already planned to observe 2017 YE5, and they were alerted by their colleagues at Goldstone of the asteroid's unique properties. On June 24, the scientists teamed up with researchers at the Green Bank Observatory (GBO) in West Virginia and used the two observatories together in a bi-static radar configuration (in which Arecibo transmits the radar signal and Green Bank receives the return signal). Together, they were able to confirm that 2017 YE5 consists of two separated objects. By June 26, both Goldstone and Arecibo had independently confirmed the asteroid's binary nature.. ..Read More...

Laser-Aided 'Hawk' Camera Snaps Spectacular New View of Star Cluster

A photograph of the star cluster called RCW 38 taken by the Very Large Telescope in Chile. The image was created with the assistance of an instrument that shoots four lasers into the sky, according to information provided by the European Southern Observatory. Credit: ESO/K. Muzic

You know an instrument is promising when even its test images are stunning. That's what this image of a nearby star cluster is, just one of a series of practice runs scientists took to make sure a new camera module on an incredibly powerful telescope was working properly.

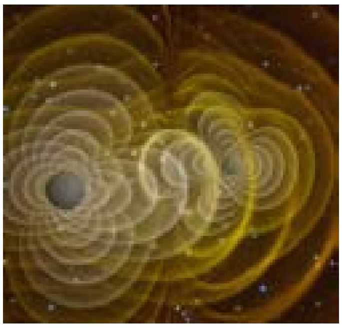
The image comes courtesy of the GRAAL module, which helps a camera attached to the Very Large Telescope in Chile produce sharper images, according to a statement from the European Southern Observatory, which runs the telescope. In early January, a team spent a few evenings gathering data that would both test the camera's partnership with the module and give scientists a good look at a few particularly intriguing objects.

Those targets included this huge cluster of stars about 5,500 light-years away, known as RCW 38, which is an astronomical baby at less than a million years old. The result is a stunningly clear view of hundreds of young stars.

Scientists want to use the new image to study how stars are born, particularly the very small stars known as brown dwarfs, which previous research has suggested are common in RCW 38. Other images from the test nights were designed to crack the secrets of a dwarf planet and of supernovas caused by collapsing stellar cores. The images will also help scientists studying the mysteries of what they think is a binary active galactic nucleus.

The GRAAL module uses four laser beams as "reference stars," which helps the camera it's attached to reduce the fuzziness produced by the atmosphere. That camera, called HAWK-I, has a relatively large field of view, letting it capture huge swaths of sky in one image. And because HAWK-I gathers infrared light, its vision isn't foiled by the clouds of dust that swirl between the camera and its target. In fact, it's the camera's response to dust clouds that helps make this image so beautiful — the billows of dark orange and red represent cooler patches ...Read More...

Could gravitational waves reveal how fast our universe is expanding?



A visualization of a supercomputer simulation of merging black holes sending out gravitational waves. Credit: NASA/C. Henze

Since it first exploded into existence 13.8 billion years ago, the universe has been expanding, dragging along with it hundreds of billions of galaxies and stars, much like raisins in a rapidly rising dough.

Astronomers have pointed telescopes to certain stars and other cosmic sources to measure their distance from Earth and how fast they are moving away from us—two parameters that are essential to estimating the Hubble constant, a unit of measurement that describes the rate at which the universe is expanding.

But to date, the most precise efforts have landed on very different values of the Hubble constant, offering no definitive resolution to exactly how fast the universe is growing. This information, scientists believe, could shed light on the universe's origins, as well as its fate, and whether the cosmos will expand indefinitely or ultimately collapse.

Now scientists from MIT and Harvard University have proposed a more accurate and independent way to measure the Hubble constant, using gravitational waves emitted by a relatively rare system: a black hole-neutron star binary, a hugely energetic pairing of a spiraling black hole and a neutron star. As these objects circle in toward each other, they should produce space-shaking gravitational waves and a flash of light when they ultimately collide.

In a paper to be published July 12th in Physical Review Letters, the researchers report that the flash of light would give scientists an estimate of the system's velocity, or how fast it is moving away from the Earth. The emitted gravitational waves, if detected on Earth, should provide an independent and precise measurement of the system's distance. Even though black hole-neutron star binaries are incredibly rare, the researchers calculate that detecting even a few should yield the most accurate value yet for the Hubble constant and the rate of the expanding universe.

"Black hole-neutron star binaries are very complicated systems, which we know very little about," says Salvatore Vitale, assistant professor of physics at MIT ..Read More...

Theorists publish highest-precision prediction of muon magnetic anomaly

The Muon g-2 storage ring installed and ready to take data at Fermi National Accelerator Laboratory. Credit: Fermilab

Theoretical physicists at the U.S. Department of Energy's (DOE's) Brookhaven National Laboratory and their collaborators have just released the most precise prediction of how subatomic particles called muons—heavy cousins of electrons—"wobble" off their path in a powerful magnetic field. The calculations take into account how muons interact with all other known particles through three of nature's four fundamental forces (the strong nuclear force, the weak nuclear force, and electromagnetism) while reducing the greatest source of uncertainty in the prediction. The results, published in Physical Review Letters as an Editors' Suggestion, come just in time for the start of a new experiment measuring the wobble now underway at DOE's Fermi National Accelerator Laboratory (Fermilab).

A version of this experiment, known as "Muon g-2," ran at Brookhaven Lab in the late 1990s and early 2000s, producing a series of results indicating a discrepancy between the measurement and the prediction. Though not quite significant enough to declare a discovery, those results hinted that new, yet-to-be discovered particles might be affecting the muons' behavior. The new experiment at Fermilab, combined with the higher-precision calculations, will provide a more stringent test of the Standard Model, the reigning theory of particle physics. If the discrepancy between experiment and theory still stands, it could point to the existence of new particles.

"If there's another particle that pops into existence and interacts with the muon before it interacts with the magnetic field, that could explain the difference between the experimental measurement and our theoretical prediction," said Christoph Lehner, one of the Brookhaven Lab theorists involved in the latest calculations. "That could be a particle we've never seen before, one not included in the Standard Model."

Finding new particles beyond those already cataloged by the Standard Model has long been a quest for particle physicists. Spotting signs of a new particle affecting the behavior of muons could guide the ...Read More...

Here's Why IceCube's Neutrino Discovery Is a Big Deal

An artist's depiction of the IceCube Neutrino Observatory at the South Pole detecting the journey of a neutrino. Credit: IceCube/NSF

Scientists have spotted a high-energy, incredibly tiny "ghost" particle called a neutrino flying through Antarctic ice and traced its origins back to a specific blazar, they announced today, July 12.

Physicists are very excited about the detective work that has told them about the neutrino's birthplace. But what the heck is a neutrino anyway, and why does it matter where the thing came from?

A neutrino is a subatomic particle just as tiny as an electron, but without any charge. Scientists know neutrinos have a tiny bit of mass, but they can't pin down exactly how little. The result is that neutrinos tend to give other matter the cold shoulder: They don't interact with their surroundings very often, which makes them difficult for scientists to spot. [Tracing a Neutrino to Its Source: The Discovery in Pictures]

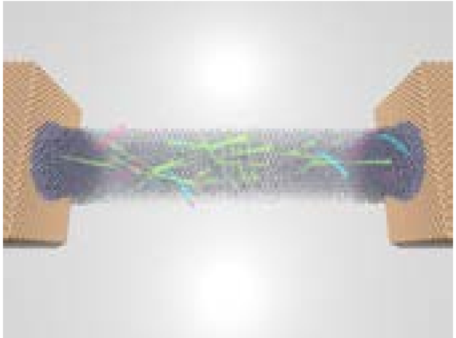
Nevertheless, they're everywhere — your body is pummeled by about 100 trillion neutrinos every second. And scientists think the weird particles may hold the key to some of the biggest mysteries about the universe, including why matter won out over antimatter early after the Big Bang.

"Neutrinos are awesome," Kate Scholberg, a particle physicist at Duke University in North Carolina, told Space.com. She's biased, since she's spent her career studying the tiny things, but that doesn't make her wrong. "We have to understand them if we want to understand everything."

The new research is a small step for scientists hoping to do just that. The discovery started at the IceCube Neutrino Observatory near the South Pole in September. Deep inside the Antarctic ice sheet, a grid of detectors traced the path of a single neutrino in 3D.

The path was clear enough that the physicists could follow the neutrino's journey backward in a straight line across the universe. In less than a minute, they ...Read More...

Physicists uncover why nanomaterial loses superconductivity



An illustration that describes Del Maestro's pair-breaking critical theory in nanowires. Electrons inside an ultra-thin MoGe wire with a radius on the order of 10 nanometers can pair up at low temperatures (green) and travel from one contact to the other without resistance in the superconducting phase. In the presence of a magnetic field penetrating the wire, the members of the pairs are deflected in opposite directions (pink and blue) and may collide with the edges of the wire and break apart. As the strength of the field is increased, all pairs break, and the nanowire undergoes a zero temperature phase transition from a superconductor to a normal metal. At the transition, the conductivity of the wire is a universal number that does not depend on any specific details of the wire composition or field direction. Credit: Adrian Del Maestro

The struggle to keep drinks cold during the summer is a lesson in classical phase transitions. To study phase transitions, apply heat to a substance and watch how its properties change. Add heat to water and at the so-called "critical point," watch as it transforms into a gas (steam). Remove heat from water and watch it turn into a solid (ice).

Now, imagine that you've cooled everything down to very low temperatures—so low that all thermal effects vanish. Welcome to the quantum realm, where pressure and magnetic fields cause new phases to emerge in a phenomenon called quantum phase transitions (QPT). More than a simple transition from one phase to another, QPT form completely new properties, such as superconductivity, in certain materials.

Apply voltage to a superconductive metal, and the electrons travel through the material with no resistance; electrical current will flow forever without slowing down or producing heat. Some metals become superconducting at high temperatures, which has important applications in electric power transmission and superconductor-based data processing. Scientists discovered the phenomenon 30 years ago, but the mechanism for superconductivity remains an enigma because the majority of materials are too complex to understand QPT physics in details. A good strategy would be first to look at less complicated model systems.

Now, University of Utah physicists and collaborators have discovered that superconducting nanowires made of MoGe alloy undergo quantum phase transitions from a superconducting to a normal metal state when placed in an increasing magnetic field at low temperatures. ...Read More...

Plasma-spewing quasar shines light on universe's youth, early galaxy formation

Artist's conception of a radio jet spewing out fast-moving material from the newly discovered quasar, which formed within the first billion years of the universe's existence. Credit: Artwork by Robin Dienel, Carnegie Institution for Science

Carnegie's Eduardo Bañados led a team that found a quasar with the brightest radio emission ever observed in the early universe, due to it spewing out a jet of extremely fast-moving material.

Bañados' discovery was followed up by Emmanuel Momjian of the National Radio Astronomy Observatory, which allowed the team to see with unprecedented detail the jet shooting out of a quasar that formed within the universe's first billion years of existence.

The findings, published in two papers in The Astrophysical Journal, will allow astronomers to better probe the universe's youth during an important period of transition to its current state.

Quasars are comprised of enormous black holes accreting matter at the centers of massive galaxies. This newly discovered quasar, called PSO J352.4034-15.3373, is one of a rare breed that doesn't just swallow matter into the black hole but also emits a jet of plasma traveling at speeds approaching that of light. This jet makes it extremely bright in the frequencies detected by radio telescopes. Although quasars were identified more than 50 years ago by their strong radio emissions, now we know that only about 10 percent of them are strong radio emitters.

What's more, this newly discovered quasar's light has been traveling nearly 13 billion of the universe's 13.7 billion years to reach us here in Earth. P352-15 is the first quasar with clear evidence of radio jets seen within the first billion years of the universe's history.

"There is a dearth of known strong radio emitters from the universe's youth and this is the brightest radio quasar at that epoch by an order of magnitude," Bañados said.

"This is the most-detailed image yet of such a bright galaxy at this great distance," Momjian added. ..Read More...

What powers the most luminous galaxies?

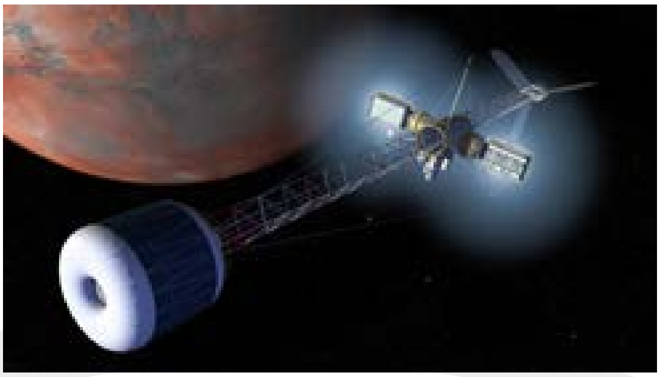
The colliding galaxy pair VV705. Astronomers have measured a set of merging galaxies to determine the relative contributions to luminosity from star formation versus from accretion around the supermassive black hole nucleus. For VV705, they find that nearly 75% of the lumi

Galaxy-galaxy interactions have long been known to influence galaxy evolution. They are commonplace events, and a large majority of galaxies show signs of interactions, including tidal tails or other morphological distortions. The most dramatic collisions trigger the galaxies to light up, especially in the infrared, and they are some of the most luminous objects in the sky. Their brightness allows them to be studied at cosmological distances, helping astronomers reconstruct activity in the early universe.

Two processes in particular are responsible for the enhanced radiation: bursts of star formation or the fueling of the supermassive black hole at a galaxy's core (an active galactic nuclei—AGN). Although in principle these two processes are quite different and should be readily distinguishable (AGN, for example, produce much hotter ultraviolet and X-ray radiation), in practice the discriminating features can be faint and/or obscured by dust in the galaxies. Astronomers therefore often use the shape of the galaxy's entire emission profile from the ultraviolet to the far infrared (its spectral energy distribution—SED), to diagnose what is going on. The dust that absorbs much of the radiation also re-radiates it at the longer infrared wavelengths and computer codes can model and unravel the numerous physical effects.

If bursts of star formation were responsible for powering luminous galaxies in the early universe, then many of today's stars may have been formed in such events, but if AGN dominated, then there should have been more outflowing jets and fewer new stars. CfA astronomers Jeremy Dietrich, Aaron S. Weiner, Matt Ashby, Rafael Martínez-Galarza, Andrés Ramos-Padilla, Howard Smith, Steve Willner, Andreas Zezas, and two colleagues analyzed twenty-four relatively nearby, luminous merging galaxies to see how often and to what extent AGN activity powered the energetics. They extracted the most meticulous SED information in thirty-three spectral bands from seven NASA missions for these galaxies, correcting for backgrounds, confusion, and other extraneous signals. They then used a new computational code to fit the shape of the SED and to derive the most likely value of the AGN ...Read More...

Method of making oxygen from water in zero gravity raises hope for long-distance space travel



Artist's rendering of a Mars artificial gravity transfer vehicle. Credit: NASA

Space agencies and private companies already have advanced plans to send humans to Mars in the next few years – ultimately colonising it. And with a growing number of discoveries of Earth-like planets around nearby stars, long-distance space travel has never seemed more exciting.

However, it isn't easy for humans to survive in space for sustained periods of time. One of the main challenges with long-distance space flight is transporting enough oxygen for astronauts to breathe and enough fuel to power complex electronics. Sadly, there's only little oxygen available in space and the great distances make it hard to do quick refills.

But now a new study, published in Nature Communications, shows that it is possible to produce hydrogen (for fuel) and oxygen (for life) from water alone using a semiconductor material and sunlight (or star light) in zero gravity – making sustained space travel a real possibility.

Using the unbounded resource of the sun to power our everyday life is one of the biggest challenges on Earth. As we are slowly moving away from oil towards renewable sources of energy, researchers are interested in the possibility of using hydrogen as fuel. The best way to do this would be by splitting water (H2O) into its constituents: hydrogen and oxygen. This is possible using a process known as electrolysis, which involves running a current through a water sample containing some soluble electrolyte. This breaks down the water into oxygen and hydrogen, which are released separately at the two electrodes.

While this method is technically possible, it has yet to become readily available on Earth as we need more hydrogen related infrastructure, such as hydrogen refilling stations, to scale it up. ...Read More...

Special Read:

What Can Lunar Eclipses Do For Science?

The steady progression of an eclipse as the Moon drifts into the Earth's shadow, June 16, 2011. Phil Hart, Author provided

On the night of July 27, 2018, the longest total lunar eclipse for the next 105 years will be visible across parts of Europe, Africa, Asia and Australia. Six months later, on January 20, 2019, there will be the 'Great American' lunar eclipse, where totality is visible across all 50 states. The Moon's journey through the Earth's shadow produces one of the most dramatic and awe-inspiring sights in Nature. But can it help us deepen our understanding of Nature?

Dr. Noah Petro is the Project Scientist for NASA's Lunar Reconnaissance Orbiter (LRO) mission, which has been orbiting the Moon since June 2009. Sky & Telescope talked to him about what lunar eclipses can do for science – and why we should study the Moon at all.

S&T: Firstly, a quick bit of background. Is it true that you had a 'light-bulb moment' at college that took you from studying geology to studying planetary geology?

NP: Yes, it was pretty much that. My Dad was involved in the Apollo program, so I was always interested in space exploration and the Moon. Then, going into high school, I had some amazing Earth Science teachers who got me excited about geology. It was a professor at my undergraduate institution, Bates College, who said, "Noah, you like space and you like geology. Did you know you could do the geology of things in space?" I thought, oh really? And that was that.

S&T: It's now 20 years later, and you're based at the Goddard Space Flight Center working on the LRO mission. What have been the most important results from the mission?

NP: That's a hard question to answer because we're learning so much. LRO has been at the Moon for almost nine years now, and no mission has ever operated at the Moon as long as that before. We're constantly rewriting our understanding of how the Moon works and changes. LRO has made measurements to constrain the rate at which new impacts are forming on the surface of the Moon. ...Read More...

This Week's Sky at a Glance
July 14-20, 2018

Jul 14	Sa	06:50	Moon Ascending Node
Jul 15	Su	02:04	Moon-Mercury: 2.2° S
		20:14	Moon-Regulus: 1.7° S
Jul 16	Mo	07:31	Moon-Venus: 1.6° S
Jul 19	Th	23:52	First Quarter

First Light of UAE's First Decametric Radio Telescope

Under a fund from the UAE Space agency, the Sharjah Center for Astronomy and Space Sciences (SCASS) inaugurated a prototype of the first "Decametric Radio Telescope" in the UAE. This prototype consists of two dipole systems tuned to observe the Sun and Jupiter at a specific frequency of 20.1 MHz. The first signal was from Jupiter. It was taken late afternoon Thursday, July 12 when Jupiter was quite high. Once finished, the full decametric radio telescope will consist of eight dipoles spread over more than 5000 square meters.

The "Radio Astronomy Laboratory" at SCASS is one of the six research laboratories being built at the center: (1) CubeSat Laboratory, (2) Meteorite Center, (3) Space Weather and Ionospheric Laboratory, (4) Radio Astronomy Laboratory, (5) Artifical Intelligence Laboratory, and (6) GIS and RS Center. In addition, the center has an astronomical observatory equipped with three different size telescopes: a reflecting 45 cm (deep-sky observations), a refracting 18 cm (lunar and planetary observations), and a refracting 10 cm (solar observations).

SCASS has presently more than 20 researchers (permanent and students assistants) working on different projects. The center is fully sponsored by the University of Sharjah, with some projects funded by the UAE Space Agency (UAE Meteor Monitoring Network and the Decametric Radio Telescope), and the Mohamed Bin Rashed Space Center (Artificial Martian Atmosphere).