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Astronomy & Physics Weekly News

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Top News

University of Sharjah

IT Support Issam Jami Designed by Mohamed Bakir

Water worlds could support life: Analysis challenges idea that life requires 'Earth clone'

This artist's concept depicts a planetary system. Credit: NASA/JPL-Caltech

The conditions for life surviving on planets entirely covered in water are more fluid than previously thought, opening up the possibility that water worlds could be habitable, according to a new paper from the University of Chicago and Pennsylvania State University.

The scientific community has largely assumed that planets covered in a deep ocean would not support the cycling of minerals and gases that keeps the climate stable on Earth, and thus wouldn't be friendly to life. But the study, published Aug. 30 in The Astrophysical Journal, found that ocean planets could stay in the "sweet spot" for habitability much longer than previously assumed. The authors based their findings on more than a thousand simulations.

"This really pushes back against the idea you need an Earth clone—that is, a planet with some land and a shallow ocean," said Edwin Kite, assistant professor of geophysical sciences at UChicago and lead author of the study.

As telescopes get better, scientists are finding more and more planets orbiting stars in other solar systems. Such discoveries are resulting in new research into how life could potentially survive on other planets, some of which are very different from Earth—some may be covered entirely in water hundreds of miles deep.

Because life needs an extended period to evolve, and because the light and heat on planets can change as their stars age, scientists usually look for planets that have both some water and some way to keep their climates stable over time. The primary method we know of is how Earth does it. Over long timescales, our planet cools itself by drawing down greenhouse gases into minerals and warms itself up by releasing them via volcanoes.

But this model doesn't work on a water world, with deep water covering the rock and suppressing volcanoes.

Kite, and Penn State coauthor Eric Ford, wanted to know if there was another way. They set up a simulation with thousands of randomly generated planets, and tracked the evolution of their climates over billions ...Read More...

The swing doctors: Physicist cracks code on material that works as both conductor, insulator

Pictured is a crystal of ytterbium dodecaboride, or YbB 12. Credit: University of Michigan

Quantum materials are a type of odd substance that could be many times more efficient at conducting electricity through our iPhones than the commonly used conductor silicon—if only physicists can crack how the stuff works.

A University of Michigan physicist has gotten one step closer with detailing a novel quantum material, ytterbium dodecaboride, or YbB12, and imaging how efficiently electricity is conducted through this material. The demonstration of this material's conductivity will help contribute to scientists' understanding of the spin, charge, and energy flow in these electromagnetic materials.

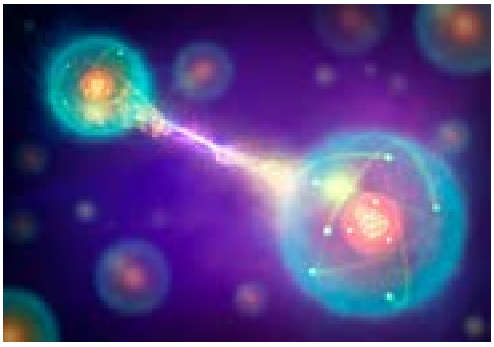
YbB12 is a very clean crystal that is unusual in it shares the properties of both conductors and insulators. That is, the bulk interior of YbB12 is an insulator and doesn't conduct electricity, while its surface is extraordinarily efficient at conducting electricity. But researchers needed to be able to measure exactly how good at conducting electricity this material is.

"Right now, we are using a phone to talk. Inside the phone are its key parts: a transistor made of silicon that passes electricity through the device," said project leader Lu Li, U-M associate professor of physics. "These silicon semiconductors use the bulk of their own material to make a path for electric current. That makes it difficult to make electronic devices faster or more compact."

Replacing a phone's silicon transistors with ones made of quantum materials would make the phone much faster—and much lighter. That's because the transistors inside the device would conduct electricity very quickly on their surfaces, but could be made much smaller, with a lighter core beneath a layer of the metal's insulating interior.

Quantum materials would not be limited to powering our phones. They could be used in quantum computing, a field still in its infancy, but which could be used for cybersecurity. Our computers currently work by processing data in binary digits: 0 and 1. But there's a limit to how fast computers can process data in this way. ...Read More...

Quantum entanglement loophole quashed by quasar light



Quantum entanglement is a bizarre offshoot of quantum mechanics that says two particles can instantly communicate with one another, even across cosmic distances. Mark Garlick/Science Photo Library/Alamy Stock Photo

That's what happens when you let quasars decide what to measure. With the help of two extremely bright quasars located more than 7 billion light-years away, researchers recently bolstered the case for quantum entanglement — a phenomenon Einstein described as "spooky action at a distance" — by eliminating one classical alternative: The freedom-of-choice loophole.

Quantum connection

Of the many mindboggling facets of quantum mechanics, one of the most intriguing is the idea of quantum entanglement. This occurs when two particles are inextricably linked together no matter their separation from one another. Although these entangled particles are not physically connected, they still are able to share information with each other instantaneously — seemingly breaking one of the most hard-and-fast rules of physics: No information can be transmitted faster than the speed of light.

As far-out as the idea seems, quantum entanglement has been proven time and time again over the years. When researchers create two entangled particles and independently measure their properties, they find that the outcome of one measurement influences the observed properties of the other particle.

But what if the apparent relationship between particles is not due to quantum entanglement, but instead is a result of some hidden, classical law of physics? In 1964, physicist John Bell addressed this question by calculating a theoretical limit beyond which correlations can only be explained by quantum entanglement, not classical physics. However, as is often the case, there are loopholes.

Freedom of choice?

One of the most stubborn of these loopholes is the so-called "freedom-of-choice" loophole, which suggests a hidden classical variable can influence how an experimenter decides to measure seemingly entangled ...Read More...

Astronomers reveal new details about 'monster' star-forming galaxies

Artist's impression of the monster galaxy COSMOS-AzTEC-1. This galaxy is located 12.4 billion light-years away and is forming stars 1,000 times more rapidly than our Milky Way galaxy. ALMA observations revealed dense gas concentrations in the disk, and intense star formation in those concentrations. Credit: National Astronomical Observatory of Japan

An international team of astronomers from Japan, Mexico and the University of Massachusetts Amherst studying a "monster galaxy" 12.4 billion light years away today report that their instruments have achieved a 10 times higher angular resolution than ever before, revealing galaxy structural details previously completely unknown. They also were able to analyze dynamic properties that could not be probed before. Details appear in Nature.

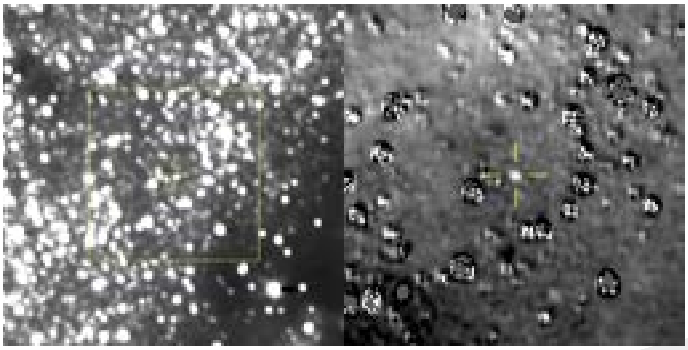
So-called "monster galaxies" or extreme starburst galaxies are thought to be ancestors of massive galaxies like the Milky Way in today's universe, so these findings about the galaxy known as COSMOS-AzTEC-1 pave the way to understanding their formation and evolution, the researchers say.

Co-author Min Yun, professor of astronomy at UMass Amherst and a member of the team that discovered this galaxy using a UMass-built instrument named AzTEC in Chile in 2007, adds, "A real surprise is that this galaxy seen almost 13 billion years ago has a massive, ordered gas disk that is in regular rotation instead of what we had expected, which would have been some kind of a disordered train wreck that most theoretical studies had predicted."

That said, he adds, they did observe that this gas disk is dynamically unstable now, which means the entire gas disk that makes up this galaxy is fragmenting and undergoing a gigantic episode of starburst, which helps to explain its enormous star formation rate, more than 1,000 times that of the Milky Way galaxy.

These most recent observational discoveries of COSMOS-AzTEC-1were made possible by the Atacama Large Millimeter/submillimeter Array (ALMA), a telescope and facility operated by an international partnership in Chile. Ken-ichi Tadaki is lead author of this week's paper and a postdoctoral researcher at the Japan Society for the Promotion of Science and the nation's National Astronomical Observatory. He says, "One of the best ..Read More...

New Horizons has sent back the first images of Ultima Thule, its next target



IN SIGHT Ultima Thule is barely a blip in images (left) from the New Horizons spacecraft. The remote world stands out more when the stars have been removed (right); the dark blobs are artifacts from imperfect star subtraction. Yellow crosshairs mark Ultima's position – right where it was predicted to be.

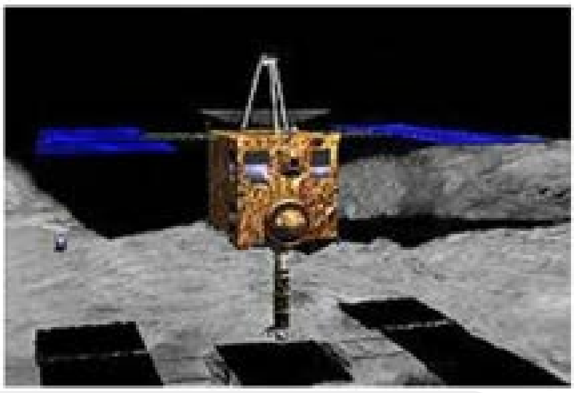
New Horizons has its next destination in sight.

The spacecraft, which buzzed Pluto in 2015, captured its first images on August 16 of the remote icy world nicknamed Ultima Thule, confirming that New Horizons is on track for its January 1 flyby. With about 160 million kilometers to go – roughly the same distance as Earth is from the sun – the tiny world appears as no more than a faint speck in the probe's camera.

The pictures also barely set a new record: At roughly 6 billion kilometers from Earth, they are the farthest images ever taken. For decades, that honor was held by the Voyager 1 spacecraft, which in 1990 snapped pictures of Earth and many of our neighboring planets from nearly the same distance.

Officially dubbed 2014 MU69, Ultima Thule is part of the Kuiper Belt, a field of frozen detritus left over from the formation of the planets 4.6 billion years ago. By sending New Horizons to take pictures and measure the chemical makeup of Ultima's surface, researchers hope to unearth clues about the origin of our solar system. ...Read More...

Particles collected by Hayabusa give absolute age of asteroid Itokawa



The Hayabusa spacecraft on sample return mission Credit: J. Garry

Understanding the origin and time evolution of near-Earth asteroids (NEAs) is an issue of scientific interest and practical importance because they are potentially hazardous to the Earth. However, when and how these NEAs were formed and what they experienced during their lifetime remain enigmas.

Japanese scientists, including those from Osaka University, closely examined particles collected from the asteroid Itokawa by the spacecraft Hayabusa, finding that the parent body of Itokawa was formed about 4.6 billion years ago when the solar system was born and that it was destroyed by a collision with another asteroid about 1.5 billion years ago. Their research results were published in Scientific Reports.

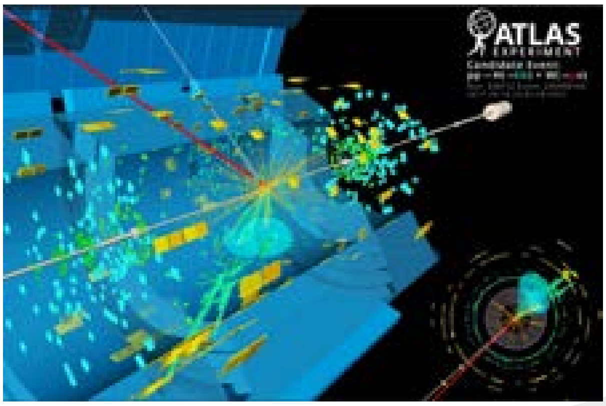
Focusing on a few micrometers of phosphate minerals, which are rarely found in Itokawa particles, the scientists performed precise isotope analyses of uranium (U) and lead (Pb) in Itokawa particles of about 50 μm in diameter using secondary ion mass spectrometry (SIMS).

Lead author Kentaro Terada says, "By combining two U decay series, 238U-206Pb (with a half-life of 4.47 billion years) and 235U-207Pb (with a half-life of 700 million years), using four Itokawa particles, we clarified that phosphate minerals crystalized during a thermal metamorphism age (4.64±0.18 billion years ago) of Itokawa's parent body, experiencing shock metamorphism due to a catastrophic impact event by another body 1.51±0.85 billion years ago."

It has been reported that the mineralogy and geochemistry of the Itokawa particles resemble those of LL (LL stands for Low (total) iron, Low metal) chondrites, which frequently fall to the Earth.

However, the shock ages of Itokawa particles obtained from this study (1.5 billion years ago) are different from previously reported shock ages of shocked LL chondrites (4.2 billion years ago). This shows that the asteroid Itokawa had a time evolution different from . ..Read More...

Here's What Happens When a Higgs Boson Dies – and What It Means for Particle Physics



An ATLAS candidate event for the Higgs boson particle decaying into two bottom quarks. Physicists at CERN recently observed this process, which further confirms the Standard Model of particle physics. Credit: ATLAS/CERN

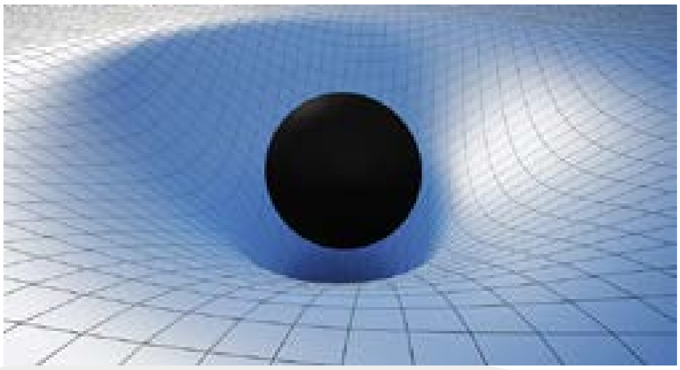
Six years after discovering the Higgs boson, physicists have observed how the particle decays – a monumental contribution to scientists' understanding of the Standard Model of particle physics and the universe at large, study researchers said.

Excitement swirled in the physics community when, in 2012, physicists discovered the Higgs boson, an elementary particle predicted by the Standard Model that relates to how objects have mass. But this discovery didn't mark the end of Higgs boson exploration. In addition to predicting the existence of Higgs boson particles, the Standard Model posits that 60 percent of the time, a Higgs boson particle will decay into fundamental particles called bottom quarks (b quarks).

In research presented on Aug. 28 at CERN, the ATLAS and CMS collaborations at the LHC at CERN say they have observed the Higgs boson decay into b quarks. The finding provides major support for the Standard Model, which has many implications for how we understand the world and the universe. "The Higgs boson is the least well-known and in many ways the most baffling particle in the standard model. Observing its decay to bottom quarks is a major milestone in our understanding of its properties," Jessie Shelton, a high-energy particle physicist at the University of Illinois who was not involved in this research, said in an email to Space.com.

Higgs boson particles don't live very long. "You'll never hold a Higgs boson in your hand," James Beacham, an experimental high-energy particle physicist working with the ATLAS collaboration at the Large Hadron Collider (LHC) at CERN (the European Organization for Nuclear Research) in Switzerland, said to Space.com. But, although the Standard Model predicts what happens to the Higgs boson when it dies, until now, researchers hadn't observed the particle decay into b quarks, Beacham said. ...Read More...

The strength of gravity has been measured to new precision



HOMING IN Gravity (illustrated here bending spacetime) has been notoriously hard to measure. Now two new lab experiments estimate the strength of gravity, or Big G, with record precision.

We now have the most precise estimates for the strength of gravity yet. Two experiments measuring the tiny gravitational attraction between objects in a lab have measured Newton's gravitational constant, or Big G, with an uncertainty of only about 0.00116 percent. Until now, the smallest margin of uncertainty for any G measurement has been 0.00137 percent.

The new set of G values, reported in the Aug. 30 Nature, is not the final word on G. The two values disagree slightly, and they don't explain why previous G-measuring experiments have produced such a wide spread of estimates. Still, researchers may be able to use the new values, along with other estimates of G, to discover why measurements for this key fundamental constant are so finicky – and perhaps pin down the strength of gravity once and for all.

The exact value of G, which relates mass and distance to the force of gravity in Newton's law of universal gravitation, has eluded scientists for centuries. That's because the gravitational attraction between a pair of objects in a lab experiment is extremely small and susceptible to the gravitational influence of other nearby objects, often leaving researchers with high uncertainty about their measurements.

The current accepted value for G, based on measurements from the last 40 years, is 6.67408×10^{-11} meters cubed per kilogram per square second. That figure is saddled with an uncertainty of 0.0047 percent, making it thousands of times more imprecise than other fundamental constants – unchanging, universal values such as the charge of an electron or the speed of light. The cloud of uncertainty surrounding G limits how well researchers can determine the masses of celestial objects and the values of other constants that are based on G.

Physicist Shan-Qing Yang of Huazhong University of Science and Technology in Wuhan, China, and colleagues measured G using two instruments called torsion pendulums. Each device contains a metal-coated ...Read More...

Electrons surf protons' waves in a new kind of particle accelerator

In a demonstration of a new particle accelerator technology, physicists with the AWAKE experiment (plasma cell, shown) accelerated electrons on the wakes of protons plowing through plasma.

Particle accelerator technology has crested a new wave. For the first time, scientists have shown that electrons can gain energy by surfing waves kicked up by protons shot through plasma. In the future, the technique might help produce electron beams at higher energies than currently possible, in order to investigate the inner workings of subatomic particles.

Standard particle accelerators rely on radiofrequency cavities, metallic chambers that create oscillating electromagnetic fields to push particles along. With the plasma wave demonstration, "we're trying to develop a new kind of accelerator technology," says physicist Allen Caldwell of the Max Planck Institute for Physics in Munich. Caldwell is a spokesperson of the AWAKE collaboration, which reported the results August 29 in Nature.

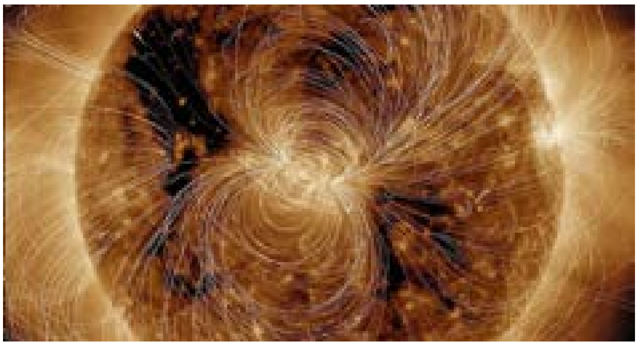
In an experiment at the particle physics lab CERN in Geneva, the researchers sent beams of high-energy protons through a plasma, a state of matter in which electrons and positively charged atoms called ions comingle. The protons set the plasma's electrons jiggling, creating waves that accelerated additional electrons injected into the plasma. In the study, the injected electrons reached energies of up to 2 billion electron volts over a distance of 10 meters.

"It's a beautiful result and an important first step," says Mark Hogan, a physicist at SLAC National Accelerator Laboratory in Menlo Park, Calif., who studies plasma wave accelerators.

Previously, scientists have demonstrated the potential of plasma accelerators by speeding up electrons using waves set off by a laser or by another beam of electrons, instead of protons (SN: 5/8/10, p. 28). But proton beams can carry more energy than laser or electron beams, so electrons accelerated by protons' plasma waves may be able to reach higher energies in a single burst of acceleration.

The new result, however, doesn't yet match the energies produced in previous plasma accelerators. ...Read More...

Strange gamma rays from the sun may help decipher its magnetic fields



The sun's knotted magnetic fields, visualized here as white lines, scramble cosmic rays and may cause them to shoot energetic light called high-energy gamma rays toward Earth.

The sleepy sun turns out to be a factory of extremely energetic light. Scientists have discovered that the sun puts out more of this light, called high-energy gamma rays, overall than predicted. But what's really weird is that the rays with the highest energies appear when the star is supposed to be at its most sluggish, researchers report in an upcoming study in Physical Review Letters. The research is the first to examine these gamma rays over most of the solar cycle, a roughly 11-year period of waxing and waning solar activity.

That newfound oddity is probably connected to the activity of the sun's magnetic fields, the researchers say, and could lead to new insights about the mysterious environment.

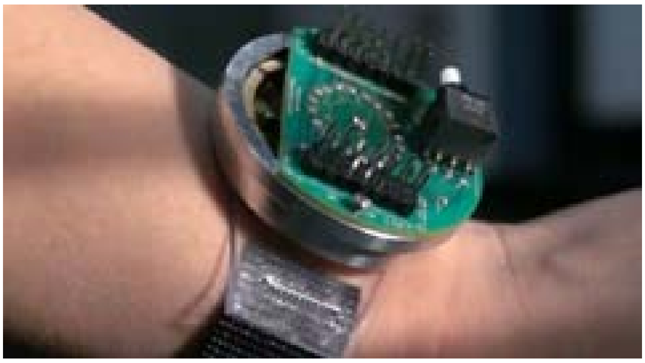
"The almost certain thing that's going on here is the magnetic fields are much more powerful, much more variable, and much more weirdly shaped than we expect," says astrophysicist John Beacom of the Ohio State University in Columbus.

The sun's high-energy gamma rays aren't produced directly by the star. Instead, the light is triggered by cosmic rays — protons that zip through space with some of the highest energies known in nature — that smack into solar protons and produce high-energy gamma rays in the process.

All of those gamma rays would get lost inside the sun, if not for magnetic fields. Magnetic fields are known to take charged particles like cosmic rays and spin them around like a house in a tornado. Theorists have predicted that cosmic rays whose paths have been scrambled by the tangled mass of magnetic fields at the solar surface should send high-energy gamma rays shooting back out of the sun, where astronomers can see them.

Beacom and colleagues, led by astrophysicist Tim Linden of Ohio State, sifted through data from NASA's Fermi Gamma-ray Space Telescope from August 2008 to November 2017. The observations spanned a period of low solar activity in 2008 and 2009, a period of higher activity in 2013 and a decline in activity to the ...Read More...

Device harvests energy from low-frequency vibrations



A piezoelectric energy harvester in a novel wristwatch-like device. Credit: Penn State

A wearable energy-harvesting device could generate energy from the swing of an arm while walking or jogging, according to a team of researchers from Penn State's Materials Research Institute and the University of Utah. The device, about the size of a wristwatch, produces enough power to run a personal health monitoring system.

"The devices we make using our optimized materials run somewhere between 5 and 50 times better than anything else that's been reported," said Susan Trolier-McKinstry, the Steward S. Flaschen Professor of Materials Science and Engineering and Electrical Engineering, Penn State.

Energy-harvesting devices are in high demand to power the millions of devices that make up the internet of things. By providing continuous power to a rechargeable battery or supercapacitor, energy harvesters can reduce the labor cost of changing out batteries when they fail and keep dead batteries out of landfills.

Certain crystals can produce an electric current when compressed or they can change shape when an electric charge is applied. This piezoelectric effect is used in ultrasound and sonar devices, as well as energy harvesting.

In this work, Trolier-McKinstry and her former doctoral student, Hong Goo Yeo, used a well-known piezoelectric material, PZT, and coated it on both sides of a flexible metal foil to a thickness four or five times greater than in previous devices. Greater volume of the active material equates to generation of more power. By orienting the film's crystal structure to optimize polarization, the performance—known as the figure of merit—of energy harvesting was increased. The compressive stresses that are created in the film as it is grown on the flexible metal foils also means that the PZT films can sustain high strains without cracking, making for more robust devices.

"There were some good materials science challenges," Trolier-McKinstry said about this work, reported in an online early view edition of Advanced Functional Materials ahead of print publication. "The first was how to get the film thickness high on a flexible metal foil. Then we needed to get the proper crystal orientation in order ..Read More...

Game-changing resolution—whose name on the laws of physics for an expanding universe?

Captured: approximately 15,000 galaxies (12,000 of which are star-forming) widely distributed in time and space. NASA, ESA, P. Oesch (University of Geneva), and M. Montes. Credit: University of New South Wales

Astronomers are engaged in a lively debate over plans to rename one of the laws of physics.

It emerged overnight in Vienna at the 30th Meeting of the International Astronomical Union (IAU), in Vienna, where members of the general assembly considered a resolution on amending the name of the Hubble Law to the Hubble-Lemaître Law.

The resolution aims to credit the work of the Belgian astronomer Georges Lemaître and his contribution – along with the American astronomer Edwin Hubble – to our understanding of the expansion of the universe.

While most (but not all) members at the meeting were in favour of the resolution, it was decided to give all members of the International Astronomical Union a chance to vote. Subsequently, voting was downgraded to a straw vote and the resolution will formally be voted on by an electronic vote at a later date.

Giving all members a say via electronic voting was introduced following criticism of the IAU's 2006 general assembly when a resolution to define a planet – that saw Pluto relegated to a dwarf-planet – was approved.

But changing the name of the Hubble Law raises the questions of who should be honoured in the naming of the laws of physics, and whether the IAU should be involved in any decision.

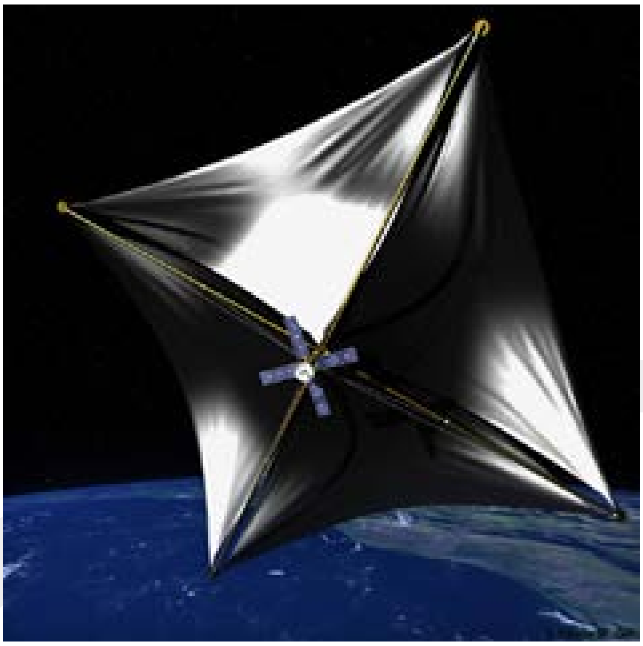
An expanding universe

The expansion of the universe was one of the most mind-blowing discoveries of the 20th century.

Expansion here means that the distance between galaxies in general increases with time, and it increases uniformly. It does not matter where you are...Read More...

Special Read:

Experiment puts pressure behind the solar wind



Solar sails rely on radiation pressure from the Sun to propel spacecraft. Kevin Gill

How does light shove matter around?

Quantum mechanics, the science of the smallest stuff, is famously kooky. Light is both a particle and a wave, electrons zip around and travel instantaneously, cats are both alive and dead – it's hard for our human brains to comprehend. One phenomenon that sort of makes a little sense, if you think about it right, is that light alone can push things around.

Formally known as 'imparting momentum,' the idea can also seem quantumly crazy. I go out in the sunlight all the time without feeling any pushing!

But here's how I've heard it explained: Momentum is defined as mass times velocity, so even though photons (particles of light) have zero rest mass, their velocity is enormous (literally the speed of light) and they're never really at rest, so they have a tiny effective mass.

That means they have a positive momentum, which can give a little kick to anything light crashes into. Plus, if you conceptualize light as a bunch of particles, it's not crazy to imagine those things moving around matter as they bump into it.

Clearly, it's still weird to think about, and physicists had never actually observed exactly how the process of light imparting momentum occurs. Until now. . ..Read More...

This Week's Sky at a Glance - Sep. 01-07, 2018

Sep 01	Sa	08:45	Venus-Spica: 1.2° S
Sep 03	Mo	05 :34	Moon-Aldebaran: 1.2° S
		06 :37	Last Quarter
Sep 05	We	10 :56	Moon North Dec.: 20.8° N
Sep 07	Fr	02:42	Moon Ascending Node
		06:13	Moon-Beehive: 1.4° N
		21:19	Neptune Opposition