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Astronomy & Physics Weekly News

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

Top News

Special Read:

Asteroid Day June 30, 2018

Asteroid Vesta observed by the Sharjah Observatory

IT Support Issam Jami

Designed by Mohamed Bakir

Habitable water world exo-planets

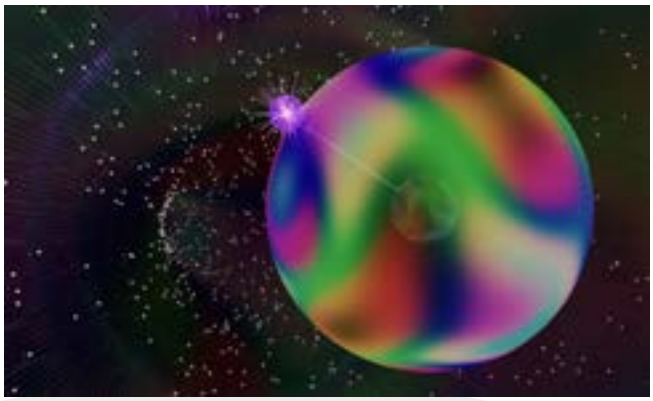
An artist's conception of a putative water world - an Earth-size exoplanet completely covered in water - based on the example of the binary star system Kepler-35A and B. Credit: NASA/JPL-Caltech

There are currently about fifty known exoplanets whose diameters range from Mars-sized to several times the Earth's and which also reside within their stars' habitable zone – the orbital distance within which their surface temperatures permit liquid water. These exoplanets are currently our best candidates for hosting life.

When, however, an exoplanet in the habitable zone has tens of percent of its total mass as water, and if it lacks an atmosphere with hydrogen or helium gas, it is called a "water world." Some scientists have argued that water worlds are unlikely sites for life. They lack the land surface that drives the carbonate-silicate cycle, a process in which carbon dioxide gas, thought to be essential to maintain hospitable surface temperatures, is balanced between the atmosphere and the planet's interior. CfA astronomer Amit Levi and his colleague have reanalyzed the physical and geological mechanisms in water worlds. They find that when the pressure of atmospheric carbon dioxide is high enough, sea ice can become enriched in chemicals other than water and sink, driving a planetary current that in effect rebalances the gas pressure in a way roughly analogous to the carbonate-silicate cycle.

These scientists find that for this effect to work, the planet needs to rotate about three times faster than the Earth; this enable a polar ice cap to develop and produce a temperature gradient in the ocean which helps sustain the mechanism. In addition, this temperature gradient will support freeze-thaw cycles necessary for the evolution of life on water worlds, according to constraints from prebiotic chemistry. They calculate a new "habitable zone" for this process around Sun-like and smaller stars; it generally falls within the boundaries of the usual habitable zone range. In conclusion, they note that for very small stars (smaller than about half the size of the Sun) the mechanism would not work because exoplanets in its habitable zone are probably tidally locked to the star and always have the same face towards the star. ..Read More...

Quantum gas reveals first signs of path-bending monopole



Credit: Joint Quantum Institute

Magnets, whether in the form of a bar, horseshoe or electromagnet, always have two poles. If you break a magnet in half, you'll end up with two new magnets, each with its own magnetic north and south.

But some physics theories predict the existence of single-pole magnets—a situation akin to electric charges, which come in either positive or negative chunks. One particular incarnation—called the Yang monopole after its discoverer—was originally predicted in the context of high-energy physics, but it has never been observed.

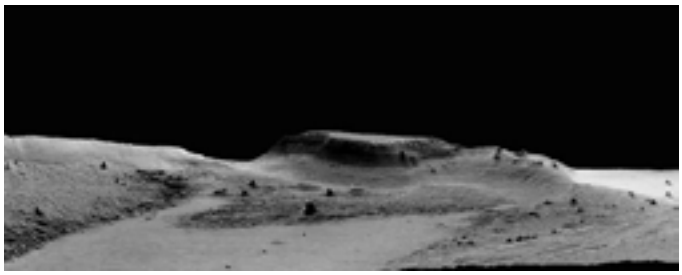
Now, a team at JQI led by postdoctoral researcher Seiji Sugawa and JQI Fellow Ian Spielman have succeeded in emulating a Yang monopole with an ultracold gas of rubidium atoms. The result, which provides another example of using cold quantum gases to simulate other areas of physics, was reported in the June 29 issue of Science.

"This new result links together ideas born in high-energy physics—the Yang monopole—with concepts in condensed matter physics—topological phase transitions—and realizes them in the atomic physics laboratory," Spielman says.

To detect the Yang monopoles in their quantum gas, Spielman, Sugawa and coworkers manipulated the internal compass needles that all atoms carry—a quantum property called spin—using radio waves and microwaves to rotate the needles in specific ways. By cycling the atoms among four different spin orientations, researchers were able to send the atoms on a journey through "spin space" and bring them back to where they started—very much like a traveler on the Earth's surface taking a trip around the globe (but in four dimensions instead of the globe's two).

The team measured the orientation of the atoms' spins after they completed their journey and compared the result to their initial orientations. They found that the atoms' spins didn't return to where they started, a discrepancy that can arise during a trip through curved space . In this case, the size and direction of the deflection matched predictions for the curvature ...Read More...

Martian Supervolcano Created Mysterious Rock Formation



An isolated hill in the Medusae Fossae Formation. The effect of wind erosion on this hill is evident by its streamlined shape.

With an area of one-fifth of the continental United States, the Medusae Fossae Formation (MFF) is one of the largest rock deposits on Mars. Scientists have been probing the nature of the massive formation since the 1960s, but new research shows that the rock stretch is likely the result of a volcanic eruption.

To find out more about the formation, scientists had previously looked to Mars-orbiting satellites, programming them to emit radar pulses toward MFF. The reflected signals shed light on MFF's ingredients and left scientists with two main possibilities – the formation might be made either of porous rock or of kilometers-thick ice covered by ash.

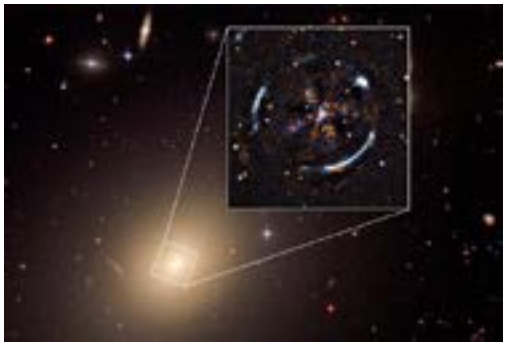
Now, scientists have used gravity data from Mars orbiters to resolve the conflict. "This is the first study that used gravity to figure out density of the sedimentary deposits on Mars," says the study's lead author Lujendra Ojha (Johns Hopkins University).

The gravitational pull of massive geological formations accelerates the orbiting satellites. From the rate of acceleration, scientists can infer the formation's mass and therefore density. "From this measurement, we can finally resolve past ambiguity," says coauthor Kevin Lewis (also at Johns Hopkins). Combining past radar data and the newly obtained density measurements allowed researchers to rule out ice as MFF's main ingredient, leaving one viable candidate: porous rock.

Such rock is formed when a volcano explodes, explains Ojha. Instead of emitting flowing lava along the surface of the ground, it spews out gas, ash, and lava into the atmosphere. The pressure from the explosion causes lava to fragment. The highly fragmented lava then descends and starts to cool, trapping gas particles inside it, a process that forms porous rock.

Jim Zimbelman (National Air & Space Museum), who was not involved in the study, finds the results very exciting. Until now, many theories competed to provide the best explanation for MFF's origin, but now "volcanoes are definitely in the lead," Zimbelman says. ..Read More...

Best Test of General Relativity on Galaxy Scales



An image of the nearby galaxy ESO 325-G004, created using data collected by the NASA/ESA Hubble Space Telescope and the MUSE instrument on the ESO's Very Large Telescope. The inset shows the Einstein ring resulting from the distortion of light from a more distant source by intervening lens ESO 325-004, which becomes visible after subtraction of the foreground lens light.
ESO / ESA / Hubble / NASA

General relativity – which describes our modern understanding of gravity as the curvature that mass induces on spacetime – has been extensively tested in our solar system. It has passed every one of these tests with flying colors.

But fewer tests exist on scales of thousands or millions of light-years. It is precisely these scales that are relevant to theories of modified gravity, which provide an alternative to the existence of dark matter. They predict that gravity behaves differently over far distances than it does in our solar system. While some tests on galactic scales have been conducted, they haven't been robust enough to rule out modified gravity.

Now, a study led by Thomas Collett (University of Portsmouth, UK) in the June 22nd Science (preprint available here) has provided such a test using Hubble Space Telescope and Very Large Telescope observations of a lensed galaxy. The light from a star-forming galaxy in a universe just 3 billion years old passed by a nearby galaxy, whose gravity acted as a lens, and bent the background galaxy's light into a blue circle.

Collett and colleagues first calculated the mass of the intervening galaxy by measuring the movements of stars within it. Then they measured the spatial curvature generated by each unit mass of the intervening galaxy. The mass inferred by spacetime curvature is precisely consistent with the mass measured by the stars, exactly as general relativity predicts.

Unlike previous lensing tests of relativity, Collett's team relied less on assumptions about the nature of the intervening galaxy. So this test is relatively free of systematic uncertainties that have plagued previous studies.
..Read More...

Hayabusa 2: Welcome to Ryugu

Hayabusa 2's Optical Navigation Camera captured this image of Ryugu on June 26, 2018. JAXA / University of Tokyo and collaborators

After a 3½-year journey, Japan's Hayabusa 2 spacecraft has arrived at its home for the next 18 months: the small, oddly-shaped asteroid Ryugu.

We got a peek at a new worldlet in the inner solar system this week, as the Japanese Aerospace Exploration Agency's (JAXA's) Hayabusa 2 returned its first good look at the half-mile-wide asteroid 162173 Ryugu.

Hayabusa 2's view of Ryugu has expanded this past week, zooming in on a world that looks like a multifaceted die straight out of Dungeons and Dragons. There's a bifurcated pole, an as-yet unnamed singular large crater crossing its equatorial bulge, and plenty of boulders strewn about its surface.

The Approach

JAXA officials announced the spacecraft's arrival at Ryugu on June 27th at 00:35 Universal Time (June 26th at 8:35 p.m. EDT). Hayabusa 2 approached Ryugu via a slow corkscrew-like path over this past week, slowly scanning the region surrounding the asteroid for any potential moonlet companions that might have posed a hazard. With a diameter of only 1 kilometer (0.6 mile) along its longest axis, Ryugu's sphere of gravitational dominance extends only 90 km from its surface. Hayabusa 2 won't orbit Ryugu so much as keep pace with it as the two orbit the Sun. The spacecraft is currently hovering 20 km away.

Welcome to Ryugu

The space rock was discovered by the Lincoln Near-Earth Asteroid Research (LINEAR) survey on the night of May 10, 1999, and provisionally designated 1999 JU3 before receiving a number and being renamed Ryugu ("Dragon's Palace" from a Japanese folktale) in late 2015.

Ryugu is an Apollo-group asteroid, dubbed "potentially hazardous" because of its potential to pass as close to Earth as 95,400 km, about a fifth of the Moon's distance. However, it won't be hazardous any time ...Read More...

'Oumuamua Was a Comet After All

An artist's impression shows 'Oumuamua as a comet.
ESA / Hubble / NASA / ESO / M. Kornmesser

Researchers have found that 'Oumuamua — the first confirmed object to enter the solar system from interstellar space — was a comet, releasing just enough gas to subtly change its course.

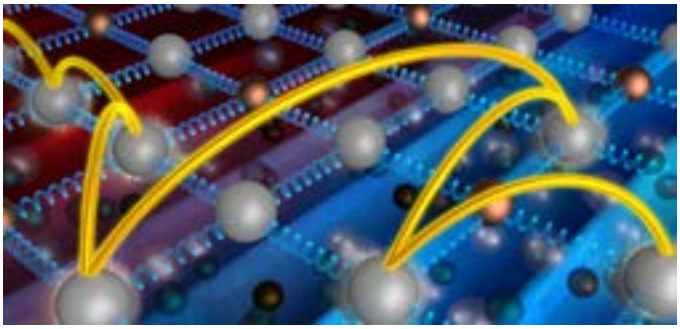
In October 2017 the robotic telescope Pan-STARRS in Hawai'i detected an unusual object entering the solar system from interstellar space. In the days after the discovery, every available telescope, including Hubble, was aimed at the interloper to collect as much information as possible before it left our system. Since then, astronomers worldwide have been reviewing the observations, trying to squeeze as much knowledge as possible about the unexpected visitor.

Named 'Oumuamua ("first scout" or "first visitor" in Hawaiian), this envoy from the stars appeared to have the form of an elongated cigar — or a flattened pancake, depending whom you ask — 800 meters (0.5 mile) long and 10 times thinner. It came tumbling into the solar system from above the plane of the planets, only to have its path changed by the by the Sun's gravitational pull before leaving out system again, never to return.

Since its detection, astronomers have had a hard time determining what 'Oumuamua is made of. It passed very close to the Sun, within Mercury's orbit, yet it didn't show any signs of outgassing, such as a cloudlike coma or tail — signatures that would have revealed an icy composition akin to the solar system's comets. Instead, 'Oumuamua looked like an inactive, dark-red, solid chunk. Astronomers thought it was probably made of solid rock weathered by space radiation, an asteroid kicked out from a planetary system forming beyond our own.

But an international team of astronomers led by Marco Micheli (ESA SSA-NEO Coordination Centre, Italy) has found unexpected clues about 'Oumuamua's nature by looking carefully at the path it followed in and out of our system. This path didn't quite fit what was expected of a body solely influenced by the gravitational pull of the Sun, planets, and large asteroids. The team observed small deviations that pointed to the action of a non-gravitational force. ...Read More...

New insights bolster Einstein's idea about how heat moves through solids



New research about the transfer of heat--fundamental to all materials--suggests that in thermal insulators, heat is conveyed by atomic vibrations and by random hopping of energy from atom to atom. This finding by Oak Ridge National Laboratory could introduce new materials as thermal energy barriers to drastically reduce energy costs, carbon emissions and waste heat. Credit: Jill Hemman and Adam Malin/Oak Ridge National Laboratory, US Dept. of Energy

A discovery by scientists at the Department of Energy's Oak Ridge National Laboratory supports a century-old theory by Albert Einstein that explains how heat moves through everything from travel mugs to engine parts.

The transfer of heat is fundamental to all materials. This new research, published in the journal Science, explored thermal insulators, which are materials that block transmission of heat.

"We saw evidence for what Einstein first proposed in 1911—that heat energy hops randomly from atom to atom in thermal insulators," said Lucas Lindsay, materials theorist at ORNL. "The hopping is in addition to the normal heat flow through the collective vibration of atoms."

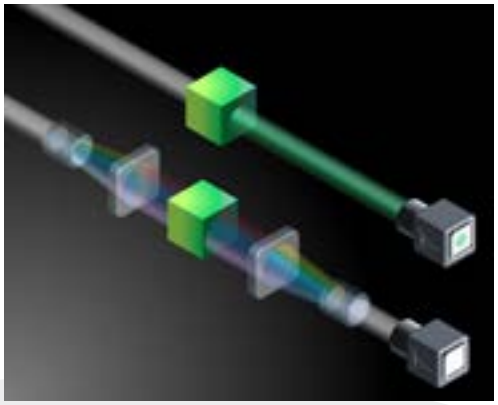
The random energy hopping is not noticeable in materials that conduct heat well, like copper on the bottom of saucepans during cooking, but may be detectable in solids that are less able to transmit heat.

This observation advances understanding of heat conduction in thermal insulators and will aid the discovery of novel materials for applications from thermoelectrics that recover waste heat to barrier coatings that prevent transmission of heat.

Lindsay and his colleagues used sophisticated vibration-sensing tools to detect the motion of atoms and supercomputers to simulate the journey of heat through a simple thallium-based crystal. Their analysis revealed that the atomic vibrations in the crystal lattice were too sluggish to transmit much heat.

"Our predictions were two times lower than we observed from our experiments. We were initially baffled," Lindsay said. "This led to the observation that another heat transfer mechanism must be at play." ...Read More...

Spectral cloaking could make objects invisible under realistic conditions



A broadband wave illuminates an object, which reflects green light in the shown example, making the object detectable by an observer monitoring the wave. A spectral invisibility cloak transforms the blocked color (green) into other colors of the wave's spectrum. The wave propagates unaltered through the object, without 'seeing its color' and the cloak subsequently reverses the previous transformation, making the object invisible to the observer. Credit: Luis Romero Cortés and José Azaña, Institut National de la Recherche Scientifique

Researchers and engineers have long sought ways to conceal objects by manipulating how light interacts with them. A new study offers the first demonstration of invisibility cloaking based on the manipulation of the frequency (color) of light waves as they pass through an object, a fundamentally new approach that overcomes critical shortcomings of existing cloaking technologies.

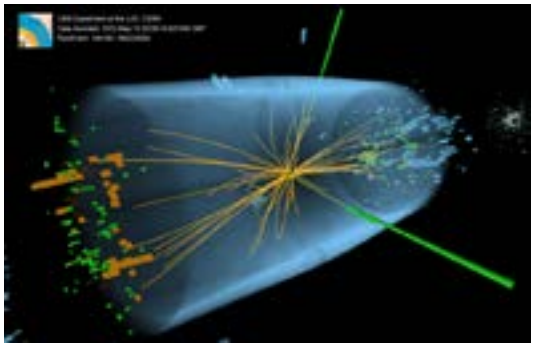
The approach could be applicable to securing data transmitted over fiber optic lines and also help improve technologies for sensing, telecommunications and information processing, researchers say. The concept, theoretically, could be extended to make 3-D objects invisible from all directions; a significant step in the development of practical invisibility cloaking technologies.

Most current cloaking devices can fully conceal the object of interest only when the object is illuminated with just one color of light. However, sunlight and most other light sources are broadband, meaning that they contain many colors. The new device, called a spectral invisibility cloak, is designed to completely hide arbitrary objects under broadband illumination.

The spectral cloak operates by selectively transferring energy from certain colors of the light wave to other colors. After the wave has passed through the object, the device restores the light to its original state. Researchers demonstrate the new approach in Optica, The Optical Society's journal for high impact research.

"Our work represents a breakthrough in the quest for invisibility cloaking," said José Azaña, National Institute of Scientific Research (INRS), Montréal, Canada. "We have made a target object fully invisible to observation under realistic broadband illumination by ...Read More...

Study provides insight into the physics of the Higgs particle



A graphic shows particle traces extending from a proton-proton collision at the Large Hadron Collider in 2012. The event shows characteristics expected from the decay of the Standard Model Higgs boson to a pair of photons. Further analysis of collisions in 2011 and 2012 has found evidence that the Higgs also decays into fermion particles, according to a new paper in Nature Physics to which Rice University scientists contributed. Credit: CERN

Physicists at the University of Bonn have succeeded in putting a superconducting gas into an exotic state. Their experiments allow new insights into the properties of the Higgs particle, but also into fundamental characteristics of superconductors. The publication, which is already available online, will soon appear in the journal Nature Physics.

For their experiments, scientists at the University of Bonn used a gas made of lithium atoms, which they cooled down significantly. At a certain temperature, the state of the gas changes abruptly: It becomes a superconductor that conducts a current without any resistance. Physicists also speak of a phase transition. A similar sudden change occurs with water when it freezes.

The lithium gas changes to a more orderly state at its phase transition. This includes the formation of so-called Cooper pairs, which are combinations of two atoms that behave like a single particle to the outside.

Partner-dancing atoms

These pairs behave fundamentally differently from individual atoms: They move together and can do so without scattering on other atoms or pairs. This is the reason for the superconductivity. But what happens when you try to excite the pairs?

"We illuminated the gas with microwave radiation," explains Prof. Dr. Michael Köhl from the Physics Institute at the University of Bonn. "This allowed us to create a state in which the pairs start to vibrate and the quality of the superconductivity therefore oscillated very quickly: One moment the gas was a good superconductor, the next a bad one."

This common oscillation of the Cooper pairs corresponds to the Higgs boson discovered at the CERN Accelerator in 2013. As this state is very unstable ...Read More...

AI recreates chemistry's periodic table of elements

A Stanford team has developed an artificial intelligence program that recreated the period table of elements; they aim to harness that tool to discover and design new materials. Credit: Claire Scully

It took nearly a century of trial and error for human scientists to organize the periodic table of elements, arguably one of the greatest scientific achievements in chemistry, into its current form.

A new artificial intelligence (AI) program developed by Stanford physicists accomplished the same feat in just a few hours.

Called Atom2Vec, the program successfully learned to distinguish between different atoms after analyzing a list of chemical compound names from an online database. The unsupervised AI then used concepts borrowed from the field of natural language processing – in particular, the idea that the properties of words can be understood by looking at other words surrounding them – to cluster the elements according to their chemical properties.

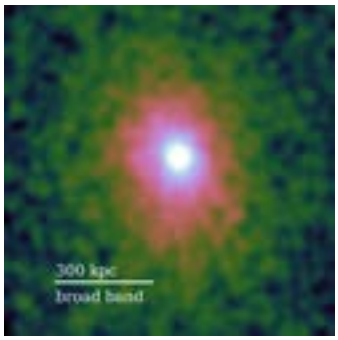
"We wanted to know whether an AI can be smart enough to discover the periodic table on its own, and our team showed that it can," said study leader Shou-Cheng Zhang, the J. G. Jackson and C. J. Wood Professor of Physics at Stanford's School of Humanities and Sciences.

Zhang says the research, published in the June 25 issue of Proceedings of the National Academy of Sciences, is an important first step toward a more ambitious goal of his, which is designing a replacement to the Turing test – the current gold standard for gauging machine intelligence.

In order for an AI to pass the Turing test, it must be capable of responding to written questions in ways that are indistinguishable from a human. But Zhang thinks the test is flawed because it is subjective. "Humans are the product of evolution and our minds are cluttered with all sorts of irrationalities. For an AI to pass the Turing test, it would need to reproduce all of our human irrationalities," Zhang said. "That's very difficult to do, and not a particularly good use of programmers' time."

Zhang would instead like to propose a new benchmark of machine intelligence. "We want to see if we can design an AI that can beat humans in discovering ...Read More...

Huge Galaxy Cluster Found Hiding in Plain Sight



Chandra broadband image of PKS1353-341, showing the bright center and the surrounding diffuse cluster.
Credit: NASA/CXC/MIT

For the first time, astronomers have discovered a galaxy cluster that was hiding in plain sight, not far from the Milky Way.

This finding might help reveal how the supermassive black holes that likely exist at the hearts of most galaxy clusters influence the clusters' evolution, researchers on the new study said.

Galaxy clusters are collections of hundreds to thousands of galaxies bound together by gravity. The nearest cluster to the Milky Way is the Virgo cluster, which holds about 2,000 galaxies and is located about 65 million light-years away from Earth, NASA officials said on an image page.

In 2012, astronomers discovered the Phoenix cluster, the brightest in X-ray light of any cluster found yet. Located about 7 billion light-years away from Earth, the Phoenix cluster is named after the constellation in which it dwells.

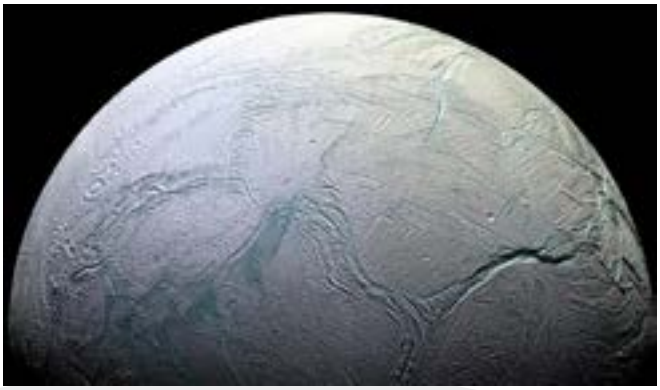
Further investigation revealed that prior work had detected this giant but had not recognized it as a cluster; its central galaxy was so bright in X-rays that scientists had misidentified it as a single bright spot instead of the heart of a cluster. This led the new study's researchers to wonder how many similar clusters might have escaped detection,they said.

Now, the researchers have discovered a Phoenix-like cluster located about 2.4 billion light-years from Earth around a quasar named PKS1353-341. They estimated that the cluster has a mass equal to about 690 trillion times that of Earth's sun; in comparison, recent estimates of the Milky Way's mass range between 400 billion and 780 billion times that of the sun.

The central galaxy of this cluster is incredibly bright: about 46 billion times more luminous than Earth's sun. The most likely source of all this energy is an extraordinarily hot disk of matter whirling into a supermassive black hole millions of times the mass of the sun, the researchers said.

This is the first result of the Clusters Hiding in Plain Sight (CHiPS) survey, which analyzes data ...Read More...

Scientists find evidence of complex organic molecules from Enceladus



Saturn's moon Enceladus. Credit: NASA

Using mass spectrometry data from NASA's Cassini spacecraft, scientists found that large, carbon-rich organic molecules are ejected from cracks in the icy surface of Saturn's moon Enceladus. Southwest Research Institute scientists think chemical reactions between the moon's rocky core and warm water from its subsurface ocean are linked to these complex molecules.

"We are, yet again, blown away by Enceladus. Previously we'd only identified the simplest organic molecules containing a few carbon atoms, but even that was very intriguing," said SwRI's Dr. Christopher Glein, a space scientist specializing in extraterrestrial chemical oceanography. He is coauthor of a paper in Nature outlining this discovery. "Now we've found organic molecules with masses above 200 atomic mass units. That's over ten times heavier than methane. With complex organic molecules emanating from its liquid water ocean, this moon is the only body besides Earth known to simultaneously satisfy all of the basic requirements for life as we know it."

Prior to its deorbit in September of 2017, Cassini sampled the plume of material emerging from the subsurface of Enceladus. The Cosmic Dust Analyzer (CDA) and the SwRI-led Ion and Neutral Mass Spectrometer (INMS) made measurements both within the plume and Saturn's E-ring, which is formed by plume ice grains escaping Enceladus' gravity.

"Even after its end, the Cassini spacecraft continues to teach us about the potential of Enceladus to advance the field of astrobiology in an ocean world," Glein said. "This paper demonstrates the value of teamwork in planetary science. The INMS and CDA teams collaborated to reach a deeper understanding of the organic chemistry of Enceladus' subsurface ocean than would be possible with only one data set."

During Cassini's close flyby of Enceladus on Oct. 28, 2015, INMS detected molecular hydrogen as the spacecraft flew through the plume. Previous flybys provided evidence for a global subsurface ocean ...Read More...

Special Read:

A satellite with a harpoon, net and drag sail to capture space junk is in orbit and will be tested soon

The RemoveDebris satellite deployed from the International Space Station on June 20. Credit: NASA/NanoRacks/Ricky Arnold

After almost 70 years of spaceflight, space debris has become a rather serious problem. This junk, which floats around in low Earth orbit (LEO), consists of the spent first rocket stages and non-functioning satellites and poses a major threat to long-term missions like the International Space Station and future space launches. And according to numbers released by the Space Debris Office at the European Space Operations Center (ESOC), the problem is only getting worse.

In addition, space agencies and private aerospace companies hope to launch considerably more in the way of satellites and space habitats in the coming years. As such, NASA has begun experimenting with a revolutionary new idea for removing space debris. It is known as the RemoveDebris spacecraft, which recently deployed from the ISS to conduct a series of active debris removal (ADR) technology demonstrations.

This satellite was assembled by Surrey Satellite Technology Ltd. and the Surrey Space Center (at the University of Surrey in the UK) and contains experiments provided by multiple European aerospace companies. It measures roughly 1 meter (3 feet) on a side and weighs about 100 kg (220 lbs), making it the largest satellite deployed to the ISS to date.

The purpose of the RemoveDebris spacecraft is to demonstrate the effectiveness of debris nets and harpoons at capturing and removing space debris from orbit. As Sir Martin Sweeting, the Chief Executive of SSTL, said in a recent statement:

"SSTL's expertise in designing and building low cost, small satellite missions has been fundamental to the success of RemoveDEBRIS, a landmark technology demonstrator for active debris removal missions that will begin a new era of space junk clearance in Earth's orbit." ...Read More...

This Week's Sky at a Glance
June 30 - July 06, 2018

Jun 30	**Sa**	06:43	Moon Apogee: 406100 km
		20:44	Moon Descending Node
Jul 04	**We**	09:39	Mercury-Beehive: 0.6° S
Jul 06	**Fr**	11:51	Last Quarter
		20:59	Aphelion: 1.0167 AU

Asteroid Day
June 30, 2018
Daily Activities (June 24-30, 2018)

Asteroid Vesta Observed by the Sharjah Observatory

To celebrate the "Asteroid Day June 30, 2018", the Sharjah Observatory of the Sharjah Center for Astronomy and Space Sciences has observed the asteroid Vesta since the mid of June 2018. The above image was taken by our observatory specialist Mohamed Talafha during a 215 minutes tracking period on June 12. A picture of the asteorid was taken every 15 minutes to show how it moved.

The asteorid was observed every night from June 24 to June 27 to allow the general public to attend our daily night observation of the asteroid and to explain its overall motion.

Vesta, minor-planet designation 4 Vesta, is one of the largest objects in the asteroid belt, with a mean diameter of 525 kilometres (326 mi).[7] It was discovered by the German astronomer Heinrich Wilhelm Olbers on 29 March 1807[5] and is named after Vesta, the virgin goddess of home and hearth from Roman mythology.