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Astronomy & Physics Weekly News

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Top News

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Gravitational waves created by black holes in the centre of most galaxies

Sagittarius A*, the black hole at the centre of our own galaxy. Credit: NASA/CXC/MIT/F. Baganoff et al.

Gravitational waves may be forged in the heart of the galaxy, says a new study led by PhD student Joseph Fernandez at Liverpool John Moores University. He sets out the work in a presentation on 3rd April at the European Week of Astronomy and Space Science in Liverpool. Gravitational waves (GWs) are small ripples in space-time that spread throughout the universe.

When there is a change in air pressure on Earth, this change moves outwards in the form of sound waves. Analogously, when pairs of compact objects - like black holes (BHs) or neutron stars (NSs) - form binaries and rotate around one another, the gravitational field around them changes, producing GWs that also move outwards.

This phenomenon was predicted by Albert Einstein in 1915. The amplitude of these ripples was predicted to be so small that Einstein thought they would never be detected. However in 2015, a century after making the prediction, GWs were observed directly for the first time

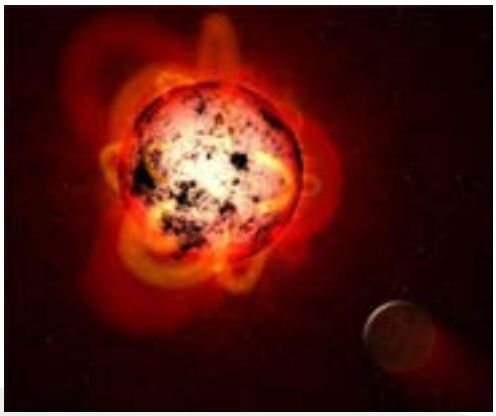
These originated from a pair of stellar mass black holes (around 30 times the mass of the Sun each), which fell together, and eventually merged.

Since then, another four confirmed observations of GWs have been reported to originate from these systems, and with the LIGO and VIRGO improvements currently underway, we expect to see many more in the near future.

These observations show that BH mergers are commonplace in the Universe. However, we are still not sure how these sort of binary systems form. This is because they need to be on very close or very eccentric orbits in order to collapse in such a way that GWs are observable.

Fernandez and colleagues, including another PhD student Brown, have shown that the orbits of binaries can be changed by the black hole that lies in the centre of most galaxies, including our own. ...Read More...

X-rays could sterilise alien planets in otherwise habitable zones



Artist's impression of a red dwarf star orbited by an exoplanet. Credit: NASA/ESA/G. Bacon (STScI).

Intense radiation could strip away the ozone layer of Earth-like planets around other stars and render them uninhabitable, according to a new study led by Dr Eike Guenther of the Thueringer Observatory in Germany.

Dr Guenther sets out the work in a presentation on 3rd April at the European Week of Astronomy and Space Science in Liverpool.

Astronomers now know of around 4000 planets in orbit around other stars. A handful of these are both Earth-sized and in the habitable zones of the stars they orbit, where the temperature is right for liquid water.

But many candidate Earth-sized worlds are in orbit around red dwarf stars, much smaller and cooler than our own. To be in the habitable zone, the planets need to be much closer to their stars than we are to the Sun.

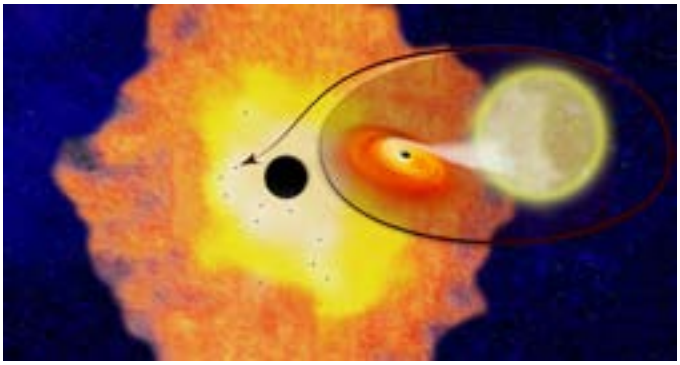
The problem, however, is that red dwarfs can produce significant X-ray emission, and often have large flares of radiation and eruptions of particles in so-called coronal mass ejections (CMEs).

To try to assess the risk, Guenther and his collaborators are intensively monitoring low-mass stars where flares might take place.

In February 2018, they observed a giant flare from the star AD Leo, located 16 light years away in the constellation of Leo. AD Leo has a giant planet orbiting 3 million kilometres away (fifty times closer than the Earth to the Sun), and it may have Earth-sized worlds further out in its habitable zone.

The astronomers are working to establish what the flare did to the known giant planet and any hypothetical planets further out. Their initial results suggest the giant planet was unaffected, and that unlike similar events on the Sun, the radiation flare was not accompanied by a CME. ..Read More...

Vast Black Hole Swarm May Surround Milky Way's Heart



The supermassive black hole at the center of the Milky Way is surrounded by a swarm of smaller black holes, according to new research. Scientists were able to pinpoint at least 12 black hole binaries, where a black hole is siphoning material from a companion star. Credit: Columbia University

A swarm of thousands of black holes may surround the giant black hole at the heart of our galaxy, a new study finds.

At the hearts of most, if not all, galaxies are supermassive black holes with masses that are millions to billions of times that of the sun. For example, at the center of our galaxy, the Milky Way, lies Sagittarius A*, which is about 4.5 million solar masses in size.

A key way in which scientists think supermassive black holes grow is by engulfing stellar-mass black holes each equal in mass to a few suns. Learning how that growth process works is vital to understanding the effects they can have on the evolution of their galaxies.

For decades, astronomers have looked for up to 20,000 black holes that previous research predicted should be concentrated around the Milky Way's core. Sagittarius A* is surrounded by a halo of gas and dust that provides the perfect breeding ground for massive stars, which can then give rise to black holes after they die, said study lead author Chuck Hailey, co-director of the astrophysics lab at Columbia University in New York. In addition, the powerful gravitational pull of Sagittarius A* can pull in black holes from outside this halo, he added.

"The Milky Way is really the only galaxy we have where we can study how supermassive black holes interact with little ones because we simply can't see their interactions in other galaxies," Hailey said in a statement. "In a sense, this is the only laboratory we have to study this phenomenon.

However, until now, researchers failed to detect such a heavy concentration of black holes, called a "density cusp." "There are only about five dozen known black holes in the entire galaxy — 100,000 light-years wide — and there are supposed to be 10,000 to 20,000 of these things in a region just six light-years wide that no one has been able to find," Hailey said in the statement. ...Read More...

3D Map Dices Space-Time to Reveal Thousands of Early Galaxies

The COSMOS field in the constellation of Sextans is seen here in infrared light. This region is associated with the part of the sky analyzed by David Sobral of Lancaster University and his research team. Credit: ESO/UltraVISTA team/TERAPIX/CNRS/INSU/CASU

Astronomers have produced one of the largest 3D maps of the young universe, where they pinpoint 4,000 early galaxies from the ancient past — many of which may resemble the Milky Way in its infancy.

The researchers can look into the past like this because of the time it takes light to travel large, cosmic distances. Light quickly fills a room when a lamp turns on, but the light from faraway galaxies can take billions of years to reach the eyes of an observer standing on Earth. So, the objects or events someone sees through a telescope may have actually happened eons ago. Telescopes, therefore, can act as time machines for scientists.

"We used large amounts of data ... to literally slice the universe in cosmic time and time-travel to the distant past with 16 well-defined cosmic-time destinations," said Sergio Santos, a team researcher at Lancaster University in the United Kingdom, in a recent statement about the findings.

In two new studies, the team of astronomers peered back in time to 16 different epochs between 11 billion and 13 billion years ago. They found light coming from galaxies that existed when the universe was only 7 percent to 20 percent of its current age, the statement said.

To pinpoint these ages, the researchers looked at universal expansion. In general, scientists use the expansion of the universe to determine from which epoch, or from how long ago, light originates. As the universe expands, the light traveling from any one of these 4,000 galaxies gets stretched on its journey to Earth. This caused the wavelength of the light to become redder, a phenomenon known as redshift. Because the redshift is tied to how far away a galaxy is, researchers can use filters to measure particular wavelengths of light and then deduce how far back in time the light is coming from. ..Read More...

Once we can capture CO2 emissions, here's what we could do with it

This figure shows the proposed timeline of CO2 utilization methods.

The thousands of metric tons of carbon dioxide (CO2) emitted from power plants each year doesn't have to go into the atmosphere. Researchers are optimistic that within the next decade we will be able to affordably capture CO2 waste and convert it into useful molecules for feedstock, biofuels, pharmaceuticals, or renewable fuels. On March 29 in the journal Joule, a team of Canadian and US scientists describe their vision for what we should make with CO2 and how we can make it.

"Similar to how a plant takes carbon dioxide, sunlight, and water to make sugars for itself, we are interested in using technology to take energy from the sun or other renewable sources to convert CO2 into small building block molecules which can then be upgraded using traditional means of chemistry for commercial use," says Phil De Luna, a PhD candidate in materials science.

"We're taking inspiration from nature and doing it faster and more efficiently."

De Luna is first author on the paper along with postdoctoral fellow Oleksandr Bushuyev, both of whom are members of the Edward Sargent Lab at the University of Toronto. Sargent, the senior author, is a professor in the Department of Electrical and Computer Engineering.

Their analysis identified a series of possible small molecules that make economic sense and could be made by converting captured CO2. For energy storage needs, hydrogen, methane, and ethane could be used in biofuels.

Additionally, ethylene and ethanol could serve as the building blocks for a range of consumer goods, and CO2-derived formic acid could be used by the pharmaceutical industry or as a fuel in fuel cells.

While current technologies that can capture CO2 waste are still in their infancy, with new start-ups currently developing strategies for commercial use, the researchers envision that the coming decades will bring major improvement to make CO2 capture and conversion a reality. ...Read More...

Finding order in disorder demonstrates a new state of matter

Cristiano Nisoli. Credit: Los Alamos National Laboratory

Physicists have identified a new state of matter whose structural order operates by rules more aligned with quantum mechanics than standard thermodynamic theory. In a classical material called artificial spin ice, which in certain phases appears disordered, the material is actually ordered, but in a "topological" form.

"Our research shows for the first time that classical systems such as artificial spin ice can be designed to demonstrate topological ordered phases, which previously have been found only in quantum conditions," said Los Alamos National Laboratory physicist Cristiano Nisoli, leader of the theoretical group that collaborated with an experimental group at the University of Illinois at Urbana-Champaign, led by Peter Schiffer (now at Yale University).

Physicists generally classify the phases of matter as ordered, such as crystal, and disordered, such as gases, and they do so on the basis of the symmetry of such order, Nisoli said.

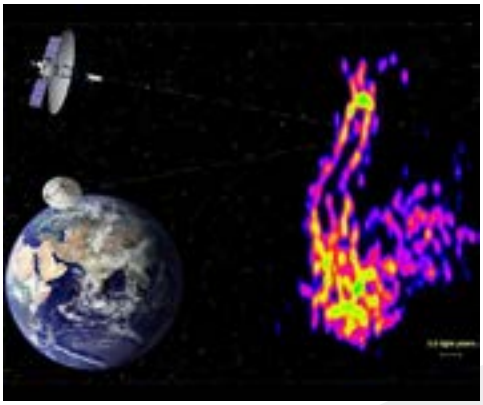
"The demonstration that these topological effects can be designed into an artificial spin ice system opens the door to a wide range of possible new studies," Schiffer said.

Specialized material maintained puzzling energy levels in experiments

In the new research, the team explored a particular artificial spin ice geometry, called Shakti spin ice. While these materials are theoretically designed, this time, the discovery of its exotic, out-of-equilibrium properties proceeded from experiments to theory.

Performing photoemission electron microscopy characterization at the U.S. Department of Energy's Advanced Light Source at Lawrence Berkeley National Laboratory, Schiffer's team revealed something puzzling: Unlike other artificial spin ices, which could reach their low-energy state as temperature was reduced in successive quenches, Shakti spin ice stubbornly remained at about the same energy level. "The system gets stuck in a ...Read More...

A telescope larger than the Earth makes a sharp image of the formation of black hole jets



Artistic composition of the radio telescopes in space and on the ground observing NGC 1275, the central galaxy of the Perseus cluster of galaxies at a distance of 230 million light years. This radio image shows a newly forming jet that is about three light years long. The central black hole is inside the bright spot at the top of the image. The details visible in the image are smaller than the Oort's comet cloud around our solar system.

An international team of researchers has imaged newly forming jets of plasma from a massive black hole with unprecedented accuracy. Radio images made with a combination of telescopes in space and on the ground resolve the jet structure merely a couple of hundred black hole radii or 12 light days from its launching site. At the centres of all massive galaxies are black holes weighing as much as several billion times the mass of our sun. It has been known for long that some of these massive black holes eject spectacular plasma jets at a near speed-of-light that can extend far beyond the confines of their host galaxy.

But how these jets form in the first place has been a long-standing mystery. One of the main difficulties in studying them has been astronomers' inability to image the structure of the jets driven by the black hole close enough to their launching site so that direct comparison to theoretical and computational models of jet formation would be possible.

Now an international team of researchers from eight different countries has made ultra-high angular resolution images of the black hole jet at the centre of the giant galaxy NGC 1275, also known as radio source Perseus A or 3C 84. The researchers were able to resolve the jet structure ten times closer to the black hole in NGC 1275 than what has been possible before with ground-based instruments, revealing unprecedented details of the jet formation region.

"The results were surprising. It turned out that the observed width of the jet was significantly wider than what was expected in the currently favoured models where the jet is launched from the black hole's ergosphere - an area of space right next to a spinning black .Read More...

Computer searches telescope data for evidence of distant planets

illustration only

As part of an effort to identify distant planets hospitable to life, NASA has established a crowdsourcing project in which volunteers search telescopic images for evidence of debris disks around stars, which are good indicators of exoplanets.

Using the results of that project, researchers at MIT have now trained a machine-learning system to search for debris disks itself. The scale of the search demands automation: There are nearly 750 million possible light sources in the data accumulated through NASA's Wide-Field Infrared Survey Explorer (WISE) mission alone.

In tests, the machine-learning system agreed with human identifications of debris disks 97 percent of the time. The researchers also trained their system to rate debris disks according to their likelihood of containing detectable exoplanets. In a paper describing the new work in the journal Astronomy and Computing, the MIT researchers report that their system identified 367 previously unexamined celestial objects as particularly promising candidates for further study.

The work represents an unusual approach to machine learning, which has been championed by one of the paper's coauthors, Victor Pankratius, a principal research scientist at MIT's Haystack Observatory. Typically, a machine-learning system will comb through a wealth of training data, looking for consistent correlations between features of the data and some label applied by a human analyst - in this case, stars circled by debris disks.

But Pankratius argues that in the sciences, machine-learning systems would be more useful if they explicitly incorporated a little bit of scientific understanding, to help guide their searches for correlations or identify deviations from the norm that could be of scientific interest.

"The main vision is to go beyond what A.I. is focusing on today," Pankratius says. "Today, we're collecting data, and we're trying to find features in the data. You end up with billions and billions of features. So what are ...Read More...

Physicists zoom in on mysterious 'missing' antimatter

Researchers believe they are a step closer to solving the missing antiparticle mystery

When the Universe arose some 13.7 billion years ago, the Big Bang generated matter and antimatter particles in mirroring pairs. So the reigning physics theory goes.

Yet everything we can see in the Cosmos today, from the smallest insect on Earth to the largest star, is made of matter particles whose antimatter twins are nowhere to be found.

On Wednesday, physicists at Europe's massive underground particle lab said they have taken a step closer to solving the mystery through unprecedented observation of an antimatter particle they forged in the lab—an atom of "antihydrogen".

"What we're looking for is (to see) if hydrogen in matter and antihydrogen in antimatter behave in the same way," said Jeffrey Hangst of the ALPHA experiment at the European Organisation for Nuclear Research (CERN).

Finding even the slightest difference may help explain the apparent matter-antimatter disparity and would rock the Standard Model of physics—the mainstream theory of the fundamental particles that make up the Universe and the forces that govern them.

But, somewhat disappointingly, the latest, "most precise test to date", has found no difference between the behaviour of a hydrogen atom and that of an antihydrogen one. Not yet.

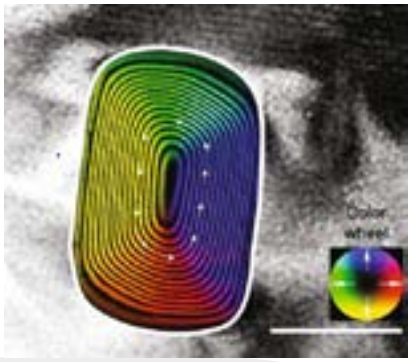
"So far, they look the same," Hangst said in a video prepared by CERN.

The Standard Model, which describes the makeup and behaviour of the visible Universe, has no explanation for "missing "antimatter.

It is widely assumed that the Big Bang generated pairs of matter-antimatter particles with the same mass but an opposite electric charge.

Trouble is, as soon as these particles meet, they annihilate one another, leaving behind nothing but pure energy—the principle that powers imaginary ...Read More...

Oldest magnetic record in the solar system discovered in a meteorit



Magnetic induction map of a magnetically non-uniform kamacite grain (consisting mostly of iron), which is encased within a dusty olivine crystal in a meteorite. The arrows and the color wheel indicate the direction of magnetic induction. Scale bar: 200 nm. Credit: Shah et al. Published in Nature Communications

Researchers have found that an iron-containing mineral called dusty olivine, present in meteorites, retains a record of the magnetic field from the early solar system around 4.6 billion years ago. The results are surprising, as the magnetism in dusty olivine is non-uniform, and non-uniform magnetic materials have previously been thought to be poor magnetic recorders. The discovery may lead to new insight into how the solar system formed—with the help of magnetic fields—from a protoplanetary disk.

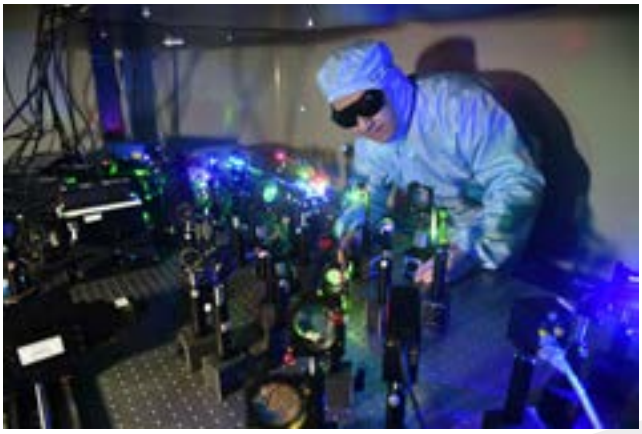
The researchers, Jay Shah and coauthors from the UK, Germany, and Norway, have published a paper on the discovery of the oldest magnetic record in a recent issue of Nature Communications.

"Our study shows that magnetic fields that were present during the birth of our solar system are credibly contained within meteorite samples that we have in our collections," Shah told Phys.org. "With a better understanding of these complex magnetization structures, we can access this magnetic field information, and deduce how our solar system evolved from a disk of dust to the planetary system we see today."

In the field of paleomagnetism, the main objects of study are ancient rocks and other materials which, as they cooled during their formation, acquired a thermoremanent magnetization imparted by the magnetic fields present at the time. By studying these magnetic materials, researchers can find clues as to what kinds of magnetic fields existed in the early solar system.

As the researchers explain in their paper, the underpinning hypothesis in paleomagnetism is Néel's single domain theory, which predicts that uniformly magnetized grains can retain their magnetic states over geological timescales. However, Néel's theory says nothing about non-uniformly magnetized grains, which are the most abundant form of magnetism present in rocks and meteorites. ..Read More...

Researchers develop nanoparticle films for high-density data storage



Researchers created a nanofilm that can store data holographically and is environmentally stable. Here, Shencheng Fu carries out experiments with the new film. Credit: Northeast Normal University

As we generate more and more data, the need for high-density data storage that remains stable over time is becoming critical. New nanoparticle-based films that are more than 80 times thinner than a human hair may help to fill this need by providing materials that can holographically archive more than 1000 times more data than a DVD in a 10-by-10-centimeter piece of film. The new technology could one day enable tiny wearable devices that capture and store 3-D images of objects or people.

"In the future, these new films could be incorporated into a tiny storage chip that records 3-D color information that could later be viewed as a 3-D hologram with realistic detail," said Shencheng Fu, who led researchers from Northeast Normal University in China who developed the new films. "Because the storage medium is environmentally stable, the device could be used outside or even brought into the harsh radiation conditions of outer space."

In the journal Optical Materials Express, the researchers detail their fabrication of the new films and demonstrate the technology's ability to be used for an environmentally-stable holographic storage system. The films not only hold large amounts of data, but that data can also be retrieved at speeds up to 1 GB per second, which is about twenty times the reading speed of today's flash memory.

Storing more data in less space

The new films are designed for holographic data storage, a technique that uses lasers to create and read a 3-D holographic recreation of data in a material. Because it can record and read millions of bits at once, holographic data storage is much faster than optical and magnetic approaches typically used for data storage today, which record and read individual bits one at a time. Holographic approaches are also inherently high-density because they record information throughout the 3-D volume of the material, not just on the surface, and can record multiple ...Read More...

From car engines to exoplanets

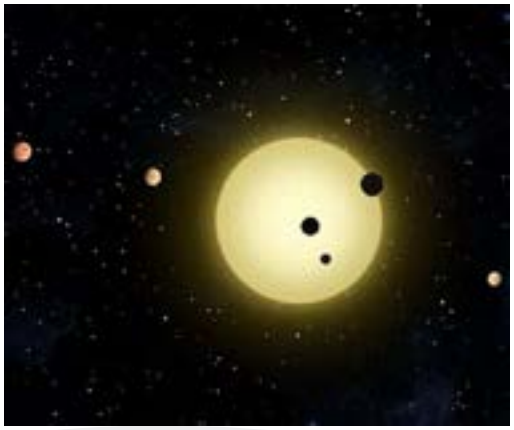


Illustration only

Chemical models developed to help limit the emission of pollutants by car engines are being used to study the atmospheres of hot exoplanets orbiting close to their stars. The results of a collaboration between French astronomers and applied combustion experts will be presented by Dr Oliva Venot and Dr Eric Hebrard at the European Week of Astronomy and Space Science (EWASS) 2018 in Liverpool.

Large planets similar to Neptune or Jupiter, orbiting 50 times closer to their star than the Earth does from the Sun, are thought to be composed of hydrogen-rich gas at temperatures between one and three thousand degrees Celsius, circulating at enormous speeds of nearly 10,000 kilometres per hour.

With these extreme conditions, the interplay of various physical processes, such as vertical transport, circulation or irradiation, can drive the atmospheres of these hot exoplanets out of chemical equilibrium, resulting in deviations that are difficult to explain through standard astrophysical models and observations.

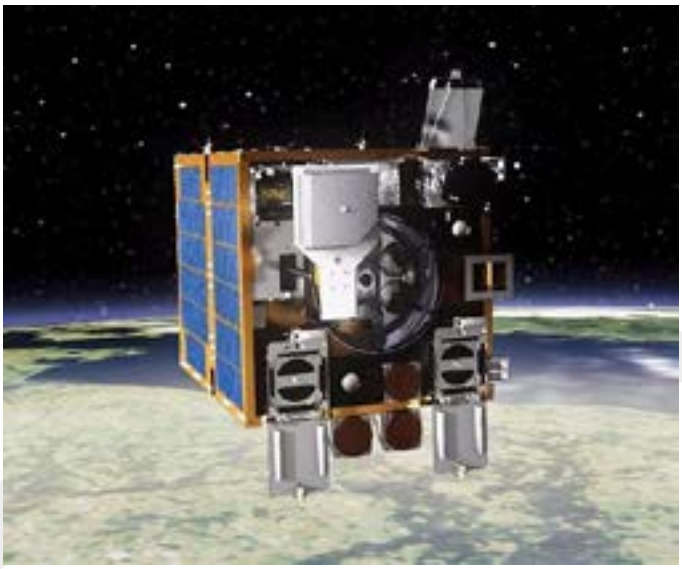
Venot, of the Laboratoire Interuniversitaire des Systemes Atmospheriques, explains: "The philosophy of our team in solving problems is to search for and import well-tried methods from any other field whenever they exist. Back in 2012, we first noticed the overlap of temperature and pressure conditions between the atmospheres of hot Jupiters and car engines.

"Chemical networks developed for car engines are very robust as a result of years of intense R and D, laboratory studies and validation through comparison with numerous measurements performed under various conditions. The car models are valid for temperatures up to over 2,000 degrees Celsius and a wide range of pressures, so are relevant to the study of a large diversity of warm and hot exoplanet atmospheres."

The project grew out of an initial collaboration between the Laboratoire d'Astrophysique de Bordeaux and the Laboratoire Reactions et Genie des ...Read More...

Special Read:

Space Maid: Robot Harpoon and Net System to Attempt Space Cleanup



View a detailed video presentation of this technology mission here

Humanity has grown accustomed to autonomous cleaning robots since the Roomba's debut in 2002. Now, we might have an upgrade: scientists have sent a prototype satellite equipped with a net and harpoon to the International Space Station to be tested. If successful, RemoveDEBRIS will lead to technology that will clean up Earth's space junk for us.

It's been 61 years since the first launch of a satellite, Sputnik 1, into Earth's orbit. That's a long time to go without cleaning up after yourself and scientists are raising concerns over the potential repercussions of the human junk floating through space - and crafting solutions, such as RemoveDEBRIS.

The project is funded by the European Commission and a number of private partners including Airbus, who supplied the harpoon, and Surrey Satellite Technology Limited, who built the spacecraft.

While not anywhere near as littered as Earth's oceans, our orbit maintains its share of trash - 16.5 million pounds (7,500 tons) of it, to be precise. According to a 2013 NASA press release, more than 500,000 pieces of trash whip around the planet at 17,500 mph. That number has likely increased since then, as launches have not ceased.

The debris comes in a variety of forms: rocket shells, spacecraft that have lost communication, screws, etc. According to the NASA, even a fleck of paint traveling at 17,500 mph poses a hazard to future missions in the event of a collision.

When it comes to the debris, size matters. As of 2013, more than 20,000 pieces of junk larger than a softball were in orbit, 500,000 pieces the size of a marble or larger and "many millions of pieces of debris that are so small they can't be tracked," according to NASA.

NASA's chief scientist for orbital debris, Nicholas Johnson, has said that the greatest risk to space missions "comes from non-trackable debris."

While all space vehicles are at risk from space junk, the International Space Station (ISS) is especially vulnerable, NASA said. RemoveDEBRIS was launched from Earth Monday with a SpaceX Falcon 9 rocket and is expected to arrive at the ISS Wednesday with a number of other supplies, Sputnik reported.

A few weeks after it arrives, astronauts will use the station's robotic arm to launch the 220-pound space Roomba. While China and Japan's space agencies have developed their own test cleaners, the harpoon-and-net system has never been tested in space.

Prof. Guglielmo Aglietti, the principal investigator for the mission, told the BBC that, while others have instead pursued robotic arms as a means to clean up Earth's orbit, "all these different technologies have their ...Read More...

Dark matter might not be interactive after all

Astronomers are back in the dark about what dark matter might be, after new observations showed the mysterious substance may not be interacting with forces other than gravity after all. Dr Andrew Robertson of Durham University will today (Friday 6 April) present the new results at the European Week of Astronomy and Space Science in Liverpool.

Three years ago, a Durham-led international team of researchers thought they had made a breakthrough in ultimately identifying what dark matter is. Observations using the Hubble Space Telescope appeared to show that a galaxy in the Abell 3827 cluster - approximately 1.3 billion light years from Earth - had become separated from the dark matter surrounding it.

Such an offset is predicted during collisions if dark matter interacts with forces other than gravity, potentially providing clues about what the substance might be. The chance orientation at which the Abell 3827 cluster is seen from Earth makes it possible to conduct highly sensitive measurements of its dark matter.

However, the same group of astronomers now say that new data from more recent observations shows that dark matter in the Abell 3827 cluster has not separated from its galaxy after all. The measurement is consistent with dark matter feeling only the force of gravity.

Lead author Dr Richard Massey, in the Centre for Extragalactic Astronomy, at Durham University, said: "The search for dark matter is frustrating, but that's science. When data improves, the conclusions can change.
...Read More...

Hubble Space Telescope image of the four giant galaxies at the heart of cluster Abell 3827. An almost three-hour exposure shows the view at wavelengths visible to the human eye, and the near infrared, as used in the original 2015 study. The distorted image of a more distant galaxy behind the cluster is faintly visible, wrapped around the four galaxies. Credit: NASA/ESA/Richard Massey (Durham University)

This Week's Sky at a Glance
Apr. 07-13, 2018

Apr 07	Sa	16:50	Moon-Saturn: 2.1° S
		18:37	Moon South Dec.: 20.3° S
		22:15	Moon-Mars: 3.5° S
Apr 08	Su	09:32	Moon Apogee: 404100 km
		11:18	Last Quarter
Apr 10	Tu	12:09	Moon Descending Node