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Astronomy & Physics Weekly News

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Top News

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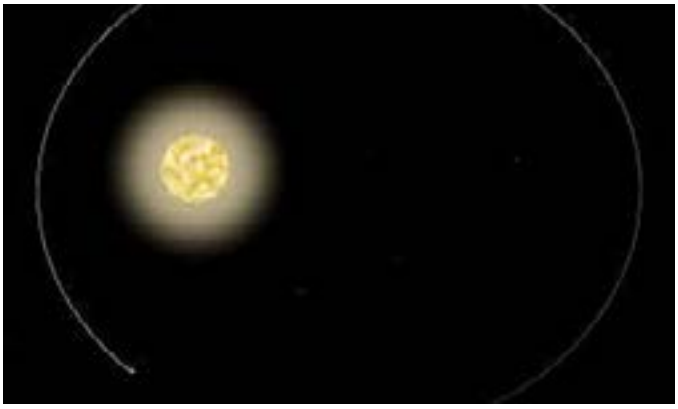
The heart of a far-off star beats for its planet



For the first time, astronomers have observed a star pulsing in response to its orbiting planet. The star, HAT-P-2, pictured, is one of the most massive exoplanets known today. The planet, named HAT-P-2b, tracks its star in a highly eccentric orbit, flying extremely close to and around the star, then hurtling far out before eventually circling back around. Image courtesy of NASA (edited by MIT News).

For the first time, astronomers from MIT and elsewhere have observed a star pulsing in response to its orbiting planet. The star, which goes by the name HAT-P-2, is about 400 light years from Earth and is circled by a gas giant measuring eight times the mass of Jupiter - one of the most massive exoplanets known today. The planet, named HAT-P-2b, tracks its star in a highly eccentric orbit, flying extremely close to and around the star, then hurtling far out before eventually circling back around.

The researchers analyzed more than 350 hours of observations of HAT-P-2 taken by NASA's Spitzer Space Telescope, and found that the star's brightness appears to oscillate ever so slightly every 87 minutes. In particular, the star seems to vibrate at exact harmonics, or multiples of the planet's orbital frequency - the rate at which the planet circles its star.

The precisely timed pulsations have lead the researchers to believe that, contrary to most theoretical model-based predictions of exoplanetary behavior, HAT-P-2b may be massive enough to periodically distort its star, making the star's molten surface flare, or pulse, in response.

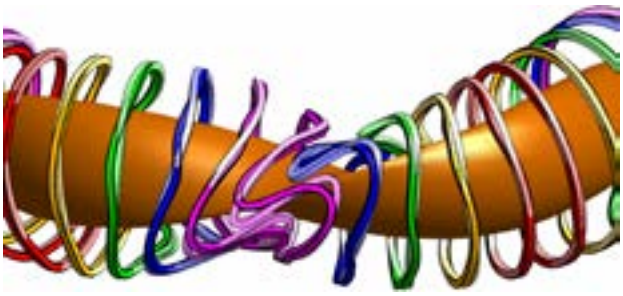
"We thought that planets cannot really excite their stars, but we find that this one does," says Julien de Wit, a postdoc in MIT's Department of Earth, Atmospheric and Planetary Sciences. "There is a physical link between the two, but at this stage, we actually can't explain it. So these are mysterious pulsations induced by the star's companion."

De Wit is a the lead author of a paper detailing the results, published this week in Astrophysical Journal Letters.

Getting a pulse

The team came upon the stellar pulsations by chance. Originally, the researchers sought to generate a precise map of an exoplanet's temperature ...Read More...

Physicists improve method for designing fusion experiments



Fusion experiments known as stellarators work by confining a mass of superheated plasma (orange horizontal mass) inside a magnetic field generated by external electromagnetic coils (multicolored vertical bands). A UMD physicist has made a revision to the software tools used to design these complex coil shapes, allowing researchers to create better designs with more room between the coils for repairs and instrumentation. The solid lines denote shapes made by the old software, while the dotted lines denote shapes made by the new software. Credit: Matt Landreman

"Measure twice, cut once" is an old carpenter's proverb—a reminder that careful planning can save time and materials in the long run.

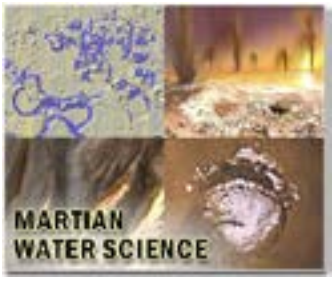
The concept also applies to the design of stellarators, which are complex nuclear fusion experiments meant to explore fusion's potential as an energy source. Stellarators work by confining a ring of blazing-hot plasma inside a precisely shaped magnetic field generated by external electromagnetic coils. When the plasma gets to several million degrees—as hot as the interior of the sun—atomic nuclei begin to fuse together, releasing massive amounts of energy.

Before turning a single bolt to build one of these rare and expensive devices, engineers create exacting plans using a series of algorithms. However, a wide variety of coil shapes can all generate the same magnetic field, adding levels of complexity to the design process. Until now, few researchers have studied how to choose the best among all potential coil shapes for a specific stellarator.

University of Maryland physicist Matt Landreman has made an important revision to one of the most common software tools used to design stellarators. The new method is better at balancing tradeoffs between the ideal magnetic field shape and potential coil shapes, resulting in designs with more space between the coils. This extra space allows better access for repairs and more places to install sensors. Landreman's new method is described in a paper published February 13, 2017 in the journal Nuclear Fusion.

"Instead of optimizing only the magnetic field shape, this new method considers the complexity of the coil shapes simultaneously. So there is a bit of a tradeoff," said Landreman, an assistant research scientist at the ...Read More....

Scientists say Mars valley was flooded with water not long ago



File Image.

Researchers have discovered the signature of periodic groundwater flooding in a Martian valley -- further evidence that water flowed on Mars in the not-so-distant past.

Researchers from Trinity College Dublin suggest the patch of land on the Red Planet would be an ideal spot to search for signs of life.

"On Earth, desert dunefields are periodically flooded by water in areas of fluctuating groundwater, and where lakes, rivers and coasts are found in proximity. These periodic floods leave tell-tale patterns behind them," Mary Bourke, a geomorphologist at Trinity, said in a news release. "You can imagine our excitement when we scanned satellite images of an area on Mars and saw this same patterned calling card, suggesting that water had been present in the relatively recent past."

The patterns discovered by Bourke and her colleagues are known as arcuate striations. Bourke first studied the phenomenon in the Namib Desert in Southern Africa. The striations are geochemically formed. As groundwater evaporates, salts interact with the sands to form cemented ridges.

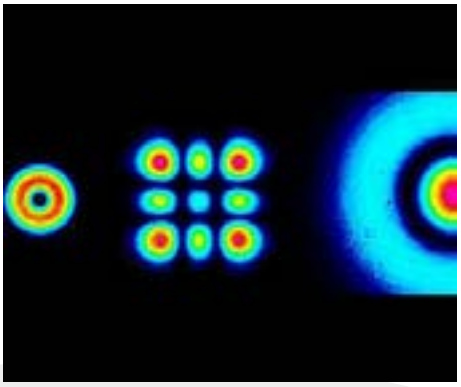
The layered cement ridges, which extend beneath the surface, remain even as sand dunes drift downwind.

"Following our work in Namibia, we hypothesise that on Mars, similar arcuate striations exposed on the surface between dunes are also indications of fluctuating levels of salty groundwater, during a time when dunes were actively migrating down the valley," Bourke said.

Their discovery, detailed in the journal Geophysical Research Letters, proved their hypothesis correct.

"These findings are hugely significant," Bourke added. "Firstly, the Martian sand dunes show evidence that water may have been active near Mars' equator -- potentially in the not-too-distant past. And secondly, this location is now a potential geological target for detecting past life forms on the Red Planet, which is important to those involved in selecting sites for future missions." ...Read More...

A new technique for creation of entangled photon states developed



These are photon beams. Photo was taken by CCD-matrix. Image courtesy Egor Kovlakov.

Members of the Faculty of Physics, the Lomonosov Moscow State University have elaborated a new technique for creation of entangled photon states, exhibiting photon pairs, which get correlated (interrelated) with each other. Scientists have described their research in an article, published in the journal Physical Review Letters.

Physicists from the Lomonosov Moscow State University have studied an entangled photon state, in which the state is determined only for the whole system and not for each separate particle.

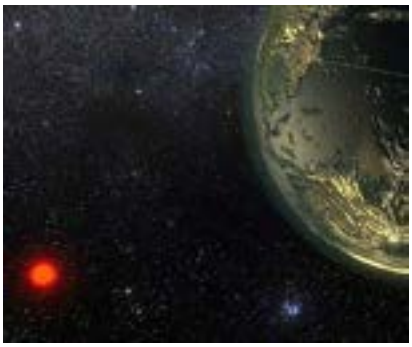
Stanislav Straupe, Doctor of Sciences in Physics and Mathematics, a member of the Quantum Electronics Department and Quantum Optical Technologies Laboratory at the Faculty of Physics, the Lomonosov Moscow State University, and one of the article co-authors says the following.

He explains: "Entangled states are typical and general. The only problem is in the point that for the majority of particles interaction with the environment destroys the entanglement. And photons hardly ever interact with other particles, thus they are a very convenient object for experiments in this sphere. The largest part of light sources we face in our life is a classical one - for instance, the Sun, stars, incandescent lamps and so on. Coherent laser radiation also belongs to the classical part. To create nonclassical light isn't an easy thing. You could, for instance, isolate a single atom or an artificial structure like a quantum dot and detect its radiation - this is the way for single photons obtaining."

An effect of spontaneous parametric down-conversion in nonlinear crystal is most commonly used for obtaining of entangled photon states. In this process a laser pumping photon splits into two.

As this takes place photon states get correlated, entangled due to the conservation laws. Egor Kovlakov, a doctoral student from the Quantum Electronics Department at the Radio Physics Division of the Faculty ...Read More...

Scientists make huge dataset of nearby stars available to public



"There seems to be no shortage of exoplanets," says Jennifer Burt, a Torres postdoctoral fellow in MIT's Kavli Institute for Astrophysics and Space Research. "There are a ton of them out there, and a ton of science to be done." Image courtesy Ricardo Ramirez.

The search for planets beyond our solar system is about to gain some new recruits. Today, a team that includes MIT and is led by the Carnegie Institution for Science has released the largest collection of observations made with a technique called radial velocity, to be used for hunting exoplanets. The huge dataset, taken over two decades by the W.M. Keck Observatory in Hawaii, is now available to the public, along with an open-source software package to process the data and an online tutorial.

By making the data public and user-friendly, the scientists hope to draw fresh eyes to the observations, which encompass almost 61,000 measurements of more than 1,600 nearby stars.

"This is an amazing catalog, and we realized there just aren't enough of us on the team to be doing as much science as could come out of this dataset," says Jennifer Burt, a Torres Postdoctoral Fellow in MIT's Kavli Institute for Astrophysics and Space Research. "We're trying to shift toward a more community-oriented idea of how we should do science, so that others can access the data and see something interesting."

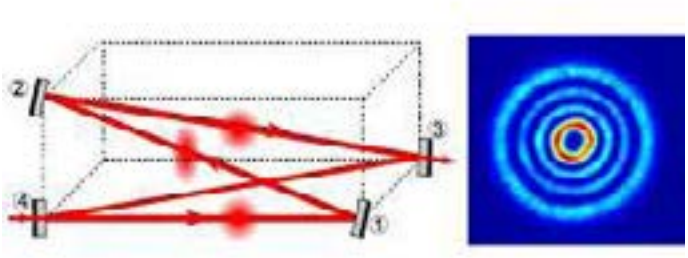
Burt and her colleagues have outlined some details of the newly available dataset in a paper to appear in The Astrophysical Journal. After taking a look through the data themselves, the researchers have detected over 100 potential exoplanets, including one orbiting GJ 411, the fourth-closest star to our solar system.

"There seems to be no shortage of exoplanets," Burt says. "There are a ton of them out there, and there is ton of science to be done."

Splitting starlight

The newly available observations were taken by the High Resolution Echelle Spectrometer (HIRES), an instrument mounted on the Keck Observatory's ...Read More...

Increasing the sensitivity of next-generation gravitational wave detectors



compensates for astigmatism that affects a Laguerre-Gauss mode laser. The astigmatism arises when the laser hits curved mirrors at an angle. Using concave mirrors at position 1 and 2 and planar mirrors at positions 3 and 4 compensates for this optical error such that a clean Laguerre Gauss mode is transmitted (right). Image courtesy Andreas Noack, Albert Einstein Institute.

Nearly one year ago the LIGO Collaboration announced the detection of gravitational waves, once again confirming Einstein's theory of General Relativity. This important discovery by the Advanced Laser Interferometer Gravitational-Wave Observatory (aLIGO) has spurred great interest in improving these advanced optical detectors.

The mission of gravitational wave scientists worldwide is to make gravitational wave detection a routine occurrence. Scientists from the institute that developed the lasers used in Advanced LIGO have made significant progress to support that goal.

Advanced LIGO is a 2.5-mile long optical device known as an interferometer that uses laser light to detect gravitational waves coming from distant cosmic events such as colliding black holes or collapsing stars. Improving the stability of the laser source and decreasing noise that can hide weak signals coming from gravitational waves could help improve the sensitivity of gravitational wave detectors.

"We have made significant progress towards stable laser sources for third-generation gravitational wave detectors and prototypes of those," said Benno Willke of the Max Planck Institute for Gravitational Physics (Albert Einstein Institute) and Leibniz Universitat Hannover, leader of the research team.

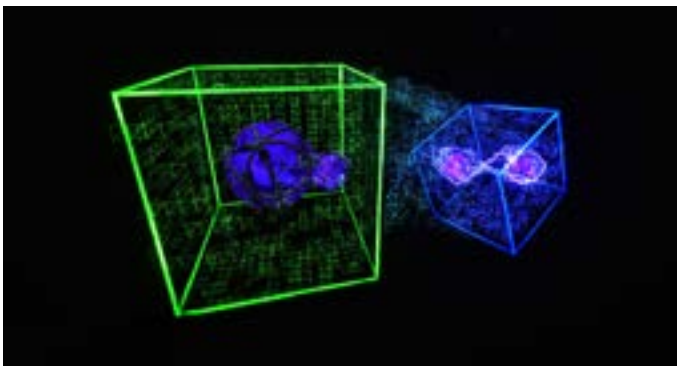
"More stable lasers enable interferometers to sense gravitational waves that are weaker and from sources further away and thus reveal important insights into astrophysical events involving black holes and neutron stars."

The new work has been reported in two new papers in The Optical Society (OSA) journal Optics Letters.

Developing a more stable laser

Achieving stable and consistent laser power, with minimal noise, is crucial to the operation of sensitive ..Read More...

Will androids dream of quantum sheep?



Quantum replicants of responsive systems can be more efficient than classical models, researchers at the Centre for Quantum Technologies in Singapore have found, because classical models have to store more past information than is necessary to simulate the future. This conceptual artist's illustration suggests the difference in resources required between a classical (green) and quantum (blue) simulation. Credit: Mile Gu and Jayne Thompson / Centre for Quantum Technologies, Singapore

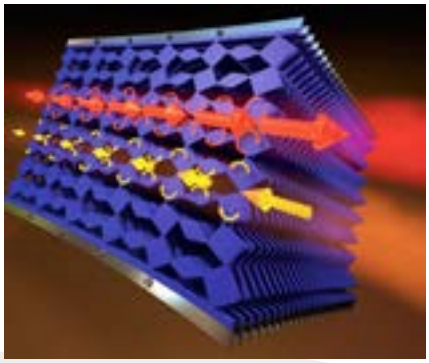
Quantum replicants of responsive systems can be more efficient than classical models, say researchers from the Centre for Quantum Technologies in Singapore, because classical models have to store more past information than is necessary to simulate the future. They have published their findings in npj Quantum Information.

The word 'replicant' evokes thoughts of a sci-fi world where society has replaced common creatures with artificial machines that replicate their behaviour. Now researchers from Singapore have shown that if such machines are ever created, they'll run more efficiently if they harness quantum theory to respond to the environment.

This follows the findings of a team from the Centre for Quantum Technologies (CQT), published 10 February in npj Quantum Information. The team investigated 'input-output processes', assessing the mathematical framework used to describe arbitrary devices that make future decisions based on stimuli received from the environment. In almost all cases, they found, a quantum device is more efficient because classical devices have to store more past information than is necessary to simulate the future.

"The reason turns out to be quantum theory's lack of a definitive reality," says co-author Mile Gu, an Assistant Professor at the Nanyang Technological University, Singapore, who is affiliated with CQT. "Quantum mechanics has this famous feature where some properties of quantum particles are not just unknown before they are measured, but fundamentally do not exist in a definitive state prior to the act of measurement," he says. The physics only specifies the probabilities the system collapses to each possible value once the measurement is performed. That lets the quantum system, in a sense, do more with less. ...Read More...

New mechanical metamaterials can block symmetry of motion, findings suggest



An artist's rendering of mechanical metamaterials. Credit: Cockrell School of Engineering

Engineers and scientists at The University of Texas at Austin and the AMOLF institute in the Netherlands have invented the first mechanical metamaterials that easily transfer motion effortlessly in one direction while blocking it in the other, as described in a paper published on Feb. 13 in Nature. The material can be thought of as a mechanical one-way shield that blocks energy from coming in but easily transmits it going out the other side.

The researchers developed the first nonreciprocal mechanical materials using metamaterials, which are synthetic materials with properties that cannot be found in nature.

Breaking the symmetry of motion may enable greater control on mechanical systems and improved efficiency. These nonreciprocal metamaterials can potentially be used to realize new types of mechanical devices: for example, actuators (components of a machine that are responsible for moving or controlling a mechanism) and other devices that could improve energy absorption, conversion and harvesting, soft robotics and prosthetics.

The researchers' breakthrough lies in the ability to overcome reciprocity, a fundamental principle governing many physical systems, which ensures that we get the same response when we push an arbitrary structure from opposite directions. This principle governs how signals of various forms travel in space and explains why, if we can send a radio or an acoustic signal, we can also receive it. In mechanics, reciprocity implies that motion through an object is transmitted symmetrically: If by pushing on side A we move side B by a certain amount, we can expect the same motion at side A when pushing B.

"The mechanical metamaterials we created provide new elements in the palette that material scientists can use in order to design mechanical structures," said Andrea Alu, a professor in the Cockrell School of Engineering and co-author of the paper. "This can be of extreme interest for applications in which it is desirable to break the natural symmetry with which the displacement of molecules travels in the microstructure of a material." ...Read More...

Research team finds radial acceleration relation in all common types of galaxies

The giant elliptical galaxy NGC 4472. Credit: Courtesy of David W. Hogg, Michael R. Blanton, and the Sloan Digital Sky Survey Collaboration

The distribution of normal matter precisely determines gravitational acceleration in all common types of galaxies, a team led by Case Western Reserve University researchers reports.

The team has shown this radial acceleration relation exists in nearby high-mass elliptical and low-mass spheroidal galaxies, building on last year's discovery of this relation in spiral and irregular galaxies. This provides further support that the relation is tantamount to a new natural law, the researchers say.

"This demonstrates that we truly have a universal law for galactic systems," said Federico Lelli, formerly an astronomy postdoctoral fellow at Case Western Reserve University and currently a fellow at the European Southern Observatory.

"This is similar to the Kepler law for planetary systems, which does not care about the specific properties of the planet. Whether the planet is rocky like Earth or gaseous like Jupiter, the law applies," said Lelli, who led this investigation.

In this case, the observed acceleration tightly correlates with the gravitational acceleration from the visible mass, no matter the type of galaxy. In other words, if astronomers measure the distribution of normal matter, they know the rotation curve, and vice versa.

"But it is still unclear what this relation means and what is its fundamental origin," Lelli said.

The study is published online in Astrophysical Journal today. Co-authors are Stacy McGaugh, chair of the Department of Astronomy at Case Western Reserve, James Schombert, astronomy professor at the University of Oregon, and Marcel Pawlowski, former astronomy postdoctoral researcher at Case Western Reserve and current Hubble fellow at the University of California, Irvine. ...Read More...

NASA-funded website lets public search for new nearby worlds

This artist's concept illustrates a close-up view of a cool brown dwarf. Objects like this, drifting just beyond our solar system, have been imaged by NASA's Wide-field Infrared Survey Explorer and could be discovered by Backyard Worlds: Planet 9. Credit: NASA/JPL-Caltech

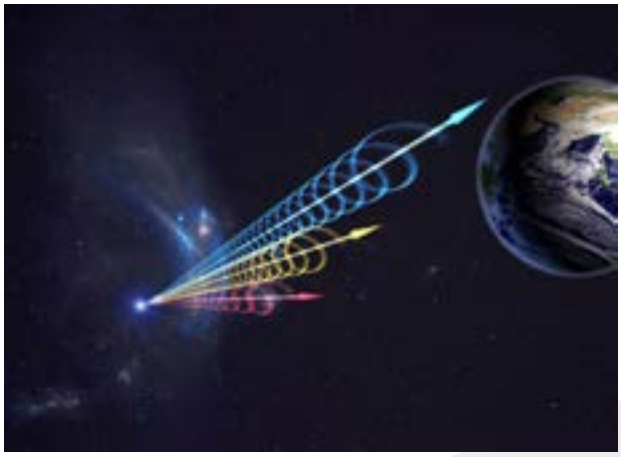
NASA is inviting the public to help search for possible undiscovered worlds in the outer reaches of our solar system and in neighboring interstellar space. A new website, called Backyard Worlds: Planet 9, lets everyone participate in the search by viewing brief movies made from images captured by NASA's Wide-field Infrared Survey Explorer (WISE) mission. The movies highlight objects that have gradually moved across the sky.

"There are just over four light-years between Neptune and Proxima Centauri, the nearest star, and much of this vast territory is unexplored," said lead researcher Marc Kuchner, an astrophysicist at NASA's Goddard Space Flight Center in Greenbelt, Maryland. "Because there's so little sunlight, even large objects in that region barely shine in visible light. But by looking in the infrared, WISE may have imaged objects we otherwise would have missed."

WISE scanned the entire sky between 2010 and 2011, producing the most comprehensive survey at mid-infrared wavelengths currently available. With the completion of its primary mission, WISE was shut down in 2011. It was then reactivated in 2013 and given a new mission assisting NASA's efforts to identify potentially hazardous near-Earth objects (NEOs), which are asteroids and comets on orbits that bring them into the vicinity of Earth's orbit. The mission was renamed the Near-Earth Object Wide-field Infrared Survey Explorer (NEOWISE).

The new website uses the data to search for unknown objects in and beyond our own solar system. In 2016, astronomers at Caltech in Pasadena, California, showed that several distant solar system objects possessed orbital features indicating they were affected by the gravity of an as-yet-undetected planet, which the researchers nicknamed "Planet Nine." If Planet Nine—also known as Planet X—exists and is as bright as some predictions, it could show up in WISE data. ..Read More...

Astronomers propose a cell phone search for galactic fast radio bursts



Artist impression of a Fast Radio Burst (FRB) reaching Earth. The colors represent the burst arriving at different radio wavelengths, with long wavelengths (red) arriving several seconds after short wavelengths (blue). This delay is called dispersion and occurs when radio waves travel through cosmic plasma. Credit: Jingchuan Yu, Beijing Planetarium / NRAO

Fast radio bursts (FRBs) are brief spurts of radio emission, lasting just one-thousandth of a second, whose origins are mysterious. Fewer than two dozen have been identified in the past decade using giant radio telescopes such as the 1,000-foot dish in Arecibo, Puerto Rico. Of those, only one has been pinpointed to originate from a galaxy about 3 billion light-years away.

The other known FRBs seem to also come from distant galaxies, but there is no obvious reason that, every once in a while, an FRB wouldn't occur in our own Milky Way galaxy too. If it did, astronomers suggest that it would be "loud" enough that a global network of cell phones or small radio receivers could "hear" it.

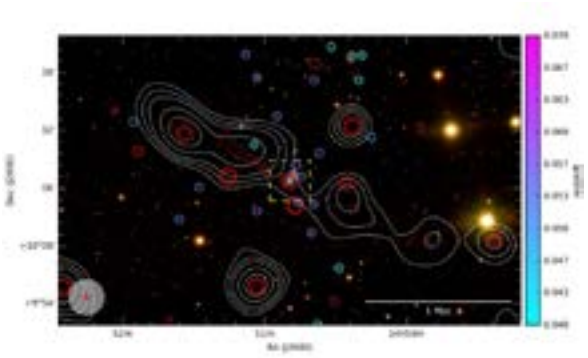
"The search for nearby fast radio bursts offers an opportunity for citizen scientists to help astronomers find and study one of the newest species in the galactic zoo," says theorist Avi Loeb of the Harvard-Smithsonian Center for Astrophysics (CfA).

Previous FRBs were detected at radio frequencies that match those used by cell phones, Wi-Fi, and similar devices. Consumers could potentially download a free smartphone app that would run in the background, monitoring appropriate frequencies and sending the data to a central processing facility.

"An FRB in the Milky Way, essentially in our own back yard, would wash over the entire planet at once. If thousands of cell phones picked up a radio blip at nearly the same time, that would be a good sign that we've found a real event," explains lead author Dan Maoz of Tel Aviv University.

Finding a Milky Way FRB might require some patience. Based on the few, more distant ones, that ...Read More...

Giant radio galaxy discovered by astronomers



Background SDSS image (composite from bands g, r and i) overlaid with white MSSS contours of the GRG at 2, 3, 4, 6 and 8 times the RMS noise (34 mJy/beam). NVSS contours are overlaid in red at 3, 5, 10 and 20 times the RMS noise (0.55 mJy/beam) revealing a bright part of the radio jet towards the north-east. The beam sizes are shown in the lower left. Credit: Clarke et al., 2017.

An international team of astronomers reports the discovery of a new giant radio galaxy (GRG) associated with the galaxy triplet known as UGC 9555. The newly discovered galaxy turns out to be one of the largest GRGs so far detected. The findings were presented Feb. 6 in a paper published online on arXiv.org.

Located some 820 million light years away from the Earth, UGC 9555 is a part of a larger group of galaxies designated MSPM 02158. Recently, a team of researchers led by Alex Clarke of the Jodrell Bank Centre for Astrophysics in Manchester, U.K., has combed through the data provided by the Low Frequency Array (LOFAR) and uncovered new, important information about this distant disturbed galaxy group.

The team has analyzed the data available in the LOFAR Multifrequency Snapshot Sky Survey (MSSS). It is the first northern-sky LOFAR imaging survey that covers the sky north of the celestial equator at frequencies from 119 to 158 MHz in eight separate 2.0 MHz bands. The images obtained as a part of the LOFAR MSSS allowed the scientists to distinguish a new giant radio galaxy.

"We report on the discovery in the LOFAR Multifrequency Snapshot Sky Survey (MSSS) of a giant radio galaxy (GRG) with a projected size of about 2.56 Mpc projected on the sky," the researchers wrote in the paper.

GRG are radio galaxies with an overall projected linear length exceeding 6.5 million light years. They are rare objects grown in low-density environments. GRGs are important for astronomers to study the formation and the evolution of radio sources.

The newly detected GRG which has not received any official designation yet has a projected linear size of 8.34 million light years. This makes it one of the largest GRGs known to date. Currently, with a projected ...Read More...

This Week's Sky at a Glance, Feb. 18 - 24

Feb. 18	Third Quarter Moon 23:33
Feb. 19	Jupiter at Aphelion 01:00
Feb. 19	Moon at Apogee 01:14 (404376 km)
Feb. 20	Venus at Perihelion 20:00
Feb. 21	Saturn 3.6° S of Moon 03:44

Future SCASS Activities

1. **Observatory Open House (Feb. 23, 2017)** - 18:30 - 20:30
2. **International Black Holes Workshop** - Mar. 06-07, 2017
3. **Special Guest Visit - Prof. Fernando Quevedo** - Director of the International Centre for Theoretical Physics (ICTP, Italy) - Mar. 11 - 12, 2017
4. **UK National Space Academy - SCASS - UAE Space Agency partnership:** "UAE Teacher Development Training and Student Masterclass program" - Apr. 02 – 06, 2017

Hubble sees spiral in Andromeda

The Andromeda constellation is one of the 88 modern constellations and should not be confused with our neighboring Andromeda Galaxy. The Andromeda constellation is home to the pictured galaxy known as NGC 7640.

Many different classifications are used to identify galaxies by shape and structure—NGC 7640 is a barred spiral type. These are recognizable by their spiral arms, which fan out not from a circular core, but from an elongated bar cutting through the galaxy's center. Our home galaxy, the Milky Way, is also a barred spiral galaxy. NGC 7640 might not look much like a spiral in this image, but this is due to the orientation of the galaxy with respect to Earth—or to Hubble, which acted as photographer in this case! We often do not see galaxies face on, which can make features such as spiral arms less obvious.

There is evidence that NGC 7640 has experienced some kind of interaction in its past. Galaxies contain vast amounts of mass, and therefore affect one another via gravity. Sometimes these interactions can be mild, and sometimes hugely dramatic, with two or more colliding and merging into a new, bigger galaxy. Understanding the history of a galaxy, and what interactions it has experienced, helps astronomers to improve their understanding of how galaxies—and the stars within them—form.
.... Read More...

The Andromeda constellation is one of the 88 modern constellations and should not be confused with our neighboring Andromeda Galaxy. The Andromeda constellation is home to the pictured galaxy known as NGC 7640. Credit: ESA/Hubble & NASA