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# Astronomy & Physics Weekly News

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## Top News



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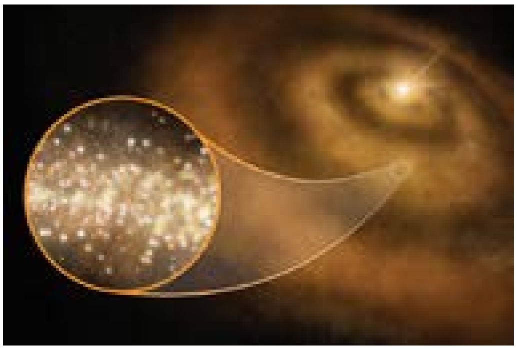
# Nanodiamonds responsible for mysterious source of microwaves across the Milky Way



Nanodiamonds in the sky. Credit: S. Dagnello, NRAO/AUI/NSF

For decades, astronomers have puzzled over the exact source of a peculiar type of faint microwave light emanating from a number of regions across the Milky Way. Known as anomalous microwave emission (AME), this light comes from energy released by rapidly spinning nanoparticles—bits of matter so small that they defy detection by ordinary microscopes. (The period on an average printed page is approximately 500,000 nanometers across.)

“Though we know that some type of particle is responsible for this microwave light, its precise source has been a puzzle since it was first detected nearly 20 years ago,” said Jane Greaves, an astronomer at Cardiff University in Wales and lead author on a paper announcing this result in Nature Astronomy.

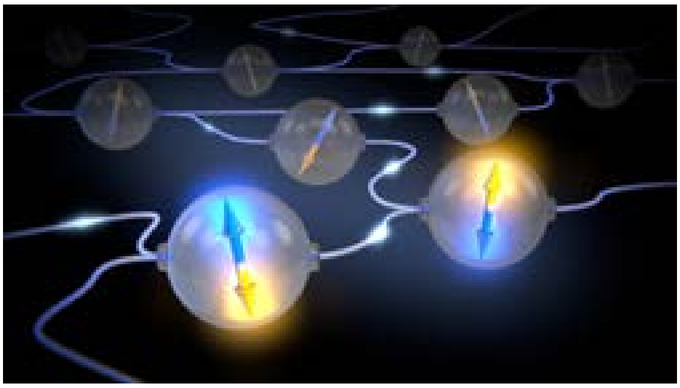
Until now, the most likely culprit for this microwave emission was thought to be a class of organic molecules known as polycyclic aromatic hydrocarbons (PAHs) - carbon-based molecules found throughout interstellar space and recognized by the distinct, yet faint infrared (IR) light they emit. Nanodiamonds—particularly hydrogenated nanodiamonds, those bristling with hydrogen-bearing molecules on their surfaces—also naturally emit in the infrared portion of the spectrum, but at a different wavelength.

A series of observations with the National Science Foundation’s Green Bank Telescope (GBT) in West Virginia and the Australia Telescope Compact Array (ATCA) has—for the first time—homed in on three clear sources of AME light, the protoplanetary disks surrounding the young stars known as V892 Tau, HD 97048, and MWC 297. The GBT observed V892 Tau and the ATCA observed the other two systems.

“This is the first clear detection of anomalous microwave emission coming from protoplanetary disks,” said David Frayer a coauthor on the paper and astronomer with the Green Bank Observatory.

The astronomers also note that the infrared light coming from these systems matches the unique signature of nanodiamonds. Other protoplanetary disks ..Read More...

# Scientists make first ‘on demand’ entanglement link



An artist impression of a quantum network based on Nitrogen Vacancies qubits in diamond. Credit: Scixel/TU Delft

Researchers at QuTech in Delft have succeeded in generating quantum entanglement between two quantum chips faster than the entanglement is lost. Via a novel smart entanglement protocol and careful protection of the entanglement, the scientists led by Prof. Ronald Hanson are the first in the world to deliver such a quantum link on demand. This opens the door to connect multiple quantum nodes and create the very first quantum network in the world. Their results are published in Nature.

By exploiting the power of quantum entanglement, it is theoretically possible to build a quantum internet invulnerable to eavesdropping. However, the realization of such a quantum network is a real challenge—it is necessary to create entanglement reliably on demand, and maintain it long enough to pass the entangled information to the next node. So far, this has been beyond the capabilities of quantum experiments.

Scientists at QuTech in Delft have are now the first to experimentally generate entanglement over a distance of two metres in a fraction of a second, on demand, and theoretically maintain this entanglement long enough to enable entanglement to a third node. “The challenge is now to be the first to create a network of multiple entangled nodes—the first version of a quantum internet,” professor Hanson says.

In 2015, Ronald Hanson’s research group was the first to generate long-lived quantum entanglement over a long distance (1.3 kilometres), , allowing them to provide full experimental proof of quantum entanglement for the first time. This experiment is the basis of their current approach to developing a quantum internet. Distant single electrons on diamond chips are entangled using photons as mediators. However, this experiment has not had the necessary performance to create a real quantum network. Hanson says, “In 2015, we managed to establish a connection once an hour, while the connection only remained active for a fraction of a second. It was impossible to add a third node, let alone multiple nodes, to the network.” ..Read More...

# No Planet Nine? Small-body Pile-up Could Explain Odd Orbits

An artist's rendering of Sedna, which looks reddish in color in telescope images. NASA / JPL-Caltech

New research shows that interactions between small objects beyond Neptune's orbit —and not a hypothetical Planet Nine — could be the reason some far-flung solar system objects "detach" from their original orbits.

Astronomers have been struggling to explain the orbits of 30 or so bodies at the outer rims of the solar system, called "detached objects." These worlds are smaller than Pluto and travel in elliptical trajectories around the Sun.

Sedna is one of the most well-known detached objects: a reddish world found in 2003, it's one-third the size of the Moon and has an orbital period of 11,400 years — the longest of any object known in the solar system. At closest approach it passes 76 times farther away than the distance between the Sun and Earth. At its farthest, it goes more than 900 times that distance.

The orbits of Sedna and the other detached objects appear to be completely removed from Neptune's gravitational pull. Yet their trajectories share similarities that seem to point to a common but unknown source of gravitational influence. For that reason astronomers have pointed to the influence of a yet-to-be-found ninth planet of the solar system, hiding far beyond Pluto's orbit. Astronomers have proposed the existence of this alleged planet to explain not only the detachment of these objects' orbits, but also other characteristics, such as their orbits' tilt relative to the plane where most of the planets of the solar system reside.

But Planet Nine isn't the only plausible source of disruption in our system's outskirts. A group of researchers led by Ann-Marie Madigan and Jacob Fleisig (both at University of Colorado, Boulder) have found that the combined gravitational pull of many smaller bodies beyond Neptune's orbit (known as trans-Neptunian objects, or TNOs) could do the trick. Thanks to computer simulations, they have found that the combined gravity of many small TNOs could push the larger members of their family — as large as Sedna — into detached orbits. The researchers presented their findings on June 6th at the 232nd ..Read More...

# Black Hole Destroys Star and Shoots Jet

This artist's conception shows a star being shredded by the powerful gravity of a supermassive black hole, creating the bright disk and jet we see as a tidal disruption event.
Sophia Dagnello / NRAO / AUI / NSF

When stars zip too close to a supermassive black hole, they enter dangerous territory. How close "too close" is depends on the black hole, but for one that's 10 million times the mass of the Sun, any star venturing closer than an astronomical unit is done for: The black hole will rip the star apart. Torn asunder, half the star goes whizzing away, while the other half forms a disk of hot gas around its destroyer. This gas heats and glows, appearing to our telescopes as a long-lasting flare.

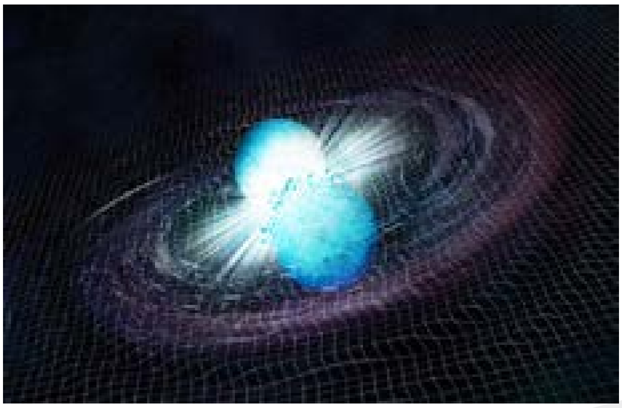
Astronomers have detected a few dozen of these tidal disruption events (TDEs), usually in optical, ultraviolet, or X-ray wavelengths. Sometimes — maybe 10% of the time — the TDEs come with jets, beams of plasma powered by the newly formed gas disks. At least, that's what observers infer based on the emission they see; light from the best-studied of the jet-shooting TDEs traveled some 4 billion years to reach us, much too far away for astronomers to see the jet itself.

Reporting June 14th in Science, Seppo Mattila (University of Turku, Finland) and colleagues say they've now done just that, successfully watching a shredded-star jet be born and grow over a decade.

The team stumbled across the event while looking for supernovae. The researchers were studying the galactic pileup Arp 299 (a.k.a. NGC 3690), two glorious spiral galaxies colliding some 140 million light-years away. The ongoing merger is driving gas into the galaxies' central regions, building a brilliant accretion disk around the black hole in the western galaxy and triggering the creation of countless stars, many of which are massive enough to go supernova.

Mattila and colleagues spotted an infrared flare in January 2005 in the western galaxy's nucleus, near the active black hole. By July, a compact radio source had joined it. As the team watched over the next decade with various ground- and space-based instruments, this radio source grew and stretched into a clumpy streak. Material in the jet at first moved at almost the speed of light ..Read More...

# The Aftermath of GW170817: Neutron Star or Black Hole?



Artist's illustration of the merger of two neutron stars. A new study suggests that the neutron-star merger detected in August 2017 might have produced a black hole. NASA/CXC/M.Weiss

When two neutron stars merged in August of last year, leading to the first simultaneous detection of gravitational waves and electromagnetic signals, we knew this event was going to shed new light on compact-object mergers.

A team of scientists says we now have an answer to one of the biggest mysteries of GW170817: after the neutron stars collided, what object was formed?

Based on gravitational-wave observations, we know that two neutron stars of about 1.48 and 1.26 solar masses merged in GW170817. But the result – an object of ~2.7 solar masses – doesn't have a definitive identity; the remnant formed in the merger is either the most massive neutron star known or the least massive black hole known.

The theoretical mass division between neutron stars and black holes is fuzzy, depending strongly on what model you use to describe the physics of these objects. Observations fall short as well: the most massive neutron star known is perhaps 2.3 solar masses, and the least massive black hole is perhaps 4 or 5, leaving the location of the dividing line unclear. For this reason, determining the nature of GW170817's remnant is an important target as we analyze past observations of the remnant and continue to make new ones.

Luckily, we may not have long to wait! Led by David Pooley (Trinity University and Eureka Scientific, Inc.), a team of scientists has obtained new Chandra X-ray observations of the remnant of GW170817. By combining this new data with previous observations, the authors have drawn conclusions about what object was left behind after this fateful merger.

### X-Rays Provide Answers

X-ray radiation is generated in a merger of two neutron stars when the merger's shock wave expands and slams into the surrounding interstellar medium. The earliest X-ray detection from GW170817 – around ...Read More...

# Alpha Centauri system could have favorable conditions for life


Alpha Centauri is the closest star system to Earth, and it happens to house Sun-like stars. Sitting only 4 light years away, or 25 trillion miles (40 trillion kilometers), Chandra found that two of its stars could have favorable conditions for habitable exoplanets. X-ray: NASA/CXC/University of Colorado/T.Ayres; Optical: Zdeněk Bardon/ESO

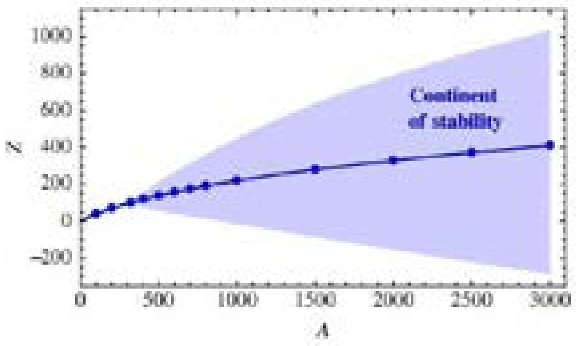
The search for habitable exoplanets spans far and wide, pushing the limits of what our modern telescopes are capable of. But rest assured that we aren't ignoring what's in our own backyard. Researchers have kept diligent eyes on Alpha Centauri, the closest system to Earth that happens to house Sun-like stars. And now, a comprehensive study published in Research Notes of the AAS clears Alpha Centauri's two brightest stars of a crucial habitability factor: dangerous X-ray radiation.

In the study, NASA's Chandra X-ray Observatory observed the three stars of Alpha Centauri, which sits just 4 light-years from Earth, twice a year since 2005. In an effort to determine the habitability of any planets within their orbits, Chandra monitored the amount of X-ray radiation that each star emitted into its habitable zone. An excess of X-ray radiation can wreak havoc on a planet by dissolving its atmosphere, causing harmful effects for potential residents, and creating destructive space weather that could mess with any technology possibly in use. But thankfully, the potential planets orbiting two of the three stars don't have to worry any of that. In fact, these stars might actually create better planetary conditions than our own Sun.

"Because it is relatively close, the Alpha Centauri system is seen by many as the best candidate to explore for signs of life," said study's author, Tom Ayres of the University of Colorado Boulder, in a press release. "The question is, will we find planets in an environment conducive to life as we know it?"

The three stars that make up Alpha Centauri aren't exactly created equal, with some more hospitable to life than others. The two brightest stars in the system are a pair known as Alpha Cen A and Alpha Cen B (AB for short), which orbit each other so closely that Chandra is the only observatory precise enough to differentiate their X-rays. Farther out in the system is Alpha Cen C, known as Proxima, which is the closest non-Sun-like star to Earth. The AB pair are both remarkably similar to our Sun, with ...Read More...

# New form of matter may lie just beyond the periodic table




The new theoretical results suggest that udQM may have a stable configuration in the "continent of stability," indicating that searches should look in the region with large mass, A (>300) and sufficiently large charge Z, Z/A~0.3. Credit: Holdom et al. ©2018 American Physical Society

Currently, the heaviest element on the periodic table is oganesson, which has an atomic mass of 294 and was officially named in 2016. Like every element on the periodic table, nearly all of oganesson's mass comes from protons and neutrons (types of baryons) that are themselves made of three quarks each. A crucial feature of all known baryonic matter is that its quarks are bound together so tightly by the strong force that they are inseparable. As particles made of bound quarks (such as protons and neutrons) are called hadrons, scientists refer to the ground state of baryonic matter as "hadronic matter."

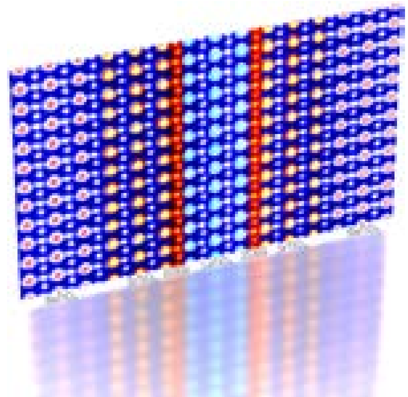
But oganesson may be one of the last of its kind. In a new paper, scientists predict that elements with masses greater than approximately 300 may be composed of freely flowing "up" and "down" quarks—the same kind that protons and neutrons are made of, but these quarks wouldn't be bound into triplets. The scientists predict that this type of matter, called "up down quark matter," or udQM, would be stable for extremely heavy elements that might exist just beyond the end of the current periodic table. If it could be produced on Earth, quark matter has the potential to be used as a new source of energy.

The possibility that heavy baryonic matter has a udQM ground state rather than a hadronic one is described in a paper published in Physical Review Letters by University of Toronto physicists Bob Holdom, Jing Ren, and Chen Zhang.

The idea that some kind of quark matter might form the ground state of baryonic matter is not new. In a famous paper from 1984, physicist Edward Witten suggested that strange quark matter (SQM) might fulfill this role. However, SQM consists of comparable amounts of up, down, and strange quarks. One of the new results of the latest study is that quark matter without strange quarks, i.e., udQM, has lower bulk energy per baryon than either SQM or hadronic matter, making it energetically favorable.

"Physicists have been searching for SQM for decades," the researchers told Phys.org. ...Read More...

# Physicists create new class of 2-D artificial materials



The positions of atoms in a ferroelectric-like metal that contains barium titanate, strontium titanate and lanthanum titanate. Credit: Zhen Wang and Yimei Zhu; image obtained at Brookhaven National Laboratory

In 1965, a renowned Princeton University physicist theorized that ferroelectric metals could conduct electricity despite not existing in nature.

For decades, scientists thought it would be impossible to prove the theory by Philip W. Anderson, who shared the 1977 Nobel Prize in physics. It was like trying to blend fire and water, but a Rutgers-led international team of scientists has verified the theory and their findings are published online in Nature Communications.

"It's exciting," said Jak Chakhalian, a team leader of the study and Professor Claud Lovelace Endowed Chair in Experimental Physics at Rutgers University-New Brunswick. "We created a new class of two-dimensional artificial materials with ferroelectric-like properties at room temperature that don't exist in nature yet can conduct electricity. It's an important link between a theory and an experiment."

A cornerstone of technology, ferroelectric materials are used in electronics such as cell phone and other antennas, computer storage, medical equipment, high precision motors, ultra-sensitive sensors and sonar equipment. None of their materials conducts electricity and the Rutgers-led findings potentially could spawn a new generation of devices and applications, Chakhalian said.

"Ferroelectrics are a very important class of materials technologically," he said. "They move, shrink and expand when electricity is applied and that allows you to move things with exquisite precision. Moreover, every modern cell phone has tens of components with properties similar to ferroelectric material."

Like many physicists, Chakhalian relishes a challenge and he could not find a law of physics that says ferroelectric metals could not be created. So his team, including study lead author Yanwei Cao, a former doctoral student who is now a professor at the Chinese Academy of Sciences, tapped Chakhalian's state-of-the-art tools to create sheets of materials only a few atoms thick. ...Read More...

## Upgrade to boost capacity of CERN's giant particle smasher (Update)

Credit: Fermilab / Reidar Hahn Aerial View of the CERN. Credit: CERN

A major upgrade began Friday for the world's most powerful proton smasher to increase the number of particle collisions inside the Large Hadron Collider and help further explore the fundamental building blocks of the universe.

The work involves heavy civil engineering at the LHC's two main sites in Switzerland and France which are run by Europe's physics lab CERN, that will allow it to operate in a high-luminosity mode from 2026.

"By 2026, this major upgrade will have considerably improved the performance of the LHC, by increasing the number of collisions in the large experiments and thus boosting the probability of the discovery of new physics phenomena," CERN said. The aim is increase tenfold the amount of data which can be picked up by the LHC, which is housed in a 27-kilometre (17-mile) ring-shaped tunnel buried more than 100 metres underground that runs beneath the border of Switzerland and France.

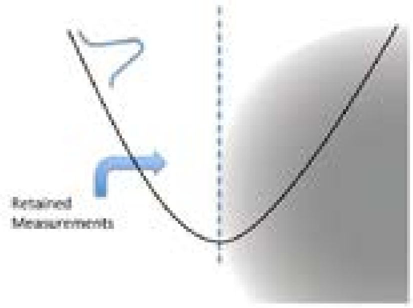
The powerful accelerator, which began operating in 2010, smashes high-energy protons into each other at velocities near the speed of light. These collisions generate new particles, giving physicists an unprecedented look at the laws of nature in the hope of better understanding particles and matter.

Until now, the LHC has been able to generate nearly a billion collisions per second but the so-called high-luminosity upgrade will allow it to increase the collision rate, thereby allowing for the accumulation of 10 times more data between 2026 and 2036.

"The High-Luminosity LHC will extend the LHC's reach beyond its initial mission, bringing new opportunities for discovery, measuring the properties of particles such as the Higgs Boson with greater precision, and exploring the fundamental constituents of the universe ever more profoundly," said CERN Director-General Fabiola Gianotti.

In 2012, the LHC was used to prove the existence of the Higgs Boson—also dubbed the God particle—which has allowed scientists to make great progress in understanding how particles acquire mass. ...Read More...

## Harmonic oscillator's most 'classical-like' state exhibits nonclassical behavior




In the proposed experiment to test the violation of macrorealism, a particle oscillates between two sides of a harmonic well. Credit: S. Bose et al. ©2018 American Physical Society

Showing just how blurry the boundary is between the quantum and classical worlds, physicists in a new study have theoretically demonstrated that a macroscopic oscillating object initially in a classical-like coherent state can exhibit nonclassical behavior—namely, it can violate the classical notion of realism by not having a single definite state at any given moment. Instead, the oscillator has one of two states with a certain probability, as theoretically shown by non-invasive measurements of the oscillator's position at different times.

The physicists, S. Bose at University College London; D. Home at the Bose Institute in Kolkata, India; and S. Mal at the S.N. Bose National Center for Basic Science in Kolkata, India, have published a paper on the nonclassicality of a harmonic oscillator's most classical-like state in a recent issue of Physical Review Letters.

"Einstein's intriguing and much debated question 'Is the moon there when nobody looks at it?' concerns the everyday notion of macrorealism, which lies at the core of the classical worldview," Home told Phys.org. "To put it simply, macrorealism means that, at any instant, a system is in a definite state having definite properties, irrespective of any observation/measurement.

"In this context, our work opens up a novel direction for testing macrorealism by showing that the quantum mechanical violation of macrorealism is testable for a system like a harmonic oscillator, which has a well-defined classical description and is initially in a state which is the most classical-like of all quantum states, the harmonic oscillator coherent state."

In their work, the physicists proposed a test involving a linear harmonic oscillator that can be implemented using a macroscopic particle that oscillates between two sides (left and right) of a harmonic well. The two sides of the well correspond to the particle's two possible states. By performing a noninvasive measurement, it's possible to determine which of the two states the particle is in without affecting its future behavior. ...Read More...

# Trio of infant planets discovered around newborn star

Artist impression of protoplanets forming around a young star. Credit: NRAO/AUI/NSF; S. Dagnello

Two independent teams of astronomers have uncovered convincing evidence that three young planets are in orbit around an infant star known as HD 163296. Using a new planet-finding strategy, the astronomers identified three discrete disturbances in a young star's gas-filled disk: the strongest evidence yet that newly formed planets are in orbit there.

Over the past several years, the Atacama Large Millimeter/submillimeter Array (ALMA) has transformed our understanding of protoplanetary disks—the gas- and dust-filled planet factories that encircle young stars. The rings and gaps in these disks provide intriguing circumstantial evidence for the presence of planets. Other phenomena, however, could account for these tantalizing features.

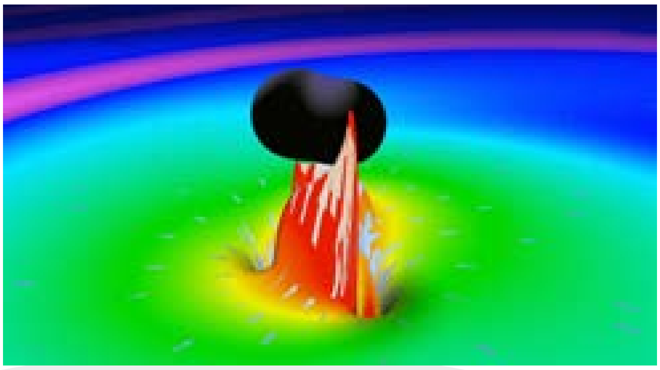
Using a new planet-hunting technique that identifies unusual patterns in the flow of gas within a protoplanetary disk, two teams of astronomers have confirmed the distinct, telltale hallmarks of newly formed planets orbiting an infant star in our galaxy. These results are presented in a pair of papers appearing in the Astrophysical Journal Letters.

"We looked at the localized, small-scale motion of gas in a star's protoplanetary disk. This entirely new approach could uncover some of the youngest planets in our galaxy, all thanks to the high-resolution images coming from ALMA," said Richard Teague, an astronomer at the University of Michigan and principal author on one of the papers.

To make their respective discoveries, each team analyzed the data from various ALMA observations of the young star HD 163296. HD 163296 is about 4 million years old and located about 330 light-years from Earth in the direction of the constellation Sagittarius.

Rather than focusing on the dust within the disk, which was clearly imaged in earlier ALMA observation, the astronomers instead studied the distribution and motion of carbon monoxide (CO) gas throughout the disk. Molecules of CO naturally emit a very distinctive millimeter-wavelength light that ALMA can observe. Subtle changes in the wavelength of this light due to the Doppler...Read More...

# Speculative wormhole echoes could revolutionize astrophysics



Instant of a simulation in which two black holes merge. The collision of two rotating wormholes would trigger a similar deformation of space-time, leaving 'echoes' in the signal. Credit: LIGO LabCaltech

The scientific collaborations LIGO and Virgo have detected gravitational waves from the fusion of two black holes, inaugurating a new era in the study of the cosmos. But what if those ripples of space-time were not produced by black holes, but by other exotic objects? A team of European physicists suggest an alternative—wormholes that can be traversed to appear in another universe.

Scientists have deduced the existence of black holes from a multitude of experiments, theoretical models and indirect observations such as the recent LIGO detections, which are believed to originate from the collision of two of these dark gravitational monsters.

But there is a problem with black holes—they present an edge, called an event horizon, from which nothing can escape. This is in conflict with quantum mechanics, whose postulates ensure that information is always preserved, not lost.

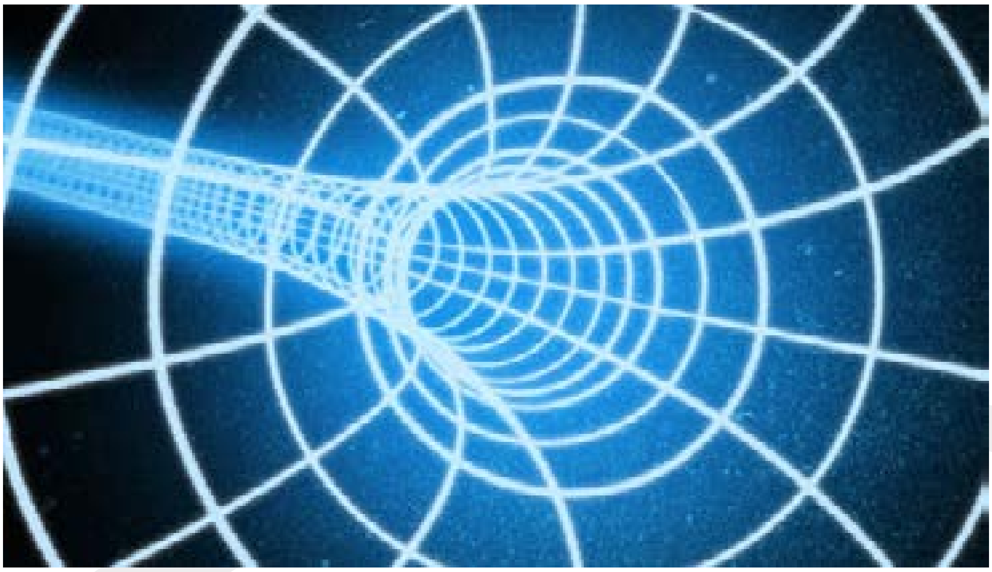
One of the theoretical ways to deal with this conflict is to explore the possibility that the alleged black holes we 'observe' in nature are no such thing, but rather some type of exotic compact objects (ECOs), such as wormholes, which do not have an event horizon.

"The final part of the gravitational signal detected by these two detectors - what is known as ringdown - corresponds to the last stage of the collision of two black holes, and has the property of completely extinguishing after a short period of time due to the presence of the event horizon," explain the Spanish researchers Pablo Bueno and Pablo A. Cano from KU Leuven University (Belgium).

"However, if there were no horizon, those oscillations would not disappear completely; instead, after a certain time, they would produce a series of 'echoes,' similar to what happens with sound in a well. Interestingly, if instead of black holes, we had an ECO, the ...Read More...

# Special Read:

## Science Fiction Wormholes Don't Exist



Artist's concept of the mouth of a wormhole. Leah Tiscione / S&T

It's a standard sci-fi trope: Space travelers in a hurry pop into a wormhole and reach a distant part of the galaxy faster than light could traverse the space in between. The scenario is not entirely divorced from reality, since in certain circumstances wormholes are theoretically possible.

But unfortunately for spacefarers, even if wormholes do exist, they are not a solution for faster-than-light travel. In fact any trip through a wormhole would take longer than the same trip through normal space.

Some of you may have just gasped. How will Odo find his fellow Changelings? Did Major Samantha Carter lie to us for 10 seasons of stargate adventures?

Theorists are still figuring out the nuances of wormhole physics, but as Juan Maldacena (Institute for Advanced Study) explained at the Black Hole Initiative Annual Conference in Cambridge, Massachusetts, both quantum and gravitational constraints would prevent wormhole travel from breaking the cosmic speed limit. But they could potentially permit a "long" wormhole to exist, one that enabled slower travel between regions, at least as measured by someone outside the tunnel.

Think of spacetime as a rubber sheet. It can curve, warp, and so on — be distorted into a saddle shape or closed in on itself like a sphere. Not all setups are equal: Some configurations change the way points on the sheet's surface are connected to one another. The nature of a surface's inherent connectness is called its topology. . ...Read More...

## This Week's Sky at a Glance
## June 16-22, 2018

| | | | |
|---|---|---|---|
| **Jun 16** | **Sa** | 17:13 | Moon-Venus: 2.3° N |
| | | 21:50 | Moon Ascending Node |
| | | 23:38 | Moon-Beehive: 1.5° N |
| **Jun 18** | **Mo** | 11:25 | Moon-Regulus: 1.7° S |
| **Jun 20** | **We** | 06:21 | Venus-Beehive: 0.4° N |
| | | 14:51 | First Quarter |
| **Jun 21** | **Th** | **14:07** | **Summer Solstice** |

# Shawwal Crescent 1439 AH Observed by Sharjah Observatory (SCASS)

## Shawwal 1439 AH

It was a very young Shawwal crescent. Only about 19.5 hours and at an altitude of about 7.7⁰ by sunset time. This is what the Sharjah observatory was able to observe on June 14, 2018 marking the end of Ramadhan 1439 AH. Sky conditions were perfect. The large 17" telescope of the observatory was used to get a glimpse of a very tiny crescent. The first picture was take at 7:10 pm, just one minute after sunset. An integration time of only 0.01 sec was needed to get it using the telescope CCD camera. This is the first time that the Sharjah Observatory was able to spot a 19.5 hour crescent.