August 20, 2016 Dhu'l Qiddah 16, 1437 AH Volume 6, Issue 34

# Astronomy & Physics Weekly News

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

مركز الشارقة لعلوم الفضاء والفلك
Sharjah Center for Astronomy & Space Sciences

## Top News

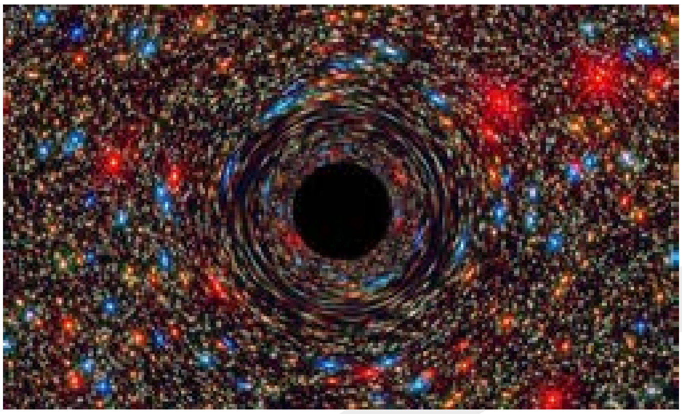


**New Weekly Addition:**
This Week's Sky at a Glance, Aug. 20-26

جامعة الشارقة
UNIVERSITY OF SHARJAH

IT Support Issam Jami Design by Mohamed Bakir

# Physicist claims to have observed quantum effects of Hawking radiation in the lab for the first time



This computer-simulated image shows a supermassive black hole at the core of a galaxy. The black region in the center represents the black hole's event horizon, where no light can escape the massive object's gravitational grip. The black hole's powerful gravity distorts space around it like a funhouse mirror. Light from background stars is stretched and smeared as the stars skim by the black hole. Credit: NASA, ESA, and D. Coe, J. Anderson, and R. van der Marel (STScI)

Jeff Steinhauer, a physicist at the Israel Institute of Technology, has published a paper in the journal Nature Physics describing experiments in which he attempted to create a virtual black hole in the lab in order to prove that Stephen Hawking's theory of radiation emanating from black holes is correct —though his experiments are based on sound, rather than light. In his paper, he claims to have observed the quantum effects of Hawking radiation in his lab as part of a virtual black hole—which, if proven to be true, will be the first time it has ever been achieved.

For many years, scientists believed that nothing could ever escape from a black hole. But in 1974, Stephen Hawking published a paper suggesting that something could—particles that are now called Hawking radiation. His idea was that if a particle (and its antimatter mate) appeared spontaneously at the edge of a black hole, one of the pair might be pulled into the black hole while the other escaped, taking some of the energy from the black hole with it—which would explain why black holes grow smaller and eventually disappear. Because such emissions are so feeble, no one has been able to measure Hawking radiation, so researchers have instead tried to build virtual black holes in labs to test the theory. One type of virtual black hole was proposed back in 1981 by Bill Unruh with the University of British Columbia—he suggested that an analogue might be created using water instead of light. He imagined a phonon existing at the edge of a waterfall—as the water speeds up, it begins to move faster than the speed of sound, causing it to be trapped. But if the phonon had an entangled mate that eluded ...Read More...

# Physicists confirm a possible 5th force

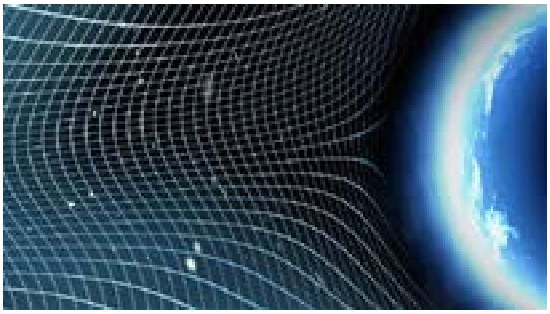


Image via sciencealert.com

Theoretical physicists speak of four fundamental forces of nature. They are gravity, electromagnetism, and the strong and weak nuclear forces that rule the inner workings of atoms. In recent months, the physics community has been buzzing with word of evidence for a possible 5th fundamental force. On August 14, 2016, physicists at University of California, Irvine announced they have confirmed evidence for this force on theoretical grounds, using experimental data acquired by Hungarian scientists in 2015. The journal Physical Review Letters has published the Irvine scientists' study.

Jonathan Feng, professor of physics and astronomy at University of California, Irvine and lead author of the new theoretical study said:

If confirmed by further experiments, this discovery of a possible 5th force would completely change our understanding of the universe, with consequences for the unification of forces and dark matter.

The UCI researchers analyzed data published last year from experimental nuclear physicists at the Hungarian Academy of Sciences. The Hungarian scientists, led by Attila Krasznahorkay, had been searching for dark photons, hypothetical elementary particles proposed as a carrier for dark matter. The Irvine scientists' statement said:

The Hungarians' work uncovered a radioactive decay anomaly that points to the existence of a light particle just 30 times heavier than an electron.

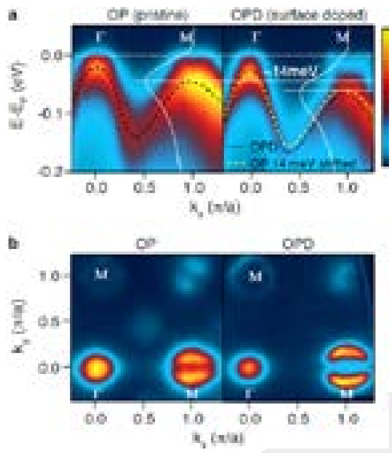
Feng explained:

The experimentalists weren't able to claim that it was a new force. They simply saw an excess of events that indicated a new particle, but it was not clear to them whether it was a matter particle or a force-carrying particle.

After study the Hungarian researchers data, as well as previous experiments in this area, the UCI group was able to show on theoretical grounds that the evidence strongly disfavors both matter particles and dark photons. They proposed a new theory that synthesizes the existing data and determined that the discovery could indicate a 5th fundamental force.

The statement about the new work said it demonstrates that, instead of being a dark photon, the particle may be what scientists call a protophobic X boson. ...Read More...

# Enhanced electron doping on iron superconductors discovered



Before and after the attachment of alkaline metals to the surface of iron-based, pniktogen superconductors.
(a) Quantity of momentum of electrons (X) and kinetic energy of electrons (Y) before and after the electron doping : electron doping has changed the distribution of electron kinetic energy.
(b) Fermi surface data before and after the electron doping: nesting condition has been weakened. Credit: IBS

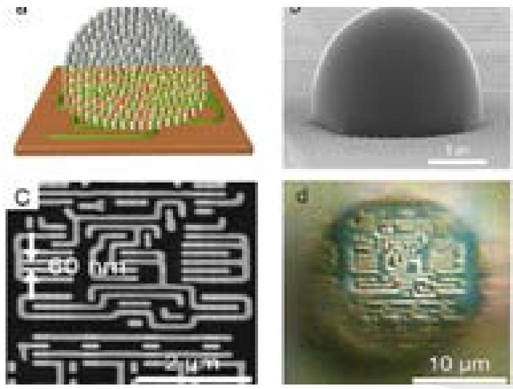
The Institute for Basic Science research team headed by the associate director of CCES, KIM Chang Young, presented the possibility of unifying theories to explain the working mechanism of iron- based superconductors.

Their research was published in Nature Materials on August 16th. Superconductors are a relatively new concept; they were brought to prominence in the late 80's when two Nobel Prize winners discovered a new superconducting material. The basic principle of superconductivity arises when a superconducting material is cooled to a fairly low critical temperature allowing an electric current to flow without resistance.

**Building on a Nobel Prize**

The Nobel Prize winners reported their superconducting material - oxides which contain copper and rare earth metals - becomes a superconducting material below -250° Celsius, higher than the previous temperature of -269° Celsius. This led to a boom in developing similar materials for commercial use. Today's research has moved on greatly; oxides are replaced with iron-based superconductors which are cheaper to mass produce and also permit a current to flow unabated. To understand the working mechanism of iron-based superconductors scientists have to significantly raise the transition temperatures to source the reason for the increase. Many researchers initially work on the assumption that the nesting effect is a dominant factor, especially in the case of pnictide superconductors {PSD}. Later, scientists discovered another type of superconductor, chalogenide superconductors {CSD}. Since it turned out that CSD is not subject to the nesting effect, the discovery of CSD generated controversy on the mechanism of their superconductivity. The nesting effect states when the surface temperature is increased, electrons become unstable thereby altering their properties both electrically and magnetically, allowing conductors to turn into superconductors. ..Read More...

# Seeing the invisible: Visible light superlens made from nanobeads



(a) Conceptual drawing of nanoparticle-based metamaterial solid immersion lens (mSIL) (b) Lab made mSIL using titanium dioxide nanoparticles (c) SEM image of 60 nm sized imaging sample (d) corresponding superlens imaging of the 60 nm samples by the developed mSIL. Credit: Bangor University Fudan University

Nanobeads are all around us- and are, some might argue, used too frequently in everything from sun-screen to white paint, but a new ground-breaking application is revealing hidden worlds.

A paper in Science Advances (12 August) provides proof of a new concept, using new solid 3D superlenses to break through the scale of things previously visible through a microscope.

Illustrating the strength of the new superlens, the scientists describe seeing for the first time, the actual information on the surface of a Blue Ray DVD. That shiny surface is not as smooth as we think. Current microscopes cannot see the grooves containing the data- but now even the data itself is revealed.

Led by Dr Zengbo Wang at Bangor University, UK and Prof Limin Wu at Fudan University, China, the team created minute droplet-like lens structures on the surface to be examined. These act as an additional lens to magnify the surface features previously invisible to a normal lens.

Made of millions of nanobeads, the spheres break up the light beam. Each bead refracts the light, acting as individual torch-like minute beam. It is the very small size of each beam of light which illuminate the surface, extending the resolving ability of the microscope to record-breaking levels. The new superlens adds 5x magnification on top of existing microscopes.

Extending the limit of the classical microscope's resolution has been the 'El Dorado' or 'Holy Grail' of microscopy for over a century. Physical laws of light make it impossible to view objects smaller than 200 nm - the smallest size of bacteria, using a normal microscope alone. However, superlenses have been the new goal since ...Read More...

# Earth-like planet around Proxima Centauri discovered

Artist's impression of a sunset seen from the surface of an Earth-like exoplanet. Credit: ESO/L. Calçada

The hunt for exoplanets has been heating up in recent years. Since it began its mission in 2009, over four thousand exoplanet candidates have been discovered by the Kepler mission, several hundred of which have been confirmed to be "Earth-like" (i.e. terrestrial). And of these, some 216 planets have been shown to be both terrestrial and located within their parent star's habitable zone (aka. "Goldilocks zone").

But in what may prove to be the most exciting find to date, the German weekly Der Spiegel announced recently that astronomers have discovered an Earth-like planet orbiting Proxima Centauri, just 4.25 light-years away. Yes, in what is an apparent trifecta, this newly-discovered exoplanet is Earth-like, orbits within it's sun's habitable zone, and is within our reach. But is this too good to be true?

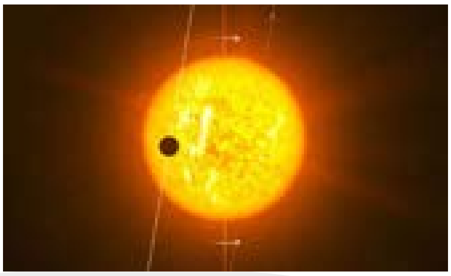
For over a century, astronomers have known about Proxima Centauri and believed that it is likely to be part of a trinary star system (along with Alpha Centauri A and B). Located just 0.237 ± 0.011 light years from the binary pair, this low-mass red dwarf star is also 0.12 light years (~7590 AUs) closer to Earth, making it the closest star system to our own.

In the past, the Kepler mission has revealed several Earth-like exoplanets that were deemed to be likely habitable. And recently, an international team of researchers narrowed the number of potentially-habitable exoplanets in the Kepler catalog down to the 20 that are most likely to support life. However, in just about all cases, these planets are hundreds (if not thousands) of light years away from Earth.

Knowing that there is a habitable planet that a mission from Earth could reach within our own lifetimes is nothing short of amazing! But of course, there is reason to be cautiously optimistic. Citing anonymous sources, the magazine stated:

"The still nameless planet is believed to be Earth-like and orbits at a distance to Proxima Centauri that could allow it to have liquid water on its surface—an important requirement... Read More...

# It's all in the rotation: Exploring planets orbiting distant stars



An artist's impression of the polar orbit of WASP-79b. Credit: ESO/B Addison, CC BY-NC

The first of a two part series that looks at what astronomers can find out about the planets that are discovered orbiting other stars in our galaxy.

With the discovery so far of more than 3,300 planets orbiting other stars, the challenge now is to learn more about these distant worlds.

The mere act of discovering an exoplanet gives some information about its nature.

With the two main planet detection techniques – the radial velocity and transit methods – we see a star wobbling or winking, periodically.

The period of the wobble, or the time between winks, tells us the orbital period. From the orbital period, we calculate the size of the planet's orbit. The closer a planet is to its star, the shorter its orbital period.

For planets discovered using the radial velocity technique we can learn a little more about the planet's orbit by studying the way that the host star wobbles. The more circular the planet's orbit, the more regular will be the wobble.

But our observations have revealed that some planets move on orbits that are far from circular. And, as we've discussed before, such planets are an important piece of our best explanation of the origin of some of the strangest planets found to date.

**Measuring up**

The radial velocity method also allows us to estimate the planet's mass. A more massive planet, moving on the same orbit, would cause a larger wobble. But because we're not actually seeing the planet, we don't know the tilt of its orbit to our line of sight.

As a result, the mass we estimate is the minimum the planet could have, assuming that its orbit is edge-on. And we have no idea of the planet's physical size, just an estimate of its mass.

The transit method, by contrast, allows us to work out the physical size of the planet, by measuring the amount of light it obscures during a transit. The bigger the planet, the more light it obscures, and the larger the wink of its host star. But this gives us no information about a planet's mass. ..Read More...

# Researchers demonstrate acoustic levitation of a large sphere

Acoustic levitation of a polystyrene sphere, the first spherical object to be acoustically levitated that is larger than the acoustic wavelength. Credit: Andrade et al. ©2016 AIP Publishing

When placed in an acoustic field, small objects experience a net force that can be used to levitate the objects in air. In a new study, researchers have experimentally demonstrated the acoustic levitation of a 50-mm (2-inch) solid polystyrene sphere using ultrasound—acoustic waves that are above the frequency of human hearing.

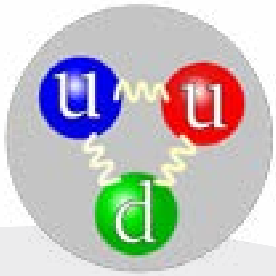
The demonstration is one of the first times that an object larger than the wavelength of the acoustic wave has been acoustically levitated. Previously, this has been achieved only for a few specific cases, such as wire-like and planar objects. In the new study, the levitated sphere is 3.6 times larger than the 14-mm acoustic wavelength used here.

The researchers, Marco Andrade and Julio Adamowski at the University of São Paulo in Brazil, along with Anne Bernassau at Heriot-Watt University in Edinburgh, UK, have published a paper on the acoustic levitation demonstration in a recent issue of Applied Physics Letters.

"Acoustic levitation of small particles at the acoustic pressure nodes of a standing wave is well-known, but the maximum particle size that can be levitated at the pressure nodes is around one quarter of the acoustic wavelength," Andrade told Phys.org. "This means that, for a transducer operating at the ultrasonic range (frequency above 20 kHz), the maximum particle size that can be levitated is around 4 mm. In our paper, we demonstrate that we can combine multiple ultrasonic transducers to levitate an object significantly larger than the acoustic wavelength. In our experiment, we could increase the maximum object size from one quarter of the wavelength to 50 mm, which is approximately 3.6 times the acoustic wavelength."

Although there are several different ways to acoustically levitate an object, most methods use an ultrasonic transducer, which converts electrical signals ...Read More...

# New measurement with deuterium nucleus confirms proton radius puzzle is real




New measurement with deuterium nucleus confirms proton radius puzzle is real

A large team made up of researchers from across the globe has repeated experiments conducted several years ago that showed a different radius for a proton when it was orbited by a muon as opposed to an electron—a finding dubbed the proton radius puzzle—using a deuterium nucleus this time and has found the same puzzle. In their paper published in the journal Science, the team describes the experiments they conducted, what they found and offer a few possible ideas to help dispel the notion that the puzzle indicates that there may be some problems with the Standard Model.

Scientists have been able to calculate the radius of a proton (0.88 ± 0.01 femtometers) for some time using the charge of the electron that orbits around it and doing so has helped confirm theories regarding the Standard Model. But, in trying to improve the accuracy of the measurement by using a negatively charged muon (which orbits closer to the proton), researchers at the Max Planck Institute back in 2010 found a different radius—one that was 7 deviations from what was considered the official value. This proton radius puzzle has had physicists scratching their heads ever since because it suggests there is an error in the Standard Model somewhere. Over the past six years various researchers have offered theories to solve the puzzle, most of which have involved ways to preserve the Standard Model, but to date, the puzzle still remains.

In this latest effort the researchers sought to gain more insight into the problem by adding another piece to the puzzle, a neutron, i.e. by using a deuterium nucleus. Their thinking was that the presence of the neutron would change the way that electrons and muons perceived the proton charge. They report that they found that the measurement they made of the radius of the proton was still different from that found with just an electron and proton, by approximately 7.5 sigma. The results by the team offer no new explanations for the measurement discrepancies—it remains a puzzle, but they do offer ...Read More...

# Beyond Neptune, a chunk of ice is orbiting the Sun in the wrong direction

An artist's concept of a trans-Neptunian object(TNOs). The distant sun is reduced to a bright star at a distance of over 3 billion miles. Credit: NASA

Beyond the orbit of Neptune, the farthest recognized-planet from our Sun, lies the mysteries population known as the Trans-Neptunian Object (TNOs). For years, astronomers have been discovering bodies and minor planets in this region which are influenced by Neptune's gravity, and orbit our Sun at an average distance of 30 Astronomical Units.

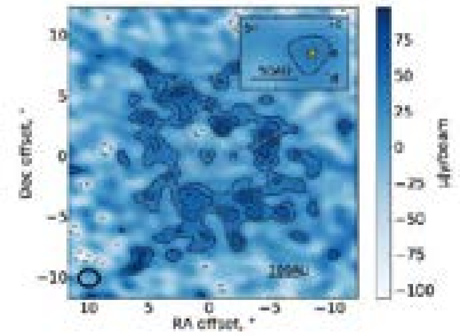
In recent years, several new TNOs have been discovered that have caused us to rethink what constitutes a planet, not to mention the history of the Solar System. The most recent of these mystery objects is called "Niku", a small chunk of ice that takes its name for the Chinese word for "rebellious". And while many such objects exist beyond the orbit of Neptune, it is this body's orbital properties that really make it live up to the name!

In a paper recently submitted to arXiv, the international team of astronomers that made the discovery explain how they found the TNO using the Panoramic Survey Telescope and Rapid Response System 1 Survey (Pan-STARRS 1). Measuring just 200 km (124 miles) in diameter, this object's orbit is tilted 110° to the plane of the Solar system and orbits the Sun backwards.

Ordinarily, when planetary systems form, angular momentum forces everything to spin in the same direction. Hence why, when viewed from the celestial north pole, all the objects in our Solar System appear to be orbiting the Sun in a counter-clockwise direction. So when objects orbit the Sun in the opposite direction, an outside factor must be at play.

What's more, the team compared the orbit of Niku with other high-inclination TNOs and Centaurs, and noticed that they occupy a common orbital plane and experience a clustering effect. As Dr. Matthew J. Holman – a professor at the Harvard-Smithsonian Center for Astrophysics and one of the researchers on the team – told ...Read More...

# Resolving the planetesimal belt around HR8799



A submillimeter image of the planetesimal disk around the star HR8799, the first directly imaged system of four exoplanets and their dust disk. The insert shows the innermost region of the system and the location of the four exoplanets. Credit: ALMA; Booth et al.

Planets develop from the dusty placental disk of material that surrounds a star after it begins to shine. The dust in that disk, according to most models, starts to stick to itself until clumps develop large enough to attract other clumps gravitationally. Astronomers believe the process of building planets and dissipating the disk takes about ten million years. Many mysteries remain, however, including the tendency of dust not to stick together, and the likelihood that colliding clumps could break apart rather than agglomerate. Recent discoveries of exoplanets have begun to overlap with studies of planetesimal disks, and enable astronomers to probe the development and evolution of a star's system of planets and their interactions with the disk.

Direct imaging of dust disks has been very limited, and so far has principally probed regions in disks at the outer zones of planetary systems – analogous to the Kuiper Belt in our own solar system. At the same time, the vast majority of exoplanets discovered and studied so far have been very close to the star, even within a distance that in the solar system would be within the orbit of Mercury. The star HR8799 is so far the only star around which direct imaging has found multiple planets. Its circumstellar disk has been known to exist for several decades, and has been modeled as having three zones: an inner asteroid belt analogue, a planetesimal belt from about one hunded astronomical units (au) to about 430 au, and a halo region extending out to over 1500 au.

CfA astronomer Denis Barkats has joined a team of colleagues to use the giant ALMA submillimeter array to image the disk around HR8799 with a spatial scale as small as only thirty-two au, enough to probe the inner zones of the disk. The team has determined that the inner edge of the planetesimal belt actually starts at around 145 au, and that the belt extends out to 430 au.

The known four exoplanets in this system orbit within this inner edge. The most distant of these four planets, planet b, has a chaotic orbit that is expected ...Read More...

# Will our black hole eat the Milky Way?


Sagittarius A*. Image credit: Chandra

Want to hear something cool? There's a black hole at the center of the Milky Way. And not just any black hole, it's a supermassive black hole with more than 4.1 million times the mass of the Sun.

It's right over there, in the direction of the Sagittarius constellation. Located just 26,000 light-years away. And as we speak, it's in the process of tearing apart entire stars and star systems, occasionally consuming them, adding to its mass like a voracious shark.

Wait, that doesn't sound cool, that sort of sounds a little scary. Right?

Don't worry, you have absolutely nothing to worry about, unless you plan to live for quadrillions of years, which I do, thanks to my future robot body. I'm ready for my singularity, Dr. Kurzweil.

Is the supermassive black hole going to consume the Milky Way? If not, why not? If so, why so?

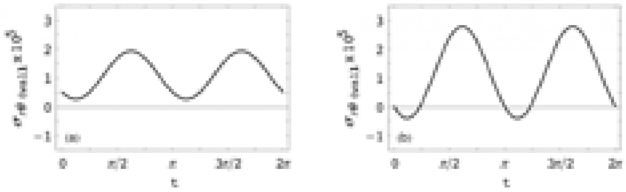
The discovery of a supermassive black hole at the heart of the Milky Way, and really almost all galaxies, is one of my favorite discoveries in the field of astronomy. It's one of those insights that simultaneously answered some questions, and opened up even more.

Back in the 1970s, the astronomers Bruce Balick and Robert Brown realized that there was an intense source of radio emissions coming from the very center of the Milky Way, in the constellation Sagittarius.

They designated it Sgr A*. The asterisk stands for exciting. You think I'm joking, but I'm not. For once, I'm not joking.

In 2002, astronomers observed that there were stars zipping past this object, like comets on elliptical paths going around the Sun. Imagine the mass of our Sun, and the tremendous power it would take to wrench ...Read More...

# Studying blood flow dynamics to identify the heart of vessel failure



Circumferential wall stress vs. time, for Womersley number α = 20. The left figure (a) corresponds to the matched asymptotic expansions solution. The right figure (b) corresponds to the single solution and shows when during the cardiac cycle the stress becomes zero or changes direction at an angle α = π/2 on the arterial wall. Credit: Gerasimos A.T. Messaris, Maria Hadjinicolaou and George T. Karahalios

When plaque, fatty deposits that build up on the inside of arteries, rupture and block blood flow, the results can be deadly. Such hardening of the arteries, also called atherosclerosis, typically leads to heart disease, the leading cause of death in the United States. Despite years of therapeutic advances, scientists are still figuring out how and why these deposits develop, searching for a way to reduce the number of heart attacks and strokes.
Now, new research from a fluid mechanics team in Greece reveals how blood flow dynamics within blood vessels may influence where plaques develop or rupture this week in Physics of Fluids. The findings could one day help doctors identify weak spots on a vessel wall that are likeliest to fail, and lead to early interventions in treating heart disease.

In the study, the scientists developed a computer-based analytical solution that helps predict sites of vessel failure based on computations of disease-causing flow. They represented the complex blood flow within the heart during a cardiac cycle—the complete sequence of events in the heart from the beginning of one beat to the next.

The research improves predictions of circumferential wall stress or the forces inside the blood vessel compared to other methods. "This is a factor that may contribute ... to the faster aging of the arterial system and the possible malfunction of the aorta," said lead researcher Gerasimos A.T. Messaris, a medical physicist at the University Hospital of Patras in Greece.

The team includes investigators from the Medical Physics Department of the University Hospital of Patras, the School of Science and Technology of the Hellenic Open University and the Division of ...Read More...

## New Weekly Addition:

### This Week's Sky at a Glance, Aug. 20-26

Aug 22 Moon at perigee (367047 km) – Local Time: 05:20
Aug 25 Last Quarter (07:40) - Meridian passage (06:08) – Altitude: 81°
Aug 25 Mars 4.4°S of Saturn – Local Time: 21:54

## All Five Naked Eye Planets Visible:

Jupiter is getting lower and lower day after each sunset, while Mars and Saturn are still making the show. Try to spot Mercury below Jupiter.


A nice get together of Mars, Saturn, and Antares over the mountains of Azeffoun (Algeria) - Aug. 17, 2016 - Photo Credit: Ridwan Fernini

مـركـز الشـارقـة لعـلـوم الفضـاء والفـلك
Sharjah Center for Astronomy & Space Sciences
Sharjah Center for Astronomy and Space Sciences
Sharjah, United Arab Emirates
Phone: 00-971-6-5166000
Website: www.scass.ae
E-mail: scass@scass.ae

جامعـــة الشـــــارقة
UNIVERSITY OF SHARJAH
College of Sciences - University of Sharjah
POB 27272 - Sharjah, United Arab Emirates
Phone: 00-971-6-5050351
Email: physics@sharjah.ac.ae