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Astronomy & Physics Weekly News

Dept. of Applied Physics & Astronomy - **University of Sharjah**
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مركز الشارقة لعلوم الفضاء والفلك
Sharjah Center for Astronomy & Space Sciences

Top News

NASA climate modeling suggests Venus may have been habitable

The fourth state of matter, plasma: A technology to improve bone healing? 2

Photonic hypercrystals drastically enhance light emission in 2D materials

The LHC MoEDAL experiment publishes its first paper on its search for magnetic monopoles 3

Curiosity Has Disproved 'Old Idea of Mars as a Simple Basaltic Planet'

Astronomers discover new substellar companion to the Pleiades member star 4

Experiments point toward memory chips 1,000 times faster than today's

5 Evidence mounts that neutrinos are the key to the universe's existence

Among galaxies, a voracious flea

6 IceCube search for the 'sterile neutrino' draws a blank

Much ado about nothing: Astronomers use empty space to study the universe

7 Astrophysicists discover mechanism for spiral-arm formation in disk galaxies

New Weekly Addition:

This Week's Sky at a Glance, Aug. 13-19

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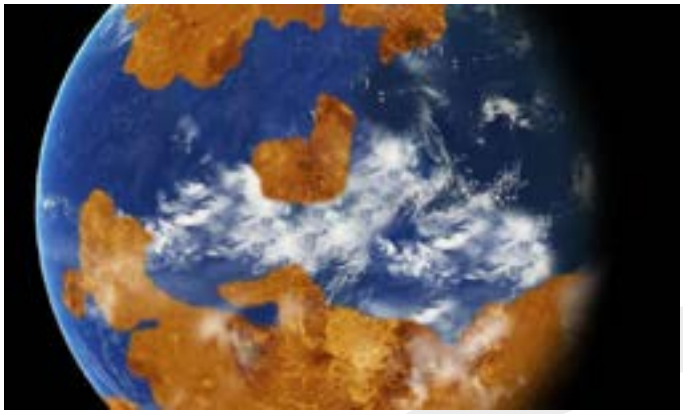
NASA climate modeling suggests Venus may have been habitable



Observations suggest Venus may have had water oceans in its distant past. A land-ocean pattern like that above was used in a climate model to show how storm clouds could have shielded ancient Venus from strong sunlight and made the planet habitable. Credit: NASA

enus may have had a shallow liquid-water ocean and habitable surface temperatures for up to 2 billion years of its early history, according to computer modeling of the planet's ancient climate by scientists at NASA's Goddard Institute for Space Studies (GISS) in New York.

The findings, published this week in the journal Geophysical Research Letters, were obtained with a model similar to the type used to predict future climate change on Earth. "Many of the same tools we use to model climate change on Earth can be adapted to study climates on other planets, both past and present," said Michael Way, a researcher at GISS and the paper's lead author. "These results show ancient Venus may have been a very different place than it is today."

Venus today is a hellish world. It has a crushing carbon dioxide atmosphere 90 times as thick as Earth's. There is almost no water vapor. Temperatures reach 864 degrees Fahrenheit (462 degrees Celsius) at its surface.

Scientists long have theorized that Venus formed out of ingredients similar to Earth's, but followed a different evolutionary path. Measurements by NASA's Pioneer mission to Venus in the 1980s first suggested Venus originally may have had an ocean. However, Venus is closer to the sun than Earth and receives far more sunlight. As a result, the planet's early ocean evaporated, water-vapor molecules were broken apart by ultraviolet radiation, and hydrogen escaped to space. With no water left on the surface, carbon dioxide built up in the atmosphere, leading to a so-called runaway greenhouse effect that created present conditions. ...Read More...

The fourth state of matter, plasma: A technology to improve bone healing?

Nanosecond cold-plasma treatment. Credit: The laboratory of Theresa Freeman, Thomas Jefferson University.

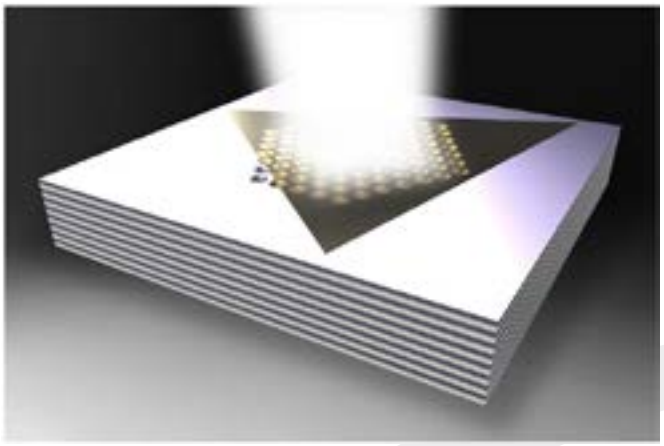
Cold plasma looks like the glow from the "Star Wars" blue light saber but this beam of energy, made of electrons that change polarity at micro-second or nanosecond speeds, could help bones heal faster, according to a study published August 11th in the Journal of Tissue Engineering and Regenerative Medicine.

Most people interact with plasma every day. It's in our TVs, fluorescent lights, lightning, the aurora borealis, and the sun. However, these are all examples of hot or "thermal" plasmas. Since the discovery of cold plasma, about 20 years ago, it has been used in agriculture to sterilize the surface of fruit without damaging the delicate edibles. More recently, scientists have been performing experiments treating living animal cells and tissues with cold plasma to learn more about its potential applications in medicine.

"We've previously studied how different applications of cold plasma can either directly kill cells, such as in skin cancer, or help them grow, as in developing bones. In this study, we asked how cold plasma would affect the area surrounding cells, known as the extracellular matrix," says lead author Theresa Freeman, Ph.D., Associate Professor in the Department of Orthopedic Surgery in the Sidney Kimmel Medical College at Thomas Jefferson University. The extracellular matrix around cells is made of collagen and other proteins that interact with the cells and can influence their growth and behavior. For example, the extracellular matrix can either promote or inhibit bone formation or cancer cell growth and metastasis.

"We showed that matrix treated with cold plasma generated using microsecond pulsing can promote differentiation of cells into cartilage and increase bone formation," says Dr. Freeman. "Conversely, we showed matrix treated with nanosecond-pulsed cold plasma inhibited cell differentiation and bone formation." ...Read More...

Photonic hypercrystals drastically enhance light emission in 2D materials



IIllustration of a photonic hypercrystal with a 2D material on top. Credit: Galfsky et al. ©2016 American Chemical Society

Researchers have developed a method for achieving an order-of-magnitude enhancement of the light emission from a class of two-dimensional (2D) materials called transition metal dichalcogenides (TMDs). The large light enhancement arises when the 2D material is placed on a photonic hypercrystal, which is an artificial optical material first proposed in 2014 by Evgenii E. Narimanov at Purdue University, who is one of the authors of the new study.

The research team is led by Vinod M. Menon, a physics professor at the City College of the City University of New York (CUNY), and Yi-Hsien Lee, a professor of materials science and engineering at National Tsing-Hua University in Hsinchu, Taiwan. Their work is published in a recent issue of Nano Letters.

In recent years, 2D materials such as 2D TMDs have attracted a great deal of attention because their atomic-scale thickness leads to exceptional electronic and optical properties, making them potential candidates for future optoelectronic devices.

2D TMDs are particularly appealing because they spontaneously emit light due to their direct band gaps, which enables electrons to directly emit photons. Currently, however, 2D TMDs don't produce enough light to make them useful as practical light-emitting devices.

In the new study, the researchers have shown that photonic hypercrystal substrates can transform low-light-emitting TMDs into much brighter sources of light.

The researchers designed a photonic hypercrystal by patterning a periodic lattice of holes, each about 100 nanometers in diameter, in a hyperbolic metamaterial. When 2D TMDs, such as WS2 or MoS2 flakes, are placed on top of the photonic hypercrystal, the light emitted by the TMDs is enhanced due to the large number of photonic states inside the hypercrystal.

For the WS2 flakes, this coupling makes the overall light intensity 56 times greater than it is on a reference substrate, and seven times greater than it is on a hyperbolic metamaterial alone (without the holes). The design also concentrates the emission so that it can be focused in a specific direction. ..Read More...

The LHC MoEDAL experiment publishes its first paper on its search for magnetic monopoles

Magnetic monopoles and dipoles. Credit: CERN

In a paper published by the journal JHEP today, the MoEDAL experiment at CERN1 narrows the window of where to search for a hypothetical particle, the magnetic monopole. Over the last decades, experiments have been trying to find evidence for magnetic monopoles at accelerators, including at CERN's Large Hadron Collider. Such particles were first predicted by physicist Paul Dirac in the 1930s but have never been observed so far.

"Today MoEDAL celebrates the release of its first physics result and joins the other LHC experiments at the discovery frontier," says Spokesperson of the MoEDAL experiment, James Pinfold.

Just as electricity comes with two charges, positive and negative, so magnetism comes with two poles, North and South. The difference is that while it's easy to isolate a positive or negative electric charge, nobody has ever seen a solitary magnetic charge, or monopole. If you take a bar magnet and cut it in half, you end up with two smaller bar magnets, each with a North and South pole. Yet theory suggests that magnetism could be a property of elementary particles. So just as electrons carry negative electric charge and protons carry positive charge, so magnetic monopoles could in theory carry a North or a South pole.

If monopoles exist, they are believed to be very massive. As the LHC produces collisions at unprecedented energy, physicists may be able to observe such particles if they are light enough to be in the LHC's reach. For instance, high-energy photon-photon interactions could produce pairs of North and South monopoles. Monopoles could manifest their presence via their magnetic charge and through their very high ionizing power, estimated to be about 4700 times higher than that of the protons. The MoEDAL experiment at the LHC is designed specifically to look at these effects. ...Read More...

Curiosity Has Disproved 'Old Idea of Mars as a Simple Basaltic Planet'

As part of the fourth year celebration NASA has released a smartphone game, which lets users control their own MSL across the rugged terrain of Mars searching for water.

As NASA's Mars Science Laboratory (MSL) celebrates four years on the Red Planet Leicester planetary scientist Professor John Bridges recounts the mission's success and explains what is next for the one-ton nuclear-powered science robot.

The Curiosity rover hit the dusty surface of Mars on 6 August 2012 - and began its mission of finding evidence about whether ancient Mars offered environmental conditions conducive for microbial life.

In March 2013 NASA reported that it had achieved its primary objective after scientists found evidence of oxygen, nitrogen, hydrogen, sulphur, phosphorous and carbon - all essential for supporting living organisms.

Now, the mission, which was scheduled to end this year, has recently been given a two-year extension, with the University of Leicester's Professor John Bridges continuing as part of the extended NASA science team.

He said: "It's been a great four years - from the excitement of landing we have now had 1421 Martian days of operations and driven 13.6 km.

"We have learnt an enormous amount about Mars.

"The old idea of Mars as a simple basaltic planet that experienced a few catastrophic floods has been disproved.

"We have encountered ancient lakes and a silica rich crust.

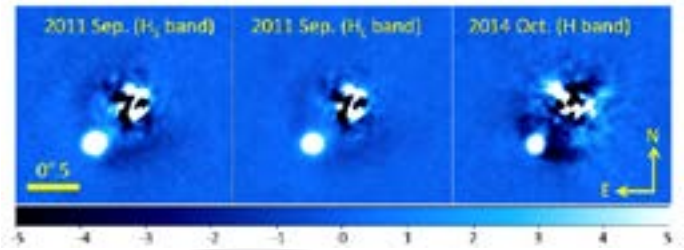
"Our laser - ChemCam - has made over 350,000 shots on Mars and we are busily interpreting the data.

"Our plutonium power source can keep us going for years to come.

"For the next few years we will gradually climb further up Mount Sharp, at the moment we are in foothills called Murray Buttes."

As part of the fourth year celebration NASA has... Read More...

Astronomers discover new substellar companion to the Pleiades member star



Final Pleiades HII 3441 images. (Left) reduced HS -band image taken in the 2011 observation. (Middle) reduced HL-band image taken in the 2011 observation. (Right) reduced H-band image taken in the 2014 observation. All images were analyzed using standard ADI. Pleiades HII 3441B can be seen southeast of the primary star. There is no methane absorption in Pleiades HII 3441B when left and middle panels are compared. Credit: Konishi et al., 2016.

An international team of astronomers has found a new substellar mass companion to one of the stars in the Pleiades open cluster. The discovery could contribute to our understanding of stellar and substellar multiplicity as well as formation mechanisms in this cluster. A study detailing the new findings was published Aug. 5 on the arXiv pre-print server.

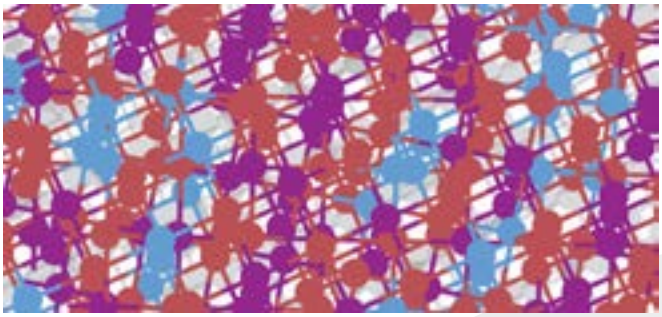
Due to its proximity, the well-known Pleiades cluster is frequently observed and studied by amateur and professional astronomers. The cluster, located some 440 light years away, is about 120 million years old, which makes it one of the nearest young open clusters. It is also a great target for searching new low-mass substellar objects such as brown dwarfs.

From 2011 to 2015, an international team of researchers led by Mihoko Konishi of the National Astronomical Observatory of Japan conducted a series of observations of the cluster's member star, designated Pleiades HII 3441, looking for planetary-mass and substellar companions. These observations were part of the Strategic Explorations of Exoplanets and Disks with Subaru (SEEDS) survey, which uses adaptive optics assisted high contrast imaging for studying planets and disks, including primordial systems, transitional systems and mature systems. The survey utilizes the 8.2 Subaru Telescope located on Mauna Kea, Hawaii. The newly detected object was named Pleiades HII 3441B. According to the study, it was found southeast of the primary star with a projected separation of about 66 AU.

"A companion candidate was detected southeast of the primary star, and subsequently confirmed as a companion object to the primary star. (...) The projected separation and position angle are 0."49 ± 0."02 (66 ± 2 AU) and 136.4° ± 3.2°, respectively. These values were derived by averaging all observations," the researchers wrote in the paper.

The mass of Pleiades HII 3441B was calculated to be approximately 68 Jupiter masses and its temperature was estimated to be 2,700 K. Moreover, the team found that there is no methane absorption in the atmosphere of this substellar companion. They emphasized that methane is considered to ..Read More...

Experiments point toward memory chips 1,000 times faster than today's



This animation shows how data is stored using phase-change memory technology. Phase-change materials can exist in two atomic structures, disordered or ordered. An electric jolt flip-flops these structures back and forth to form the zeroes and ones of digital software. Credit: Tricia Seibold

Silicon memory chips come in two broad types: volatile memory, such as computer RAM that loses data when the power is turned off, and nonvolatile flash technologies that store information even after we shut off our smartphones.

In general, volatile memory is much faster than nonvolatile storage, so engineers often balance speed and retention when picking the best memory for the task. That's why slower flash is used for permanent storage. Speedy RAM, on the other hand, works with processors to store data during computations because it operates at speeds measured in nanoseconds, or billionths of a second.

Now Stanford-led research shows that an emerging memory technology, based on a new class of semiconductor materials, could deliver the best of both worlds, storing data permanently while allowing certain operations to occur up to a thousand times faster than today's memory devices. The new approach may also be more energy efficient.

"This work is fundamental but promising," said Aaron Lindenberg, an associate professor of materials science and engineering at Stanford and of photon science at the SLAC National Accelerator Laboratory. "A thousandfold increase in speed coupled with lower energy use suggests a path toward future memory technologies that could far outperform anything previously demonstrated."

Lindenberg led a 19-member team, including researchers at SLAC, who detailed their experiments in Physical Review Letters.

Their findings provide new insights into the experimental technology of phase-change memory. ...Read More...

Evidence mounts that neutrinos are the key to the universe's existence

The T2K near detector. Credit: Imperial College London

New experimental results show a difference in the way neutrinos and antineutrinos behave, which could explain why matter persists over antimatter.

The results, from the T2K experiment in Japan, show that the degree to which neutrinos change their type differs from their antineutrino counterparts. This is important because if all types of matter and antimatter behave the same way, they should have obliterated each other shortly after the Big Bang.

So far, when scientists have looked at matter-antimatter pairs of particles, no differences have been large enough to explain why the universe is made up of matter – and exists – rather than being annihilated by antimatter.

Neutrinos and antineutrinos are one of the last matter-antimatter pairs to be investigated since they are difficult to produce and measure, but their strange behaviour hints that they could be the key to the mystery.

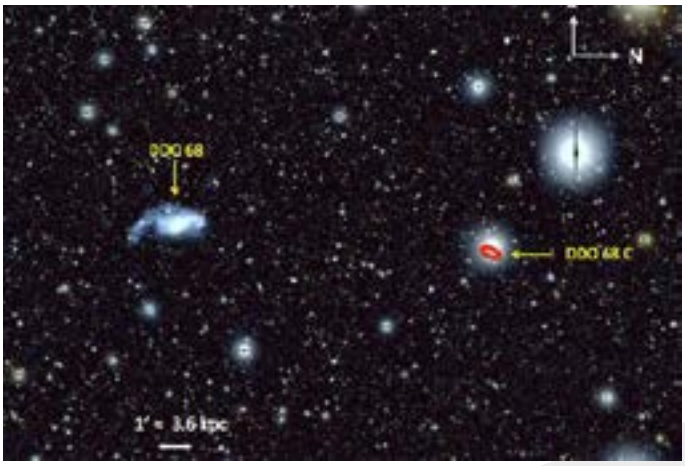
Flavour change

Neutrinos (and antineutrinos) come in three 'flavours' of tau, muon and electron, each of which can spontaneously change into the other as the neutrinos travel over long distances.

The latest results, announced today by a team of researchers including physicists from Imperial College London, show more muon neutrinos changing into electron neutrinos than muon antineutrinos changing into electron antineutrinos.

This difference in muon-to-electron changing behaviour between neutrinos and antineutrinos means they would have different properties, which could have prevented them from destroying each other and allow the universe to exist. ...Read More...

Among galaxies, a voracious flea



This visible-light image taken with the Large Binocular Telescope shows dwarf galaxy DDO 68, which lies in a comparatively "empty" region of space 39 million light-years from Earth, and one of its companion objects, DDO 68 C. The scale bar indicates a distance of 3.6 kiloparsecs, or just under 12,000 light-years. Credit: Francesca Annibali/INAF.

Even a dwarf galaxy with very low mass is capable of accreting smaller nearby galaxies, according to an international team of astronomers led by Francesca Annibali of INAF, the Italian National Institute for Astrophysics. This result has been achieved thanks to observations of the region surrounding the dwarf galaxy DDO 68, which has a total stellar mass of only 100 million solar masses, roughly one thousandth of the Milky Way.

Theoretical models predict hierarchical galaxy formation in which galaxies form by successive mergers of smaller systems at all scales. However, until now, direct observational evidence confirming these predictions was available only for massive galaxies and their smaller companions.

In the new study, Annibali and collaborators took advantage of the sensitivity and the large field of view of the Large Binocular Telescope, or LBT, located on Mt. Graham in southeastern Arizona (U.S.). The team discovered that DDO 68, a dwarf galaxy located in an isolated region of space defined as a "void," is actually surrounded by a number of smaller satellite galaxies, and is accreting them.

"In a way, what we saw reminded us of a quote by Jonathan Swift," Annibali said. "'So, naturalists observe, a flea has smaller fleas that on him prey; and these have smaller still to bite 'em; and so proceed ad infinitum.' It turns out that even the smallest of galaxies feed on companions that are even smaller, and so our paper bears that quote in its title."

DDO 68 is one of three known least-evolved galaxies among those that still form stars, with a chemical composition similar to predictions of the Big Bang. Scientists had already thought that its extremely irregular morphology—with a long tail hosting both stars ...Read More...

IceCube search for the 'sterile neutrino' draws a blank

The IceCube Laboratory at the Amundsen-Scott South Pole Station in Antarctica. Image courtesy Erik Beiser, IceCube/NSF.

In an effort to fill in the blanks of the Standard Model of particle physics, science has been conducting a diligent search for a hypothesized particle known as the "sterile neutrino." Now, with the latest results from an icy particle detector at the South Pole, scientists are almost certain that there is no such particle.

If discovered, the sterile neutrino would have added to the neutrino family portrait and helped explain a number of puzzles that suggest the existence of more than the three known flavors of neutrinos. Ultimately, such a particle could also help resolve the mystery of the origin of dark matter and the matter/antimatter asymmetry in the universe.

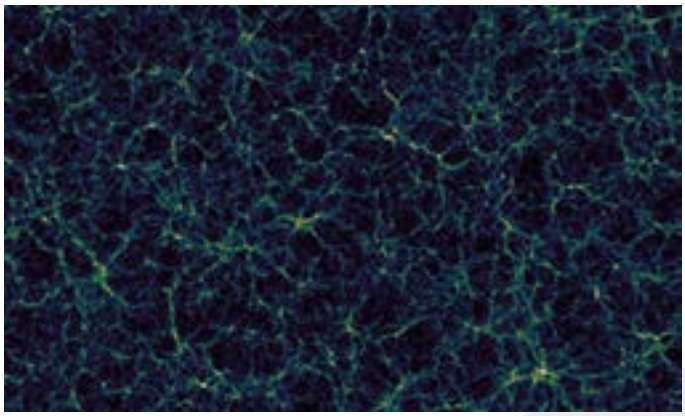
Neutrinos are ghostly particles with almost no mass and only rarely interact with matter. Trillions of neutrinos will course through your body in the time it takes to read this sentence. There are three known types of neutrinos: muon, electron and tau. Hints of a possible fourth type of neutrino have come from several experiments. Known as the "sterile neutrino," the hypothesized particle would not interact at all with matter except, possibly, through gravity.

Discovering the sterile neutrino would also throw a wrench into the Standard Model, which allows for only the three known types of neutrino.

"If you throw in a fourth neutrino, it changes everything," explains Francis Halzen, a University of Wisconsin-Madison professor of physics and principal investigator for the IceCube Neutrino Observatory, a massive detector embedded deep in the ice beneath the South Pole. "Sterile means it doesn't interact with matter itself, although it can dramatically interfere with the way conventional neutrinos do."

The only way to detect a sterile neutrino is to catch it in the act of transforming into one of the other types. The presence of the sterile neutrino has been hinted at by several experiments, including at the Los Alamos National Laboratory in the 1990s and, more recently, at the Daya Bay nuclear reactor facility near Hong Kong. But definitive evidence of the particle's existence has ...Read More...

Much ado about nothing: Astronomers use empty space to study the universe



This simulation of the large-scale structure of the universe reveals the cosmic web of galaxies and the vast, empty regions known as voids. Credit: Nico Hamaus, Universitäts-Sternwarte München.

Researchers who are looking for new ways to probe the nature of gravity and dark energy in the universe have adopted a new strategy: looking at what's not there.

In a paper to appear in upcoming issue of Physical Review Letters, the international team of astronomers reports that they were able to achieve four times better precision in measurements of how the universe's visible matter is clustered together by studying the empty spaces in between.

Paul Sutter, study co-author and staff researcher at The Ohio State University, said that the new measurements can help bring astronomers closer to testing Einstein's general theory of relativity, which describes how gravity works.

Sutter likened the new technique to "learning more about Swiss cheese by studying the holes," and offered another analogy to explain why astronomers would be interested in the voids of space.

"Voids are empty. They're boring, right? Galaxies are like the cities of the universe, full of bright lights and activity, and voids are like the miles and miles of quiet farmland in between," Sutter explained.

"But we're looking for bits of evidence that general relativity might be wrong, and it turns out that all the activity in galaxies makes those tiny effects harder to see. It's easier to pick up on effects in the voids, where there's less distraction—like it's easier to spot the glimmer of a firefly in a dark cornfield than in a lit-up city bustling with nightlife."

The voids, he pointed out, are only empty in the sense that they contain no normal matter. They are, in fact, full of invisible dark energy, which is causing ...Read More...

Astrophysicists discover mechanism for spiral-arm formation in disk galaxies

File Image - Andromeda galaxy

Astrophysicists at the University of Arkansas have discovered a mechanism for the formation of the spiral arms in disk galaxies.

The finding was published in the Astrophysical Journal Letters, the journal of the American Astronomical Society.

The discovery provides a better understanding for the formation of spiral arms in a kind of disk galaxy known as a spiral galaxy, said Hamed Pour-Imani, a physics doctoral student at the U of A and lead author of the study. Spiral arms are the elongated and curved spiral sections that are connected to the center of a spiral galaxy, such as our own Milky Way.

"Spiral galaxies are fascinating structures in astronomy, and the exact mechanism of the formation of spiral arms is still a mystery in astrophysics," Pour-Imani said. "Our work provides strong evidence for the density wave theory of spiral galaxies, which is one of two popular theories to explain the spiral structures."

Density wave theory was proposed in the 1960s to explain the spiral arm structure of spiral galaxies. The theory posited that spiral arms are not material in nature, but instead made up of areas of greater density, similar to a traffic jam on the highway. Stars move in and out of the spiral arms as they orbit the galaxy. The density wave theory predicts that the pitch angle of spiral arms should vary with the wavelength of the galaxy's image.

Previous research either failed to find any significant variation in pitch angle or only limited evidence for it, Pour-Imani said. In this study, U of A astrophysicists used an optical wavelength image for disk galaxies and images from the NASA Spitzer Space Telescope at two infrared wavelengths. The pitch angles agreed with the density wave theory. ...Read More...

New Weekly Addition:

This Week's Sky at a Glance, Aug. 13-19

Aug 15	Mercury at aphelion (20:00)
Aug 17	Mercury at greatest elongation (27.4°E) – Local Time: 01:12
Aug 18	Full Moon (13:26) - Meridian passage (00:47) – Altitude: 55°
Aug 19	Moon at descending node (Local Time: 18:14)

All Five Naked Eye Planets Visible:

The view for the five naked eye planets (Mercury, Venus, Mars, Jupiter and Saturn) is getting better as Venus and Mercury are getting higher and higher day after day.

Beautiful sunset over the Mediteranean sea - Azeffoun (Algeria) - Aug. 11, 2016 - Photo Credit: Ridwan Fernini

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