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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

New Weekly Addition:
This Week's Sky at a Glance, July 23 - 29

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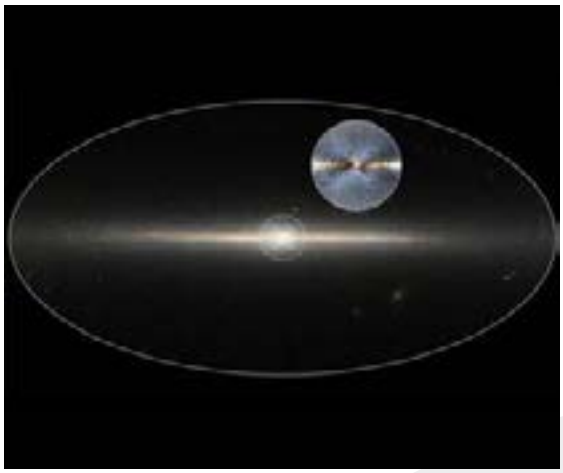
X marks the spot at the center of the Milky Way galaxy



WISE allsky map of the sky showing the Milky Way Galaxy. The central circle indicates the centre of the Galaxy and the inset shows an enhanced view of the x-shaped structure. Credit: NASA/JPL-Caltech; D. Lang/Dunlap Institute

Two astronomers - with the help of Twitter - have uncovered the strongest evidence yet that an enormous X-shaped structure made of stars lies within the central bulge of the Milky Way Galaxy.

Previous computer models, observations of other galaxies, and observations of our own galaxy have suggested that the X-shaped structure existed. But no one had observed it directly; and some astronomers argued that previous research that pointed indirectly to the existence of the X could be explained in other ways.

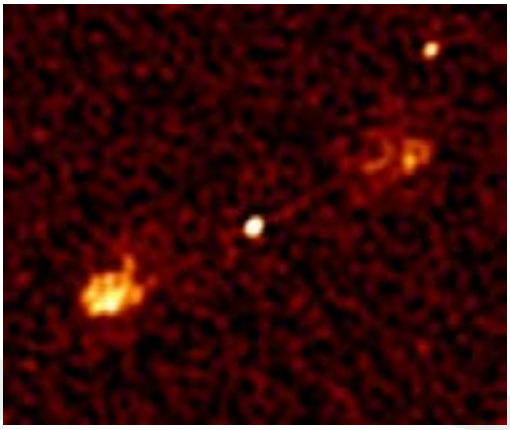
"There was controversy about whether the X-shaped structure existed," says Dustin Lang, a Research Associate at the Dunlap Institute for Astronomy and Astrophysics, University of Toronto, and co-author of the paper describing the discovery. "But our paper gives a good view of the core of our own galaxy. I think it has provided pretty good evidence for the existence of the X-shaped structure."

The results appear in the July issue of the Astronomical Journal. The lead author is Melissa Ness, a postdoctoral researcher at the Max Planck Institute for Astronomy in Heidelberg.

The Milky Way Galaxy is a barred spiral galaxy: a disk-shaped collection of dust, gas and billions of stars, 100,000 light-years in diameter. It is far from a simple disk structure, being comprised of two spiral arms, a bar-shaped feature that runs through its centre, and a central bulge of stars. The central bulge, like other barred galaxy's bulges, resembles a rectangular box or peanut when viewed - as we view it - from within the plane of the galaxy. The X-shaped structure is an integral component of the bulge.

Astronomers think the bulge could have formed in two different ways: it may have formed when ...Read More...

First Light Image from the MeerKAT Radio Telescope



This view, covering about 1% of the full MeerKAT First Light image, shows a "Fanaroff-Riley Class 2" (FR2) object: a massive black hole in the distant universe (matter falling into it produces the bright dot at the center) launching jets of powerful electrons moving at close to the speed of light that emit radio waves detected with MeerKAT's sharp view of the radio sky (thin lines connecting the central dot to the brighter lobes of radio emission).

The MeerKAT first light image of the sky, released by the South African Minister of Science and Technology, Naledi Pandor, shows unambiguously that MeerKAT is already the best radio telescope of its kind in the Southern Hemisphere. Array Release 1 (AR1) being celebrated today provides 16 of an eventual 64 dishes integrated into a working telescope array. It is the first significant scientific milestone achieved by MeerKAT, the radio telescope under construction in the Karoo that will eventually be integrated into the Square Kilometre Array (SKA).

In a small patch of sky covering less than 0.01 percent of the entire celestial sphere, the MeerKAT first light image shows more than 1,300 galaxies in the distant universe, compared to 70 known in this location prior to MeerKAT.

"Based on the results being shown today, we are confident that after all 64 dishes are in place, MeerKAT will be the world's leading telescope of its kind until the advent of SKA," according to Professor Justin Jonas, SKA South Africa Chief Technologist.

MeerKAT will consist of 64 receptors, each comprising a 13.5-meter diameter dish antenna, cryogenic coolers, receivers, digitiser, and other electronics. The commissioning of MeerKAT is done in phases to allow for verification of the system, early resolution of any technical issues, and initial science exploitation. Early science can be done with parts of the array as they are commissioned, even as construction continues. AR1 consists of 16 receptors, AR2 of 32 and AR3 of 64, expected to be in place by late 2017.

Dr. Rob Adam, Project Director of SKA South Africa, says: "The launch of MeerKAT AR1 and its first ...Read More...

Weird quantum effects stretch across hundreds of miles

The MINOS detector

In the world of quantum, infinitesimally small particles, weird and often logic-defying behaviors abound. Perhaps the strangest of these is the idea of superposition, in which objects can exist simultaneously in two or more seemingly counterintuitive states. For example, according to the laws of quantum mechanics, electrons may spin both clockwise and counter-clockwise, or be both at rest and excited, at the same time.

The physicist Erwin Schrödinger highlighted some strange consequences of the idea of superposition more than 80 years ago, with a thought experiment that posed that a cat trapped in a box with a radioactive source could be in a superposition state, considered both alive and dead, according to the laws of quantum mechanics. Since then, scientists have proven that particles can indeed be in superposition, at quantum, subatomic scales. But whether such weird phenomena can be observed in our larger, everyday world is an open, actively pursued question.

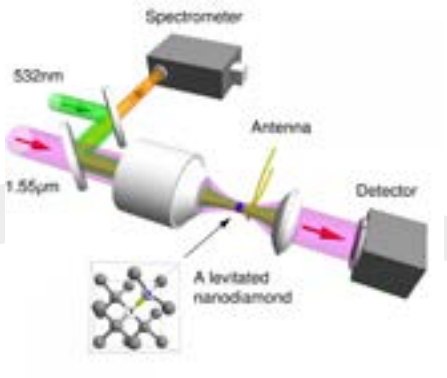
Now, MIT physicists have found that subatomic particles called neutrinos can be in superposition, without individual identities, when traveling hundreds of miles. Their results, to be published later this month in Physical Review Letters, represent the longest distance over which quantum mechanics has been tested to date.

A subatomic journey across state lines

The team analyzed data on the oscillations of neutrinos—subatomic particles that interact extremely weakly with matter, passing through our bodies by the billions per second without any effect. Neutrinos can oscillate, or change between several distinct "flavors," as they travel through the universe at close to the speed of light.

The researchers obtained data from Fermilab's Main Injector Neutrino Oscillation Search, or MINOS, an experiment in which neutrinos are produced from ...Read More...

Electron 'spin control' of levitated nanodiamonds could bring advances in sensors, quantum information processing



A schematic of an optical tweezer used in a vacuum chamber by Purdue University researchers, who controlled the "electron spin" of a levitated nanodiamond. The advance could find applications in quantum information processing, sensors and studies into the fundamental physics of quantum mechanics. (Purdue University image/ Tongcang Li)

Researchers have demonstrated how to control the "electron spin" of a nanodiamond while it is levitated with lasers in a vacuum, an advance that could find applications in quantum information processing, sensors and studies into the fundamental physics of quantum mechanics.

Electrons can be thought of as having two distinct spin states, "up" or "down." The researchers were able to detect and control the electron spin resonance, or its change from one state to the other.

"We've shown how to continuously flip the electron spin in a nanodiamond levitated in a vacuum and in the presence of different gases," said Tongcang Li, an assistant professor of physics and astronomy and electrical and computer engineering at Purdue University.

Findings are detailed in a research paper being published on Tuesday (July 19) in the journal Nature Communications. The electron spin resonance was shown to differ in the presence of helium and oxygen gases, meaning the technique could be used in a new type of sensor to detect and measure gases. Oxygen gas sensors are extensively used to monitor the oxygen concentration in automotive exhaust and in medical instruments such as anesthesia monitors and respirators. Nanodiamond-based sensors represent a potential improvement over conventional sensors. "While more detailed studies are required to fully understand this phenomenon, our observation suggests a potential application for oxygen gas sensing," Li said. ...Read More...

World's most sensitive dark matter detector completes search

The LUX Dark Matter Experiment operates a mile underground at the Sanford Underground Research Facility. It's location helps shield the detector from background radiation that could confound a dark matter signal. Credit: C. H. Faham

The Large Underground Xenon (LUX) dark matter experiment, which operates beneath a mile of rock at the Sanford Underground Research Facility in the Black Hills of South Dakota, has completed its silent search for the missing matter of the universe.

Today at an international dark matter conference (IDM 2016) in Sheffield, U.K., LUX scientific collaborators presented the results from the detector's final 20-month run from October 2014 to May 2016. The new research result is also described with further details on the LUX Collaboration's website.
LUX's sensitivity far exceeded the goals for the project, collaboration scientists said, but yielded no trace of a dark matter particle. LUX's extreme sensitivity makes the team confident that if dark matter particles had interacted with the LUX's xenon target, the detector would almost certainly have seen it. That enables scientists to confidently eliminate many potential models for dark matter particles, offering critical guidance for the next generation of dark matter experiments.
"LUX has delivered the world's best search sensitivity since its first run in 2013," said Rick Gaitskell, professor of physics at Brown University and co-spokesperson for the LUX experiment. "With this final result from the 2014 to 2016 search, the scientists of the LUX Collaboration have pushed the sensitivity of the instrument to a final performance level that is four times better than the original project goals. It would have been marvelous if the improved sensitivity had also delivered a clear dark matter signal. However, what we have observed is consistent with background alone."
Dark matter is thought to account for more than four-fifths of the mass in the universe. Scientists are confident of its existence because the effects of its gravity can be seen in the rotation of galaxies and in the way light bends as it travels through the universe, but experiments have yet to make direct contact with a dark matter particle. The LUX experiment was designed to look for weakly interacting massive particles, or WIMPs, the leading theoretical candidate for a dark matter particle. If the WIMP idea is correct, billions of these particles pass through your hand every second, and also through the Earth and everything on it. But because WIMPs interact so weakly with ordinary matter, this ghostly traverse goes entirely unnoticed. ... Read More...

NASA's Viking Data Lives on, Inspires 40 Years Later

Illustration Only.

orty years ago, NASA's Viking mission made history when it became the first mission to successfully land a fully operational spacecraft on Mars. This mission gave us our first real look at the Martian surface, as well as the fundamental science that has enabled continued missions to the Red Planet, laying the foundation for NASA's Journey to Mars.

The spacecraft, dubbed Viking 1, touched down on the Martian surface July 20, 1976 - its counterpart, Viking 2, followed suit and landed September 3 of that same year.

The mission objectives were carefully laid out: Obtain high-resolution images of the Martian surface, characterize the composition of the Martian surface and its atmosphere, and search for life.

After years of imaging, measuring and experimenting, the Viking spacecraft ended communication with the team on Earth, leaving behind a multitude of data that scientists would study for the next several years.

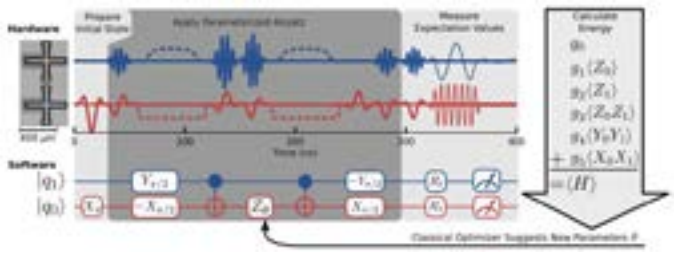
As engineers and scientists planned for later missions to Mars, the rolls of microfilm containing the Viking data were stored away for safekeeping and potential later use. It would be another 20 years before someone looked at some of these data again.

NASA's Deep Archives
David Williams is the planetary curation scientist for the NASA Space Science Data Coordinated Archive at Goddard Space Flight Center in Greenbelt, Maryland. The archive houses much of NASA's planetary and lunar spacecraft data stored on microfilm and computer tapes, including the Viking data. Williams works to digitize all of the data so that it can be easily accessed from the web.

"At one time, microfilm was the archive thing of the future," Williams said. "But people quickly turned to digitizing data when the web came to be. So now we are going through the microfilm and scanning every frame into our computer database so that anyone can access it online."

In the early 2000s, Williams received a call from Joseph Miller, professor of pharmacology at the American University of the Caribbean School of Medicine, requesting data ..Read More...

First completely scalable quantum simulation of a molecule



Hardware and software schematic of the variational quantum eigensolver. Credit: Physical Review X (2016). DOI: 10.1103/PhysRevX.6.031007

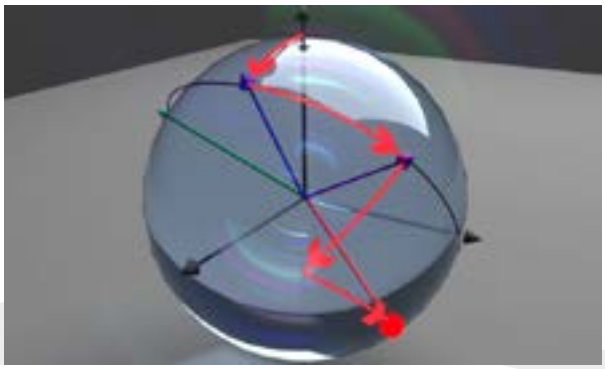
A team of researchers made up of representatives from Google, Lawrence Berkeley National Labs, Tufts University, UC Santa Barbara, University College London and Harvard University reports that they have successfully created a scalable quantum simulation of a molecule for the first time ever. In a paper uploaded to the open access journal Physical Review X, the team describes the variational quantum eigensolver (VQE) approach they used to create and solve one of the first real-world quantum computer applications.

As research continues with the development of a true quantum computer, some in the field have turned their attention to selecting certain types of problems that such computers could solve, as opposed to what are now being called classical computers. One such problem is solving the molecular electronic structure problem, which as Google Quantum Software Engineer Ryan Babbush notes in a blog post involves searching for the lowest electron energy configuration of a given molecule. What this means in practice is using a machine to compute the energies of molecules—doing so for some, such as methane, is relatively easy and can be done very quickly on a classical computer, but others, such as propane, can take days. This makes it an ideal test case for a quantum computer.

To calculate molecular energies on a quantum computer, the researchers used the VQE approach because it translates well as a quantum equivalent of a neural network, i.e., quantum bits could be used to represent molecular wave functions. Once they had built and programmed the system, they tested it by computing the energy of a hydrogen molecule. Their results very closely matched prior results found using classical computers.

The researchers are aiming to create a quantum computer that is capable not only of computing single molecule energies, but entire chemical systems. As one example, they would like to be able to simulate what happens as bacteria do their work in producing fertilizer—a process they note that currently consumes approximately ...Read More...

Researchers make leap in measuring quantum states



The unknown quantum state is shown as a red dot on the Bloch sphere. The algorithm estimates the gradient performing measurements with the green and purple projectors, updates the current estimate of the state (red line), and repeats until the desired accuracy is achieved. Credit: RMIT University

A breakthrough into the full characterisation of quantum states has been published today as a prestigious Editors' Suggestion in the journal Physical Review Letters.

The full characterisation (tomography) of quantum states is a necessity for future quantum computing. However, standard techniques are inadequate for the large quantum bit-strings necessary in full scale quantum computers.

A research team from the Quantum Photonics Laboratory at RMIT University and EQuS at the University of Sydney has demonstrated a new technique for quantum tomography—self-guided quantum tomography—which opens future pathways for characterisation of large quantum states and provides robustness against inevitable system noise.

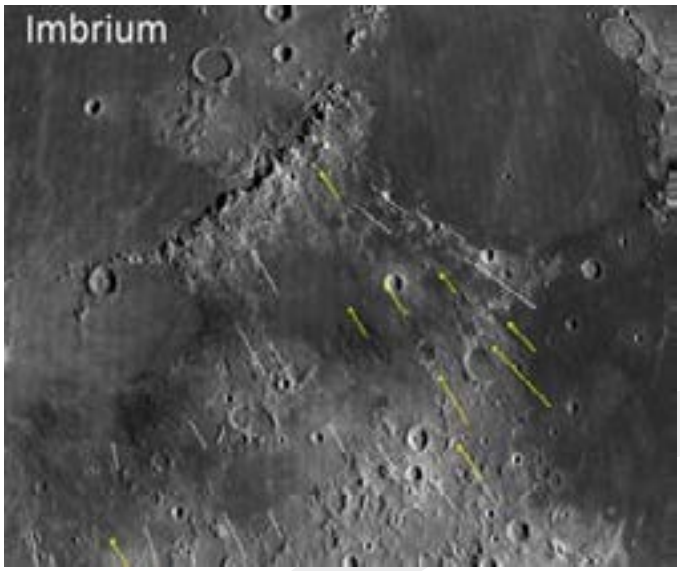
Dr Alberto Peruzzo, Director of the Quantum Photonics Laboratory, said: "This is a big step forward in quantum tomography. Our technique can be applied to all quantum computing architectures in laboratories around the world." "Characterising quantum states is a serious bottleneck in quantum information science. Self-guided quantum tomography uses a search algorithm to iteratively 'find' the quantum state.

"This technique significantly reduces the necessary resources by removing the need for any data storage or post-processing."

Robert Chapman, lead author and RMIT PhD student, said the technique employed was far more robust against inevitable noise and experimental errors than standard techniques.

"We experimentally characterise quantum states encoded in single photons—single particles of light. ...Read More...

Asteroid that formed moon's Imbrium Basin may have been protoplanet-sized



Grooves and gashes associated with the Imbrium Basin on the moon have long been puzzling. New research shows how some of these features were formed and uses them to estimate the size of the Imbrium impactor. The study suggests it was big enough to be considered a protoplanet. Credit: NASA/Northeast Planetary Data Center/Brown University

Around 3.8 billion years ago, an asteroid more than 150 miles across, roughly equal to the length of New Jersey, slammed into the Moon and created the Imbrium Basin - the right eye of the fabled Man in the Moon. This new size estimate, published in the journal Nature, suggests an Imbrium impactor that was two times larger in diameter and 10 times more massive than previous estimates.

"We show that Imbrium was likely formed by an absolutely enormous object, large enough to be classified as a protoplanet," said Pete Schultz, professor of earth, environmental and planetary sciences at Brown University. "This is the first estimate for the Imbrium impactor's size that is based largely on the geological features we see on the Moon."

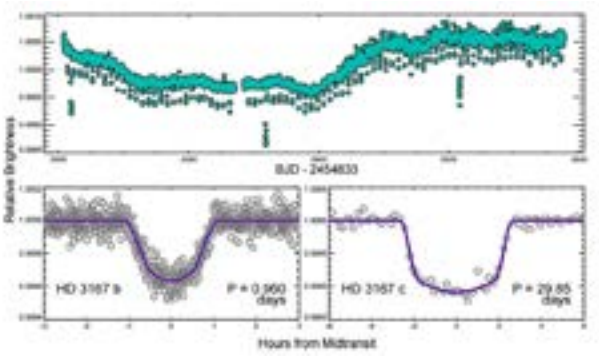
Previous estimates, Schultz said, were based solely on computer models and yielded a size estimate of only about 50 miles in diameter.

These new findings help to explain some of the puzzling geological features that surround the Imbrium Basin. The work also suggests - based on the sizes of other impact basins in the Moon, Mars and Mercury - that the early solar system was likely well stocked with protoplanet-sized asteroids.

Imbrium sculpture

The Imbrium Basin - seen from Earth as a dark patch in the northwestern quadrant of the Moon's face - measures about 750 miles across. The basin is surrounded by grooves and gashes, large enough to be seen with even small telescopes from Earth, created by ...Read More...

Two super-Earth-sized planets discovered orbiting a nearby star



K2 light curve of HD 3167. Top: the full K2 light curve. Both the numerous, shallow transits of HD 3167 b and three deeper transits of HD 3167 c are evident in the light curve by eye. Bottom left: K2 light curve (grey dots) phase folded on the transits of HD 3167 b, and best-fit transit model (thick purple line). Bottom right: K2 light curve (grey dots) phase folded on the transits of HD 3167 c, and best-fit transit model (thick purple line). Credit: Vanderburg et al., 2016.

NASA's Kepler spacecraft continues its fruitful exoplanet hunt with the newest discovery of two super-Earth-sized alien worlds. The newly detected planets are orbiting a nearby sun-sized star known as HD 3167, located some 150 light years away. The results are presented in a paper published July 18 on the arXiv pre-print server.

Although Kepler has lost two of its four reaction wheels and therefore cannot be precisely pointed toward stars, it is still capable of detecting new exoworlds. The spacecraft is now in its extended mission, known as K2, during which it has already found over 100 new planets. The HD 3167 system is just the latest addition to the vast collection of extrasolar worlds detected by K2.

HD 3167 was observed by Kepler between January 3 and March 23, 2016 during Campaign 8 of its K2 mission. This observation campaign allowed a team of astronomers, led by Andrew Vanderburg of the Harvard-Smithsonian Center for Astrophysics (CfA), to detect two transit signals that could be planets circling around this nearby star.

"We identified two planet candidates transiting HD 3167 after processing pixel-level data to produce a light curve, removing systematic effects due to Kepler's unstable pointing, and searching for planets using a Box Least Squares periodogram search," the researchers wrote in the paper.

To confirm the planetary status of these candidates, the team conducted follow-up observations employing the Tillinghast Reflector Echelle Spectrograph (TRES) on the 1.5 m telescope at the Fred L. Whipple Observatory on Mt. Hopkins, Arizona and the Robo-AO adaptive optics system installed at the 2.1 m telescope at the Kitt Peak National Observatory, also in Arizona. They also used statistical techniques to validate the planetary nature of the transiting signals. ...Read More...

Why Galaxies Stop Creating Stars

Illustration Only.

Astronomers have studied 70,000 galaxies across cosmic time to find out why some cease generating stars.

The processes that cause galaxies to "quench," (cease star formation) are not well understood and constitute an outstanding problem in the study of the evolution of galaxies.

The international research team includes Behnam Darvish and Bahram Mobasher at the University of California, David Sobral from Lancaster University in the UK and Alessandro Rettura, Nick Scoville, Andreas Faisst and Peter Capak from Caltech.

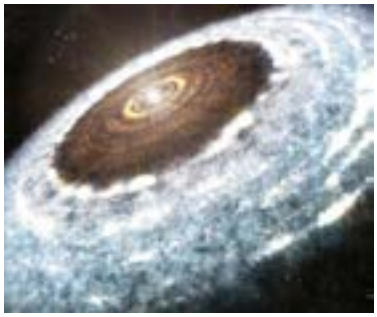
By exploring the unique COSMOS UltraVISTA survey, astronomers were able to study the role of "nature" (internal processes) and "nurture" (external processes) in the evolution of galaxies over the past 11 billion years with unprecedented detail.

Dr. David Sobral said: "Just like humans, galaxies are affected by both the environment in which they form and evolve, but also by their 'nature' and internal processes; both can have dramatic effects."

"Surprisingly, we find that the external processes are only really relevant in shutting down the production of stars in galaxies over the last eight billion years. At earlier times in the universe, internal processes are the main mechanism for shutting down star formation. In other words: back then, it was all about nature, not nurture, but later on the environment starts to play a major role."

External mechanisms include drag generated from an in-falling galaxy within a cluster of galaxies, which pulls gas away; multiple gravitational encounters with other galaxies and the dense surrounding environment, resulting in material being stripped away from the galaxy; and the halting of the supply of cold gas to the galaxy, thus strangling the galaxy of the material needed to produce new stars. ...Read More...

ALMA makes first sighting of water snow line around young star



This artist's impression of the water snowline around the young star V883 Orionis, as detected with ALMA. Credit: A. Angelich (NRAO/AUI/NSF)/ALMA (ESO/NAOJ/NRAO)

Young stars are often surrounded by dense, rotating discs of gas and dust, known as protoplanetary discs, from which planets are born. The heat from a typical young solar-type star means that the water within a protoplanetary disc is gaseous up to distances of around 3 au from the star - less than 3 times the average distance between the Earth and the Sun - or around 450 million kilometres.

Further out, due to the extremely low pressure, the water molecules transition directly from a gaseous state to form a patina of ice on dust grains and other particles. The region in the protoplanetary disc where water transitions between the gas and solid phases is known as the water snow line.

But the star V883 Orionis is unusual. A dramatic increase in its brightness has pushed the water snow line out to a distance of around 40 au (about 6 billion kilometres or roughly the size of the orbit of the dwarf planet Pluto in our Solar System).

This huge increase, combined with the resolution of ALMA at long baselines, has allowed a team led by Lucas Cieza (Millennium ALMA Disk Nucleus - and Universidad Diego Portales, Santiago, Chile) to make the first ever resolved observations of a water snow line in a protoplanetary disc.

The sudden brightening that V883 Orionis experienced is an example of what occurs when large amounts of material from the disc surrounding a young star fall onto its surface. V883 Orionis is only 30% more massive than the Sun, but thanks to the outburst it is experiencing, it is currently a staggering 400 times more luminous - and much hotter.

Lead author Lucas Cieza explains: "The ALMA observations came as a surprise to us. Our observations were designed to look for disc fragmentation leading to planet formation. We saw none of that; instead, we found what looks like a ring at 40 au. This illustrates well the transformational power of ALMA, which ...Read More...

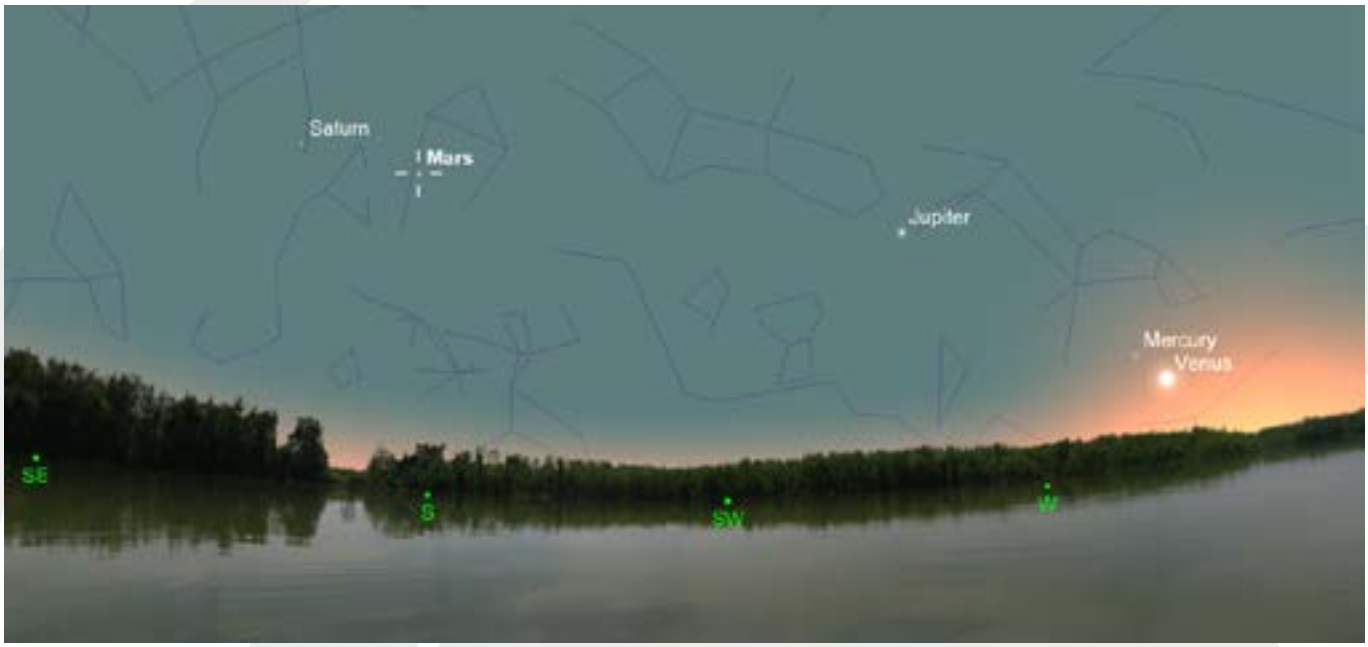
New Weekly Addition:

This Week's Sky at a Glance, July 23 - 29

July 23	Moon at descendind node (Local Time: 11:49)
July 27	Last Quarter (02:59) - Meridian passage (05:29) – Altitude: 71°
July 27	Moon at perigee (369659 km) : (Local Time: 15:25)
July 28	Delta-Aquarid meteor shower – Active Dates: 15 Jul – 19 Aug

All Five Naked Eye Planets Visible:

All five naked eye planets (Mercury, Venus, Mars, Jupiter and Saturn) can be visible just after sunset til the end of the month. Just look southwest after sunset. But, you must have a very clear southwesternn horizon and your sky must be free of light horizon especially for Mercury and Venus since both will be quite low above the western horizon. The illustration below from "Starry Night College" App. will guide you.



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