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Astronomy & Physics Weekly News

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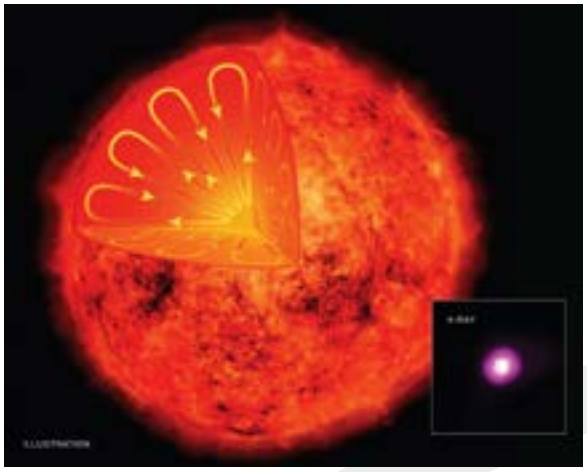
Top News

New Weekly Addition:
This Week's Sky at a Glance, Jul. 30 - Aug. 05

IT Support Issam Jami

Design by Mohamed Bakir

Astronomers gain new insight into magnetic field of Sun and its kin



Magnetic fields on the Sun and stars like it are responsible for much of their behavior, including the generation of powerful storms that can produce spectacular auroras on Earth, damage electrical power systems, knock out communications satellites, and affect astronauts in space. As discussed in our latest press release, new research relying on data from NASA's Chandra X-ray Observatory is helping astronomers better understand how these magnetic fields are produced. By comparing the X-ray emission, an excellent indicator of a star's magnetic field strength, between low-mass stars and the Sun, a pair of astronomers was able to find an important clue about how stellar magnetic fields are generated. Credit: X-ray: NASA/CXC/Keele Univ/N.Wright et al; Illustration: NASA/CXC/M.Weiss

stronomers have used data from NASA's Chandra X-ray Observatory to make a discovery that may have profound implications for understanding how the magnetic field in the Sun and stars like it are generated.

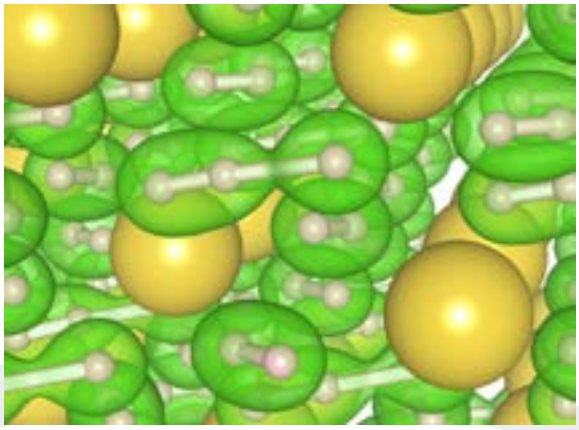
Researchers have discovered that four old red dwarf stars with masses less than half that of the Sun are emitting X-rays at a much lower rate than expected.

X-ray emission is an excellent indicator of a star's magnetic field strength so this discovery suggests that these stars have much weaker magnetic fields than previously thought.

Since young stars of all masses have very high levels of X-ray emission and magnetic field strength, this suggests that the magnetic fields of these stars weakened over time. While this is a commonly observed property of stars like our Sun, it was not expected to occur for low-mass stars, as their internal structure is very different.

The Sun and stars like it are giant spheres of superheated gas. The Sun's magnetic field is responsible for producing sunspots, its 11-year cycle, and powerful eruptions of particles from the solar surface. These solar storms can produce spectacular auroras on Earth, damage electrical power systems, knock out communications satellites, and affect astronauts in space. ...Read More...

New material could advance superconductivity

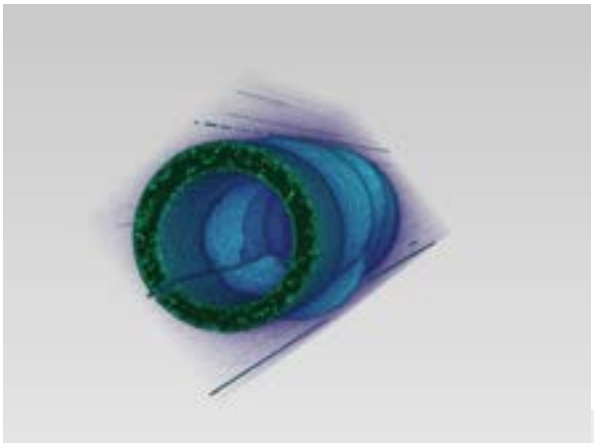


At center, in green, is the new three-atom hydrogen 'chain.' It is surrounded by several 'normal' two-atom molecules of hydrogen, also in green. The new chain configuration appears in the new material NaH7, which was produced under high pressure and high temperature conditions. The new material could change the superconductivity landscape and be useful for hydrogen storage in hydrogen fuel cells. Credit: Duck Young Kim

Scientists have looked for different ways to force hydrogen into a metallic state for decades. A metallic state of hydrogen is a holy grail for materials science because it could be used for superconductors, materials that have no resistance to the flow of electrons, which increases electricity transfer efficiency many times over. For the first time researchers, led by Carnegie's Viktor Struzhkin, have experimentally produced a new class of materials blending hydrogen with sodium that could alter the superconductivity landscape and could be used for hydrogen-fuel cell storage. The research is published in Nature Communications.

It had been predicted that certain hydrogen-rich compounds consisting of multiple atoms of hydrogen with so-called alkali metals like lithium, potassium or sodium, could provide a new chemical means to alter the compound's electronic structure. This, in turn, may lead the way to metallic high-temperature superconductors.
"The challenge is temperature," explained Struzhkin. "The only superconductors that have been produced can only exist at impractically cold temperatures. In recent years, there have been predictions of compounds with several atoms of hydrogen coupled with alkali metals that could exist at more practical temperatures. They are theorized to have unique properties useful to superconductivity."
Now, the predictions have been confirmed. The Struzhkin team included Carnegie researchers Duck Young Kim, Elissaios Stavrou, Takaki Muramatsu, Ho-Kwang Mao, and Alexander Goncharov, with researchers from other institutions.
The team used theory to guide their experiments and measured the samples using both a method that reveals the atomic structure (X-ray diffraction) ...Read More...

Mapping electromagnetic waveforms



A three-dimensional depiction of the spatial variation of the optical electromagnetic field around a microantenna following excitation with terahertz pulse. The optical field is mapped with the aid of electron pulses. Credit: Dr. Peter Baum

Munich Physicists have developed a novel electron microscope that can visualize electromagnetic fields oscillating at frequencies of billions of cycles per second.

emporally varying electromagnetic fields are the driving force behind the whole of electronics. Their polarities can change at mind-bogglingly fast rates, and it is difficult to capture them in action. However, a better understanding of the dynamics of field variation in electronic components, such as transistors, is indispensable for future advances in electronics. Researchers in the Laboratory for Attosecond Physics (LAP), jointly run by Ludwig-Maximilians-Universität (LMU) and the Max Planck Institute of Quantum Optics (MPQ), have now taken an important step towards this goal – by building an electron microscope that can image high-frequency electromagnetic fields and trace their ultrafast dynamics.

The electronic devices we have become so familiar with and use every day are – without exception – powered by changing electromagnetic fields. These fields control the flow of electrons in components such as 'field-effect' transistors, and are ultimately responsible for the manipulation, flow and storage of data in our computers and smartphones. A better understanding of electromagnetic waveforms and their ultrafast reconfiguration in individual components will help to shape the future of electronics. The LMU and MPQ physicists who belong to the research group in Ultrafast Electron Imaging have now developed an electron microscope that is specifically designed for the analysis of rapidly varying electromagnetic fields.

This instrument makes use of ultrashort pulses of laser light, each of which lasts for a few femtoseconds (a femtosecond equals one millionth of a billionth (10-15) of a second). These laser pulses are used to generate bunches of electrons made up of very few particles, which are then temporally compressed by the action of terahertz (1012 Hz) near-infrared radiation. The Munich team first described this strategy earlier this year in the journal Science (Science 22. April 2016, DOI: 10.1126/science.aae0003), and demonstrated that it can generate electron pulses that are shorter than a half-cycle of the optical field.

The researchers now show that these ultrashort electron pulses can be used to map high-frequency ...Read More...

CP violation or new physics?

This is the "South Pillar" region of the star-forming region called the Carina Nebula. Like cracking open a watermelon and finding its seeds, the infrared telescope "busted open" this murky cloud to reveal star embryos tucked inside finger-like pillars of thick dust. Credit: NASA

Over the past few years, multiple neutrino experiments have detected hints for leptonic charge parity (CP) violation—a finding that could help explain why the universe is made of matter and not antimatter. So far, matter-antimatter asymmetry cannot be explained by any physics theory and is one of the biggest unsolved problems in cosmology.

But now in a new study published in Physical Review Letters, physicists David V. Forero and Patrick Huber at Virginia Tech have proposed that the same hints could instead indicate CP-conserving "new physics," and current experiments would have no way to tell the difference.

Both possibilities—CP violation or new physics—would have a major impact on the scientific understanding of some of the biggest questions in cosmology. Currently, one of the most pressing problems is the search for new physics, or physics beyond the Standard Model, which is a theory that scientists know is incomplete but aren't sure exactly how to improve. New physics could potentially explain several phenomena that the Standard Model cannot, including the matter-antimatter asymmetry problem, as well as dark matter, dark energy, and gravity.

As the scientists show in the new study, determining whether the recent hints indicate CP violation or new physics will be very challenging. The main goal of the study was to "quantify the level of confusion" between the two possibilities. The physicists' simulations and analysis revealed that both CP violation and new physics have distributions centered at the exact same value for what the neutrino experiments measure—something called the Dirac CP phase. This identical preference makes it impossible for current neutrino experiments to distinguish between the two cases.

"Our results show that establishing leptonic CP violation will need exceptional care, and that new physics can in many ways lead to non-trivial confusion ...Read More...

Russia, US Discuss Lunar Station for Mars Mission

Illustration Only.

Russia's Roscosmos Corporation and NASA are in discussions about future of joint space missions following the conclusion of the ISS project in 2024; one proposal is to create a space base close to the Moon which will enable the deep space exploration of Mars and beyond. The International Space Station project, a partnership between Russia, the US, EU, Japan and Canada, is planned to end in 2024, when the spacecraft will plunge into the sea.

Construction of the ISS began in 1998 when Russia's Zarya module was launched. It's last major part, the Alpha Magnetic Spectrometer module, was delivered in May 2011 by the US Space Shuttle Endeavour on its 25th and final mission.

In March last year the head of Roscosmos Igor Komarov confirmed that the ISS will continue its scientific investigations until 2024, and revealed that the US and Russia are in talks about the successor to the international project.

"Roskosmos and NASA are going to work on a project for a future orbital station," Komarov said. "It will be an open project, and not just the current participants in the ISS will take part. It will be open to everybody who wants to join (the project)," Komarov said, Vesti.ru reported.

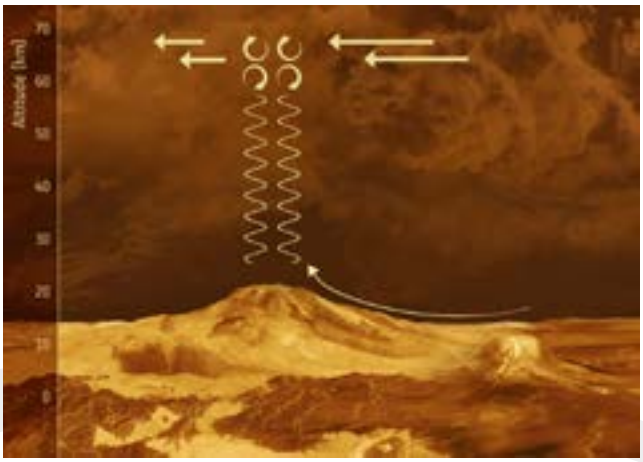
NASA administrator Charles Bolden said that the countries might collaborate on a mission to Mars.

"The direction of our collaboration is Mars. We are in discussions about how best to use resources, finances, determine timeframes and how to coordinate our efforts so that activities are not duplicated," Bolden said, as reported by Vesti.

Several rovers and orbiters are currently studying Mars; the latest is ExoMars, a joint mission by Roscosmos and the European Space Agency, launched from Baikonur in March 2016. However, a human mission is planned for the 2030s at the earliest.

In July 2015 William Gerstenmaier, NASA's Associate Administrator for Human Exploration and Operations said that political differences between Washington and Moscow should not interfere with space exploration programs. "We are very reliant on one another," in the ISS project, and mission control centers in Moscow and Houston are in daily ... Read More...

Cloud study reveals Venus' surface



Artist's concept of the proposed behavior of gravity waves in the vicinity of mountains on Venus, via ESA.

Venus is Earth's twin in size, but its surface features are perpetually hidden below clouds. What little we know about Venus' surface comes mainly from radar studies. This week, though (July 18, 2016), the European Space Agency (ESA) said that – rather than acting as a barrier – Venus' clouds can also offer insights into what lies on the surface. ESA described a study by scientists using data from the Venus Express spacecraft. These scientists were able to show, for the first time, how Venus' weather patterns are directly linked to its surface topography. For part of their study, they used what are called gravity waves (not to be confused with gravitational waves), generated as winds push their way slowly across mountain slopes hidden beneath Venus' clouds.

The scientists explored three aspects of Venus' weather: how quickly winds circulate, how much water is locked up in Venus' clouds, and how bright these clouds are across the spectrum (specifically in ultraviolet light).

Geophysicist and lead study author Jean-Loup Bertaux of LATMOS near Versailles, France said:

Our results showed that all of these aspects – the winds, the water content, and the cloud composition – are somehow connected to the properties of Venus' surface itself.

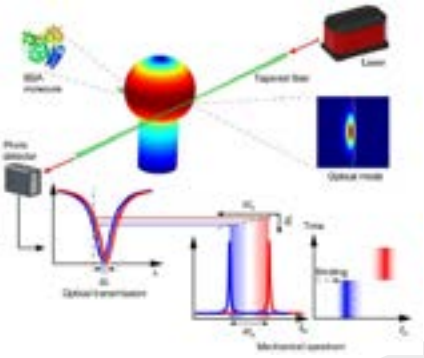
The scientists found that an area of clouds near Venus' equator is hoarding more water vapor than other parts of the atmosphere. This part of Venus' atmosphere is located above a mountain range on Venus that earthly scientists call Aphrodite Terra, one of two large elevated regions on Venus.

Aphrodite Terra is comparable in size to the continent of Africa. It's 14,700 feet (4,500 meters) high at its highest.

It appears that water-rich air from the lower atmosphere is being forced upwards above the mountains of Aphrodite Terra. Researchers have nicknamed this atmospheric feature the "fountain of Aphrodite."

Wojciech Markiewicz of the Max-Planck Institute for Solar System Research in Göttingen, Germany, is a co-author on the new study. He said: This 'fountain' was locked up ..Read More...

Optical spring detects single molecules



Schematic illustrating the sensing mechanism. Credit: (c) Nature Communications (2016). DOI: 10.1038/NCOMMS12311

A team of engineering researchers from the University of Victoria (UVic) and the University of Rochester (UR) has developed a way to detect single molecules using a light-based technology inspired by the "whispering gallery" effect, first discovered in London's iconic St. Paul's Cathedral.

The new technology, described in a study published today in the peer-reviewed journal, Nature Communications, has many potential applications, including medical diagnostics, drug development, security screening and environmental science.

"The ability to detect a single molecule or nanoparticle is essential for many applications," says Wenyan Yu, a PhD student and one of the paper's authors along with photonic engineer Tao Lu of UVic, and optical engineers Wei Jiang and Qiang Lin of UR. "To date, many approaches have been used to observe single particles. Our discovery may allow scientists the ability to detect particles as miniscule as a single atom, or a single base pair of DNA."

The whispering gallery of St. Paul's Cathedral in London is an acoustic marvel. When a person whispers against one wall, the voice travels around the chamber's circular rim and is clearly audible over 34 metres away on the other side. A "whispering gallery microcavity" is a kind of gallery-in-miniature, typically 100 microns in diameter—about the width of a human hair—in which waves of light, rather than sound, can be confined in a microstructure.

Light circulating inside the cavity produces a force that makes the cavity vibrate, or quiver, creating the so-called optical spring effect. The research team discovered that when an individual particle or biomolecule lands on the surface of quivering microcavity, the optical spring force changes the vibration in a particular and measurable way.

"Although the optical spring effect has been known for more than a decade," says Wei Jiang, "this discovery significantly enhances the sensitivity of the device."

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Physicist offers leading theory about mysterious Large Hadron Collider excess

The Large Hadron Collider, courtesy of CERN.

In December of last year, scientists at the Large Hadron Collider in Europe announced startling results hinting at the existence of an undiscovered subatomic particle—one with a mass six times heavier than the Higgs boson, the particle that made headlines in 2012.

The evidence is still thin, but if more data confirm the finding, it could sharpen humankind's understanding of the building blocks of the universe.

"This was a very surprising announcement and a puzzle at the same time, because the lifetime and mass of the particle could reveal something else beyond simply one extra particle, if it turns out to be a real signal," said Kyoungchul "K.C." Kong, associate professor of physics and astronomy at the University of Kansas. "Yet we do not claim this as a discovery, and we need more data."

Based on the LHC findings, theoretical physicists around the world rushed to offer ideas that could explain the mystery signal and guide further experimentation. Physical Review Letters, the leading peer-reviewed journal in the field, received hundreds of papers purporting to illuminate the LHC results.

"We explore ideas," Kong said of theoretical particle physicists. "Probably most of ideas are wrong—but we learn from them, and we propose better ideas."

Of the mountain of papers tendered to Physical Review Letters about the LHC findings, the journal chose to publish only four—including one co-authored by Kong, who had the original idea behind the submission.

The KU physicist said the enigmatic signal, detected at 750 giga-electron volts, or GeV, suggests "the first hint for new particles beyond the Standard Model." (The Standard Model of particle physics is a longstanding theory used to explain the forces and subatomic particles working in atoms that constitute all known matter ...Read More...

Atmospheric chemistry on paper

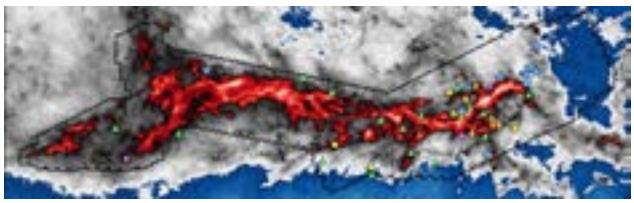
Rendering of an earth-like exoplanet with atmosphere. Credit: © ESO

Normally computers speed up calculations. But with his new pen-and-paper formula Kevin Heng of the University of Bern, Switzerland, gets his results thousands of times faster than using conventional computer codes. The astrophysicist calculates the abundances of molecules (known as atmospheric chemistry) in exoplanetary atmospheres. Ultimately, deciphering the abundances of molecules allows us to interpret if features in a spectrum are due to physics, geology or biology.

With their sophisticated instruments, astronomers today not only detect new exoplanets outside our solar system but are able to characterize the atmospheres of some of these distant worlds. To know what to anticipate and when to be surprised theorists calculate the expected abundances of molecules. Kevin Heng, director of the Center of Space and Habitability (CSH) at the University of Bern, is an expert in these calculations. "The sun - and other stars - have a very definite proportion of chemical elements like hydrogen, carbon, oxygen or nitrogen", he explains: "And there is a lot of evidence that planets form from the essence of stars." But whereas in stars the elements exist as atoms, in the lower temperatures of exoplanetary atmospheres they form different molecules according to temperature and pressure.

At low temperatures, for instance, the dominant carrier of carbon is methane (CH4), at high temperatures it is carbon monoxide (CO). The network of possible chemical reactions is well known but very large. Therefore, conventional calculations are complex and very time-consuming. "I found a way to do this much faster by solving 99% of the problem on paper, before one even touches a computer," says Kevin Heng. "Normally, one solves what we call a system of coupled, non-linear equations. I managed to reduce the problem to solving a single polynomial equation. Effectively, I 'uncoupled' the system of equations on ...Read More...

Orphaned protostars



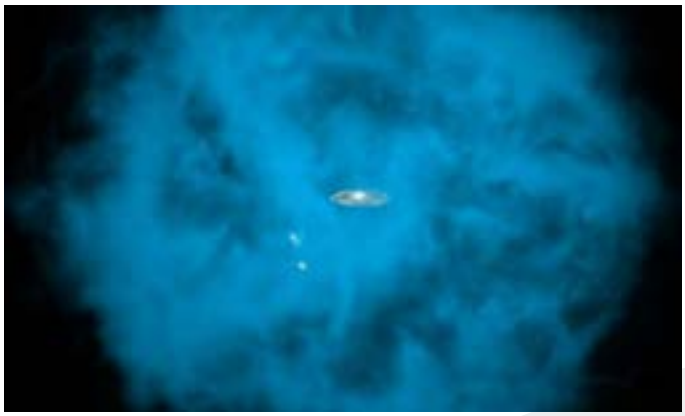
A far-infrared dust map of the star formation region in Orion showing protostellar candidates (of various types) with very low extinction using blue and green markers. The background color corresponds to the infrared brightness; the black line represents one survey region. Astronomers have confirmed that ten of these candidates objects are true protostars even though, contrary to expectations, they are not deeply buried within their clouds.. Credit: Lewis and Lada 2016

Stars form as gravity contracts the gas and dust in an interstellar cloud until clumps develop that are dense enough to coalesce into stars. Precisely how this happens, however, is very uncertain, and the processes are hard to study because they occur inside the opaque interiors of these clouds. The numbers of stars that form from a single clump is not well understood, for example, nor are the stellar masses. In the earliest stages of formation, the so-called protostellar stage, the newborn star is still accreting material from an envelope and is ringed by a circumstellar disk (which can develop into a system of planets). This earliest stage, which occurs when the star is the most heavily obscured, is therefore also the most mysterious.

Infrared observations can penetrate the dust in a stellar womb, at least partially, with the reddest wavelengths being least obscured. Astronomers examining Spitzer Space Telescope infrared images of the Orion star-forming complex discovered 329 protostars in the region, and forty-four of them did not appear to be very red—and hence not deeply embedded, contrary to expectations. CfA astronomers John Lewis and Charlie Lada wondered how that could be. After re-examining the dataset with more stringent criteria, they concluded that only ten were true protostars, with the others being extragalactic objects and nebulous regions with a few unclassified sources. But these ten were still ten more than would be predicted.

The astronomers modeled these ten protostars (including for their analysis a variety of other data) and conclude that indeed they are protostars ... and they are not presently embedded in a cloud. The scientists dub them "orphan protostars," and speculate that they have left their nursery at a young age, perhaps ejected in a gravitational interaction with a more-massive sibling. Alternative possibilities include that they just migrated away, or that somehow they were able to dissipate their immediate surroundings through winds. Additional research will narrow these choices. On the one hand these new results make the class of protostars even more varied, but on ...Read More...

Astronomers discover dizzying spin of the Milky Way galaxy's 'halo'



Our Milky Way galaxy and its small companions are surrounded by a giant halo of million-degree gas (seen in blue in this artists' rendition) that is only visible to X-ray telescopes in space. University of Michigan astronomers discovered that this massive hot halo spins in the same direction as the Milky Way disk and at a comparable speed. Credit: NASA/CXC/M.Weiss/Ohio State/A Gupta et al

Astronomers at the University of Michigan's College of Literature, Science, and the Arts (LSA) discovered for the first time that the hot gas in the halo of the Milky Way galaxy is spinning in the same direction and at comparable speed as the galaxy's disk, which contains our stars, planets, gas, and dust. This new knowledge sheds light on how individual atoms have assembled into stars, planets, and galaxies like our own, and what the future holds for these galaxies.

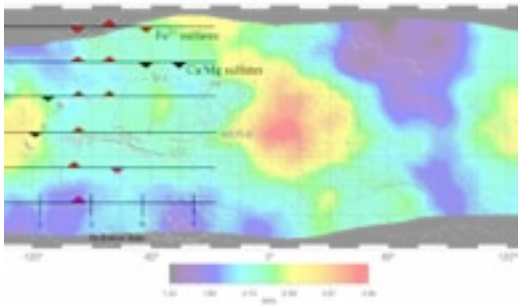
"This flies in the face of expectations," says Edmund Hodges-Kluck, assistant research scientist. "People just assumed that the disk of the Milky Way spins while this enormous reservoir of hot gas is stationary - but that is wrong. This hot gas reservoir is rotating as well, just not quite as fast as the disk."

The new NASA-funded research using the archival data obtained by XMM-Newton, a European Space Agency telescope, was recently published in the Astrophysical Journal. The study focuses on our galaxy's hot gaseous halo, which is several times larger than the Milky Way disk and composed of ionized plasma.

Because motion produces a shift in the wavelength of light, the U-M researchers measured such shifts around the sky using lines of very hot oxygen. What they found was groundbreaking: The line shifts measured by the researchers show that the galaxy's halo spins in the same direction as the disk of the Milky Way and at a similar speed—about 400,000 mph for the halo versus 540,000 mph for the disk.

"The rotation of the hot halo is an incredible clue to how the Milky Way formed," said Hodges Kluck. "It tells us that this hot atmosphere is the original source of a lot of the matter in the disk." ...Read More...

Digging deeper into Mars



Global map of Mars sulfur concentration (as percentage by mass) derived from the 2001: Mars Odyssey Gamma Ray Spectrometer spectra. Overlay shows qualitatively what types of hydrated sulfates are consistent with the variations seen in sulfur and water across the latitudes. Upright triangles indicate peaks in possible sulfate type abundance while the inverted triangles show less prominent values. Credit: Nicole Button, LSU Planetary Science Lab

Water is the key to life on Earth. Scientists continue to unravel the mystery of life on Mars by investigating evidence of water in the planet's soil. Previous observations of soil observed along crater slopes on Mars showed a significant amount of perchlorate salts, which tend to be associated with brines with a moderate pH level. However, researchers have stepped back to look at the bigger picture through data collected from the 2001: Mars Odyssey, named in reference to the science fiction novel by Arthur C. Clarke, "2001: A Space Odyssey," and found a different chemical on Mars may be key. The researchers found that the bulk soil on Mars, across regional scales the size of the U.S. or larger, likely contains iron sulfates bearing chemically bound water, which typically result in acidic brines. This new observation suggests that iron sulfates may play a major role in hydrating martian soil.

This finding was made from data collected by the 2001: Mars Odyssey Gamma Ray Spectrometer, or GRS, which is sensitive enough to detect the composition of Mars soil up to one-half meter deep. This is generally deeper than other missions either on the ground or in orbit, and it informs the nature of bulk soil on Mars. This research was published recently in the Journal of Geophysical Research: Planets.

"This is exciting because it's contributing to the story of water on Mars, which we've used as a path for our search for life on Mars," said Nicole Button, LSU Department of Geology and Geophysics doctoral candidate and co-author in this study.

The authors expanded on previous work, which explored the chemical association of water with sulfur on Mars globally. They also characterized how, based on the association between hydrogen and sulfur, the soil hydration changes at finer regional scales. The study revealed that the older ancient southern hemisphere is more likely to contain chemically bound water while the sulfates and any chemically bound water are unlikely to be associated in the northerly regions of Mars. ...Read More...

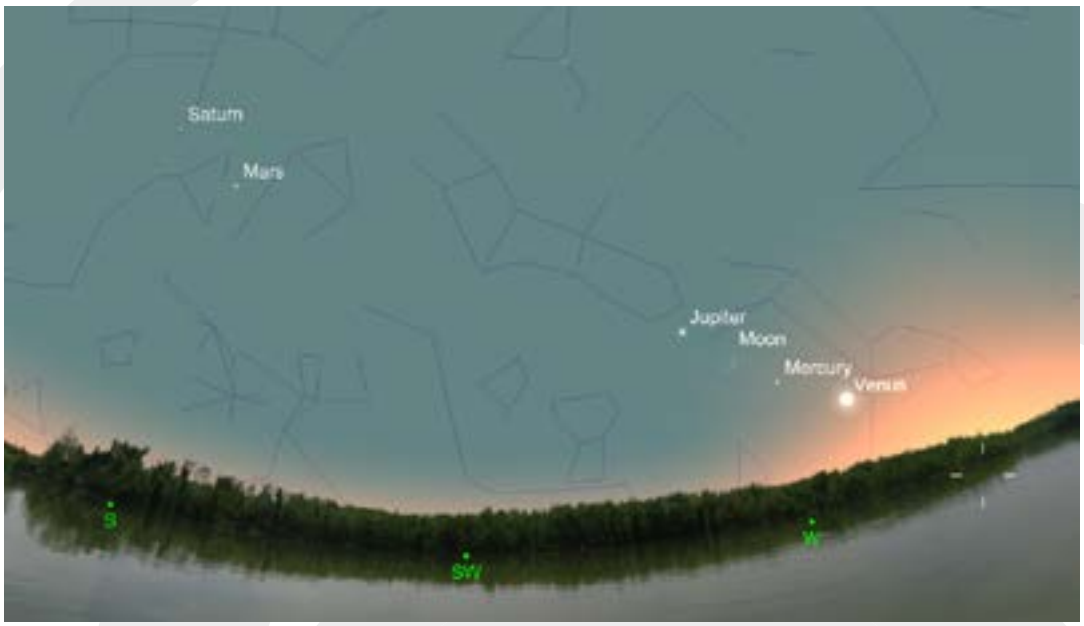
New Weekly Addition:

This Week's Sky at a Glance, Jul. 30 - Aug 05

July 30	Delta-Aquarid meteor shower – Active Dates: 15 Jul – 19 Aug
Aug. 03	New Moon (00:44) - Meridian Passage (11:57) - Altitude: 81°
Aug. 05	First Day of Dhu'l Qiddah
Aug. 05	Moon at ascending node (11:48)

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. Look southwest after sunset. On August 05, a beuatiful crescent Moon will join the five planets. The illustration below from "Starry Night College" App. will guide you.



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