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Astronomy & Physics Weekly News

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Top News

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Study may give new respect to our Milky Way neighborhood

This July 23, 2014 file photo shows the Milky Way galaxy on a moonless night from a cattle pasture in the Sand Hills of Nebraska. Our solar system lies at the edge of a structure called the Local Arm or the Orion Spur, and according to a paper released Wednesday, Sept. 28, 2016, researchers calculated that it stretches more than 20,000 light-years long, maybe about four times what scientists had thought before. (Travis Heying/ The Wichita Eagle via AP)

Our corner of the Milky Way galaxy may be a bigger deal than scientists thought.

The galaxy is shaped like a disk, with four major arms of stars, dust and gas spiraling out from the center. Our solar system lies at the edge of what's called the Local Arm, which resembles a separate piece of an arm.

Historically, the Local Arm "didn't get much respect.... People thought it was just a tiny little thing," says Mark Reid of the Harvard-Smithsonian Center for Astrophysics in Cambridge, Massachusetts. But a new paper he co-authored concludes it is bigger than scientists thought.

Researchers calculated that it stretches more than 20,000 light-years long, maybe about four times what scientists had thought before, he said. That's still a lot shorter than the major arms.

The work was done by analyzing radio-wave emissions with the Very Long Baseline Array, a series of Earth-based dishes. Results were released Wednesday by the journal Science Advances.

The study, which also investigates other aspects of the Local Arm, "provides important contributions to the better understanding of our galaxy," said Denilso Camargo of Federal University of Rio Grande do Sul in Porto Alegre, Brazil. He didn't participate in the new work. ...Read More...

Making space rocket fuel from water could drive a power revolution on Earth

Credit: NASA/Northrop Grumman/William Furlong

Researchers led by NASA's former chief technologist are hoping to launch a satellite carrying water as the source of its fuel. The team from Cornell University, guided by Mason Peck, want their device to become the first shoebox-sized "CubeSat" to orbit the moon, while demonstrating the potential of water as a source of spacecraft fuel. It's a safe, stable substance that's relatively common even in space, but could also find greater use here on Earth as we search for alternatives to fossil fuels.

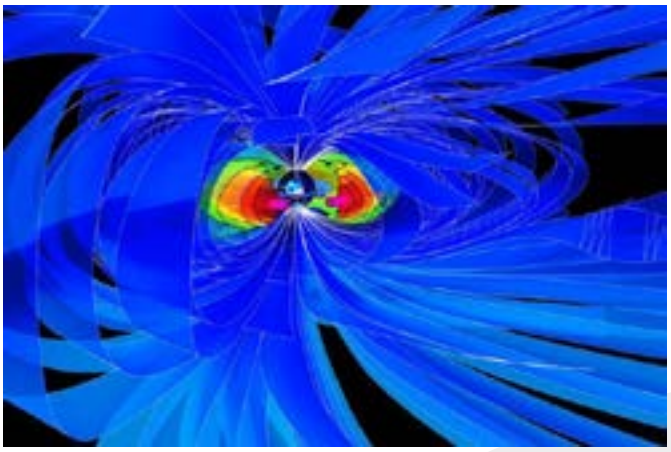
Until we develop a warp drive or some other futuristic propulsion system, space travel is likely to rely largely on the kind of propellant-based rockets we use today. These work by firing gas out of the rear of the vehicle in a way that, thanks to the laws of physics, pushes it forward. Such propulsion systems for satellites need to be lightweight and carry a lot of energy in a small space (high energy density) in order to continuously pack a powerful punch over the many years, or even decades, that the craft are in orbit.

Safety too is of prime concern. Packing energy into a small volume and mass in the form of a fuel means even the slightest issue can have disastrous consequences, as we saw with the recent SpaceX rocket explosion. Putting satellites in orbit with any form of unstable fuel on board could spell disaster for expensive hardware or even worse, human life.

Water is a way around this issue because it is essentially an energy carrier rather than a fuel. The Cornell team isn't planning to use water itself as a propellant but to rather use electricity from solar panels to split the water into hydrogen and oxygen and use them as the fuel. The two gasses, when recombined and ignited will burn or explode, giving out the energy that they took in during the splitting process. This combustion of gasses can be used to drive the satellite forward, gaining speed or altering its position in orbit of whichever desired planet or moon is the target.

Solar panels, with high reliability and no moving parts, are ideally suited to operate in zero gravity and in the extreme environments of space, producing current ...Read More...

Research resolves a debate over 'killer electrons' in space



A visualization of the Earth's magnetic environment. Credit: Martin Rother/GFZ Research Centre for Geosciences

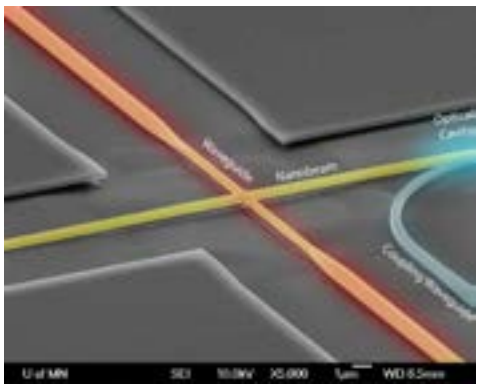
New findings by a UCLA-led international team of researchers answer a fundamental question about our space environment and will help scientists develop methods to protect valuable telecommunication and navigation satellites. The research is published today in the journal Nature Communications.

Using measurements from the first U.S. satellite that traveled to space, Explorer 1 physicist James Van Allen discovered in 1958 that space is radioactive. The Earth is surrounded by two doughnut-shaped rings of highly charged particle radiation—an inner ring of high-energy electrons and positive ions and an outer ring of high-energy electrons—that are now known as Van Allen Radiation Belts. Flying close to the speed of light, the high-energy particles that populate the belts create a harsh environment for satellites and humans in space.

In recent years, there has been much scientific interest in understanding the Van Allen belts. New technologies now require that telecommunication satellites spend a great deal of time in those belts and that GPS satellites operate in the heart of the belts. With the increasingly smaller size of space electronics has come greater vulnerability of satellites to space radiation, according to Yuri Shprits, a research geophysicist with Earth, Planetary and Space Sciences in the UCLA College and a member of the international team.

The particles that are most dangerous to spacecraft are known as relativistic and ultra-relativistic electrons. The ultra-relativistic, or "killer electrons," are especially hazardous and can penetrate the most protected and valuable satellites in space, Shprits said. While it is possible to protect the satellites from relativistic particles, shielding from ultra-relativistic particles is practically impossible, he added. Understanding the dynamics of these particles has been a major challenge for scientists since Van Allen discovered space radiation. Since the late 1960s, scientists have made many observations to try ...Read More...

Photons do the twist, and scientists can now measure it



Measurement of the twisting force, or torque, generated by light on a silicon chip holds promise for applications such as miniaturized gyroscopes and sensors to measure magnetic field, which can have significant industrial and consumer impact. Credit: University of Minnesota

Researchers in the University of Minnesota's College of Science and Engineering have measured the twisting force, or torque, generated by light on a silicon chip. Their work holds promise for applications such as miniaturized gyroscopes and torsional sensors to measure magnetic field, which can have significant industrial and consumer impact.

The new study, entitled "Optomechanical measurement of photon spin angular momentum and optical torque in integrated photonic devices" was published in the American Association for the Advancement of Science's journal Science Advances. The authors are University of Minnesota Department of Electrical and Computer Engineering Associate Professor Mo Li, graduate student Li He, and postdoctoral associate Huan Li.

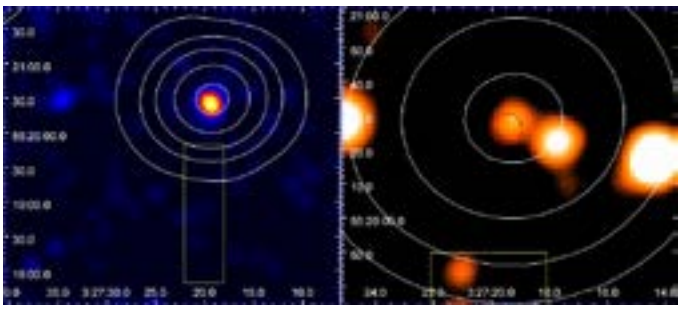
Torque, in the context of light, stems from the spin angular momentum of photons (particles of light), and its measurement is mechanical proof of the quantum nature of light. Although such measurements have been performed in much larger scale systems, the latest results were achieved within a micrometer-sized waveguide—a thin wire that guides light—and demonstrated the use of optical torque to induce rotational motion in a microscale mechanical device.

Polarized light and optical torque

Light is an electromagnetic wave, and its electric field is free to oscillate in any direction. This is called the polarization of light. Your polarizing sunglasses and the goggles you wear to see 3D movies work by using the polarization properties of light.

In a type of polarization state called circular polarization, the electric field of light rotates in a circle because of which the photons have spin angular momentum. Theory suggests that such spin angular momentum...Read More...

Scientists investigate unidentified radio sources



The sky map in the direction of the radio source designated 3C 86, obtained by XRT in the 0.3-10 keV energy band (left panel) and by WISE in the w1 filter (right panel). A yellow dashed line marks the positional uncertainty region of the 3CR source. White continuous lines shape the radio contours obtained from the NVSS map and corresponding to 0.01, 0.2, 0.7, 2, and 4 Jy beam−1; a white cross marks the position of the catalogued NVSS source. A red circle marks the position of the detected XRT source with the corresponding error radius. Credit: Maselli et al., 2016.

A team of researchers led by Andrea Maselli of the Institute of Space Astrophysics and Cosmic Physics of Palermo, Italy, has conducted an observational campaign of a group of unassociated radio sources with NASA's Swift space observatory. The observations were aimed at revealing the true nature of these so far unidentified sources. The results were published Sept. 23 in a paper on arXiv.org.

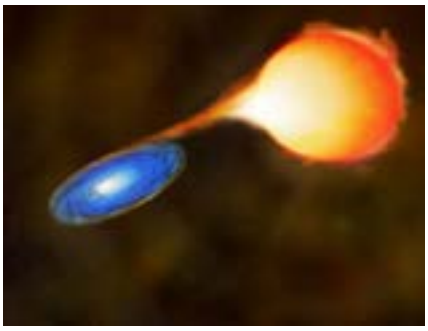
The Swift spacecraft, scanning the universe in the gamma-ray, X-ray, ultraviolet, and optical wavebands, is an invaluable tool when it comes to studying gamma-ray bursts and other electromagnetic events. It has already proved its scientific importance in many ways, for example by performing the first sensitive hard X-ray survey of the sky.

Recently, Maselli and his team employed Swift to observe 21 bright radio sources included in the revised Third Cambridge Catalogue (3CR) of radio sources. The catalog contains celestial radio sources detected at 178 MHz that could advance our knowledge about the nature and evolution of powerful radio galaxies and quasars.

However, some sources described in the 3CR catalog, including these detected by the NRAO VLA Sky Survey (NVSS), are not only unobserved in X-rays, but are, in fact, completely unidentified, lacking an assigned optical or infrared counterpart. The authors of the paper decided to fill this gap by conducting a supplementary optical-to-X-ray campaign with the Swift spacecraft, in order to better characterize the properties of these unidentified sources.

"We have investigated a group of unassociated radio sources included in the 3CR catalog to increase the multi-frequency information on them and possibly obtain an identification," the researchers wrote in the paper. Each of the 21 sources was observed by two telescopes onboard Swift - the X-ray Telescope (XRT) and the ...Read More...

The ultraviolet diversity of supernovae



A Type Ia supernova occurs when a white dwarf star accretes material from a companion. Astronomers have completed the first thorough study of the short-wavelength ultraviolet spectra of supernovae. Credit: NASA/CXC/M. Weiss

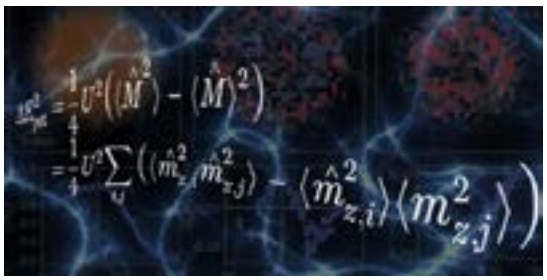
Supernovae, the explosive deaths of massive stars, are among the most momentous events in the cosmos because they disburse into space all of the chemical elements that were produced inside their progenitor stars, including the elements essential for making planets and life. One class of supernovae (Type Ia) provides yet another benefit: these objects are considered to be standard distance candles. They result when enough material from an orbiting companion star falls onto the progenitor star to trigger it to explode.

Type Ia's are therefore used by astronomers to estimate the distances to remote galaxies whose supernovae appear faint because they are far away, and thus they calibrate the cosmic distance scale.

Astronomers have a pretty good physical understanding of how Type Ia supernovae work, but some significant questions remain, for example, about the nature of the companion star. A unique way to probe the physics of SN Ia explosions and progenitors is through their ultraviolet (UV) spectra. The UV can be used to probe directly the composition of the outermost layers of the supernova, layers which are transparent at optical wavelengths right after explosion. CfA astronomer Jerod Parrent and his colleagues have completed the first study of a complete sample of high-quality Type Ia spectra at very short UV wavelengths.

They find that that there is significantly more spectral diversity in the UV than in the optical, and that the variations they find seem to correlate with the shape of the light-curve (the detailed way the supernova brightness changes with time), although there are no obvious physical connections. The astronomers produce a crude model based on their light-curve matching results that they can use to compare against future events. They expect that the differences between observed properties of supernovae and this model reflect differences in the energetics, chemistry, and/or morphologies. ...Read More...

Closing in on high-temperature superconductivity



This composite image contains an equation in the foreground related to theory research in high-temperature superconductivity, and images in the background resulting from high-temperature superconductivity experiments. Image: Penn State

The quest to know the mysterious recipe for high-temperature superconductivity, which could enable revolutionary advances in technologies that make or use electricity, just took a big leap forward thanks to new research by an international team of experimental and theoretical physicists.

The research paper appears in the journal Science on Sept. 16, 2016. The research is focused on revealing the mysterious ingredients required for high-temperature superconductivity - the ability of a material's electrons to pair up and travel without friction at relatively high temperatures, enabling them to lose no energy - to be super efficient - while conducting electricity.

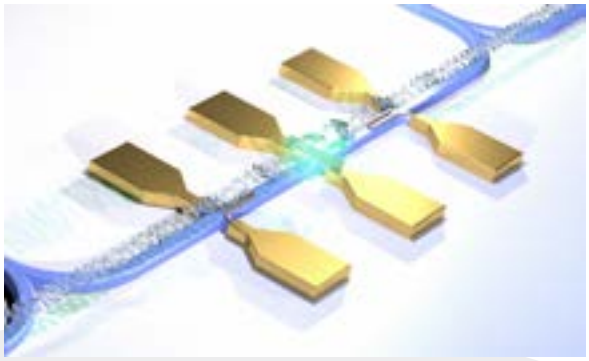
The research team's achievements are an important step in recent efforts to improve today's superconducting materials, which have superconducting powers only if they are cooled below a critical temperature, hundreds of degrees below the freezing point of water - temperatures at which helium is a liquid - making them impractical for use in most electronic devices.

"We want to understand exactly which ingredients are necessary for high-temperature superconductivity, a beautiful quantum phenomenon with potentially important uses," said Marcos Rigol, professor of physics at Penn State University and a theorist on the research team led by Martin Zwierlein, professor of physics and principal investigator at the NSF Center for Ultracold Atoms and the Research Laboratory of Electronics at the Massachusetts Institute of Technology (MIT).

For the first time, experimenters on the team have made hundreds of observations of individual potassium atoms, cooled to just slightly above absolute zero, trapped by lasers in a two-dimensional grid, and interacting with each other in intriguing ways that could help to reveal the behaviors of superconducting electrons.

The team's scientists suspect that they have observed one of the important dynamics that contribute to producing high-temperature superconductivity; ...Read More...

First quantum photonic circuit with an electrically driven light source



Credit: Karlsruhe Institute of Technology

Whether for use in safe data encryption, ultrafast calculation of huge data volumes or so-called quantum simulation of highly complex systems: Optical quantum computers are a source of hope for tomorrow's computer technology. For the first time, scientists now have succeeded in placing a complete quantum optical structure on a chip, as outlined Nature Photonics. This fulfills one condition for the use of photonic circuits in optical quantum computers.

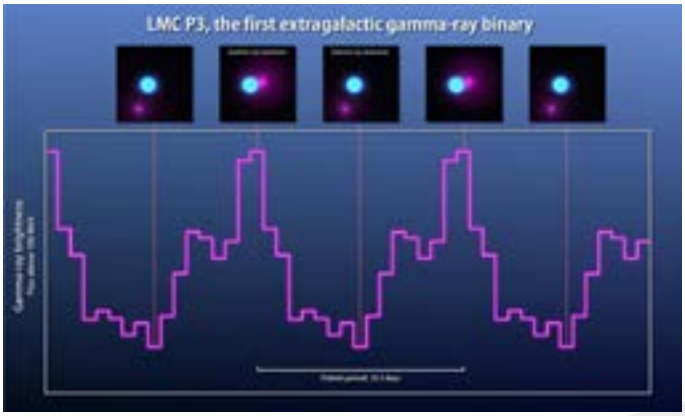
"Experiments investigating the applicability of optical quantum technology so far have often claimed whole laboratory spaces," explains Professor Ralph Krupke of the KIT. "However, if this technology is to be employed meaningfully, it must be accommodated on a minimum of space." Participants in the study were scientists from Germany, Poland, and Russia under the leadership of Professors Wolfram Pernice of the Westphalian Wilhelm University of Münster (WWU) and Ralph Krupke, Manfred Kappes, and Carsten Rockstuhl of the Karlsruhe Institute of Technology (KIT).

The light source for the quantum photonic circuit used by the scientists for the first time were special nanotubes made of carbon. They have a diameter 100,000 times smaller than a human hair, and they emit single light particles when excited by laser light. Light particles (photons) are also referred to as light quanta. Hence the term "quantum photonics."

That carbon tubes emit single photons makes them attractive as ultracompact light sources for optical quantum computers. "However, it is not easily possible to accommodate the laser technology on a scalable chip," admits physicist Wolfram Pernice. The scalability of a system, i.e. the possibility to miniaturize components so as to be able to increase their number, is a precondition for this technology to be used in powerful computers up to an optical quantum computer.

As all elements on the chip now developed are triggered electrically, no additional laser systems are ...Read More...

Fermi finds record-breaking binary in galaxy next door



Observations from Fermi's Large Area Telescope (magenta line) show that gamma rays from LMC P3 rise and fall over the course of 10.3 days. The companion is thought to be a neutron star. Illustrations across the top show how the changing position of the neutron star relates to the gamma-ray cycle. Credit: NASA's Goddard Space Flight Center

Using data from NASA's Fermi Gamma-ray Space Telescope and other facilities, an international team of scientists has found the first gamma-ray binary in another galaxy and the most luminous one ever seen. The dual-star system, dubbed LMC P3, contains a massive star and a crushed stellar core that interact to produce a cyclic flood of gamma rays, the highest-energy form of light.

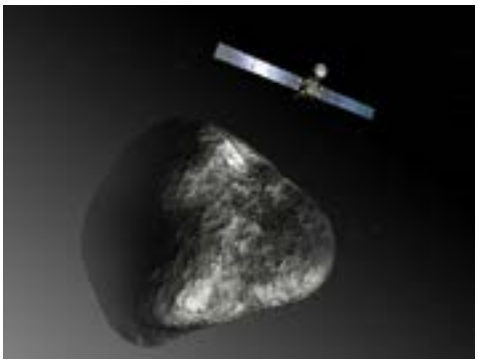
"Fermi has detected only five of these systems in our own galaxy, so finding one so luminous and distant is quite exciting," said lead researcher Robin Corbet at NASA's Goddard Space Flight Center in Greenbelt, Maryland. "Gamma-ray binaries are prized because the gamma-ray output changes significantly during each orbit and sometimes over longer time scales. This variation lets us study many of the emission processes common to other gamma-ray sources in unique detail."

These rare systems contain either a neutron star or a black hole and radiate most of their energy in the form of gamma rays. Remarkably, LMC P3 is the most luminous such system known in gamma rays, X-rays, radio waves and visible light, and it's only the second one discovered with Fermi.

A paper describing the discovery will appear in the Oct. 1 issue of The Astrophysical Journal and is now available online.

LMC P3 lies within the expanding debris of a supernova explosion located in the Large Magellanic Cloud (LMC), a small nearby galaxy about 163,000 light-years away. In 2012, scientists using NASA's Chandra X-ray Observatory found a strong X-ray source within the supernova remnant and showed that it was orbiting a hot, young star many times the sun's mass. The researchers concluded the compact object was either a neutron star or a black hole and classified the system as a high-mass ...Read More...

Rosetta: beginning of the end for Europe's comet craft



An artist's impression of the Rosetta orbiter at comet 67P/Churyumov-Gerasimenko on December 3, 2012

Europe was poised Thursday to crashland its Rosetta spacecraft on a comet it has stalked for over two years, joining robot lander Philae on the cosmic wanderer's icy surface in a final suicide mission.

A 12-year odyssey to probe the origins of our Solar System will conclude with a last-gasp spurt of science-gathering after Rosetta is instructed at 2050 GMT to quit the orbit of Comet 67P/Churyumov-Gerasimenko.

The space explorer will descend over a leisurely 14 hours, from an altitude of 19 kilometres (12-miles), sniffing the comet's gassy coma, or halo, measuring its temperature and gravity, and taking pictures from closer than ever before.

"It's all go," Rosetta project scientist Matt Taylor told AFP at the European Space Agency's mission control centre in Darmstadt.

"We're all very excited. In the final descent, we will get into a region that we have never sampled before. We've never been below two kilometres, and that region is where the coma, the comet atmosphere, becomes alive, it's where it goes from being an ice to a gas."

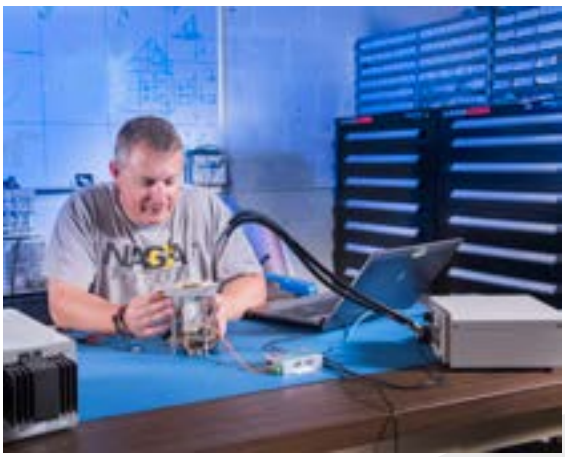
Rosetta will receive the command to crash at a distance of 720 million kilometres (450 million miles) from Earth, with the comet zipping through space at a speed of over 14 kilometres (nine miles) per second.

A "controlled impact" at human walking speed, about 90 cm (35 inches) per second, is scheduled for 1040 GMT on Friday—give or take 20 minutes.

Confirmation of the mission's end is expected in Darmstadt some 40 minutes later, when Rosetta's delayed signal vanishes from ground controllers' computer screens. "It's mixed emotions," Taylor said of the impending end.

While it will all be over for mission controllers, scientists will be analysing the information gleaned ...Read More...

MAHRS on Mars: Looking at Weather and Habitat on the Surface



NASA Glenn engineer Norman Prokop refines microscope that could study Martian soil. Image courtesy NASA.

When human explorers embark on the journey to Mars, they need to know the natural conditions of the red planet before they arrive. That's why NASA sends rovers to the surface of Mars to photograph the landscape and operate scientific experiments to understand the habitat for humans or other kinds of life.

One of those future rover missions may host the Martian Aqueous Habitat Reconnaissance Suite (MAHRS), a set of five instruments that can take surface measurements in the search for habitable environments.

Developed at NASA Glenn in partnership with the University of Michigan, MAHRS is specifically focused on searching for wet brine environments in the shallow subsurface of Mars.

"Brine environments are where you would look for life," says Project Manager Dan Vento. "Any water that exists today on Mars would likely be in the form of a brine if is in a liquid state."

The MAHRS research hardware includes an optical microscope to study the size and characteristics of settling dust on Mars. The 4" x 4" cube is outfitted with a sensor, a circuit board and a microscope lens turned upward. When Martian dust settles on the top of the settling glass, the lens can take high-resolution images for scientific evaluation.

"The interesting feature about the microscope, is that the electronics architecture can support a camera lens or hyperspectral sensor depending on the scientific goals of the mission," says Norman Prokop, NASA Glenn engineer.

Mounted to the microscope, a radiometer measures the amount of solar energy absorbed at the surface to study the amount of dust in the Martian atmosphere. Less energy making it to the surface means more dust in the atmosphere is absorbing the solar energy. ...Read More...

NASA-Funded Sounding Rocket Solves One Cosmic Mystery, Reveals Another

The Diffuse X-ray emission from the Local galaxy, or DXL, sounding rocket launched from White Sands Missile Range in New Mexico on Dec. 13, 2012, to study the source of certain X-rays observed near Earth. Image courtesy White Sands Missile Range, Visual Information Branch.

In the last century, humans realized that space is filled with types of light we can't see - from infrared signals released by hot stars and galaxies, to the cosmic microwave background that comes from every corner of the universe. Some of this invisible light that fills space takes the form of X-rays, the source of which has been hotly contended over the past few decades.

It wasn't until the flight of the DXL sounding rocket, short for Diffuse X-ray emission from the Local galaxy, that scientists had concrete answers about the X-rays' sources. In a new study, published Sept. 23, 2016, in the Astrophysical Journal, DXL's data confirms some of our ideas about where these X-rays come from, in turn strengthening our understanding of our solar neighborhood's early history.

But it also reveals a new mystery - an entire group of X-rays that don't come from any known source. The two known sources of X-ray emission are the solar wind, the sea of solar material that fills the solar system, and the Local Hot Bubble, a theorized area of hot interstellar material that surrounds our solar system.

"We show that the X-ray contribution from the solar wind charge exchange is about forty percent in the galactic plane, and even less elsewhere," said Massimiliano Galeazzi, an astrophysicist at the University of Miami and an author on the study. "So the rest of the X-rays must come from the Local Hot Bubble, proving that it exists."

However, DXL also measured some high-energy X-rays that couldn't possibly come from the solar wind or the Local Hot Bubble.

"At higher energies, these sources contribute less than a quarter of the X-ray emission," said Youaraj Uprety, lead author on the study and an astrophysicist at University of Miami at the time the research ...Read More...

This Week's Sky at a Glance

Oct. 01-07

Oct 01 New Moon (04:10) - Meridian passage (12:19) – Altitude: 63°

Oct 03 Venus 4.0° South of Moon (Local Time: 18:15)

Oct 04 Moon at apogee: 406100 km (Local Time: 15:02)

Lecture: Multiwavelength Astronomy
Speaker: Dr. Ilias M. Fernini
Date: Oct. 01, 2016 (18:00 - 19:00)
Location: SCASS