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Astronomy & Physics Weekly News

Dept. of Applied Physics & Astronomy - University of Sharjah
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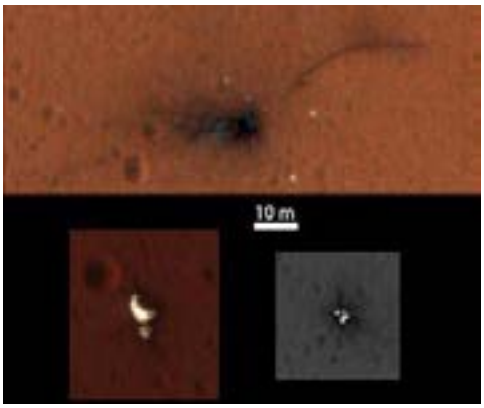
Computer glitch blamed for European Mars lander crash



File Image.

A tiny lander that crashed on Mars last month flew into the Red Planet at 540 kilometres (335 miles) per hour instead of gently gliding to a stop, after a computer misjudged its altitude, scientists said.

Schiaparelli was on a test-run for a future rover meant to seek out evidence of life, past or present, but it fell silent seconds before its scheduled touchdown on October 19.

After trawling through mountains of data, the European Space Agency said Wednesday that while much of the mission went according to plan, a computer that measured the rotation of the lander hit a maximum reading, knocking other calculations off track.

That led the navigation system to think the lander was much lower than it was, causing its parachute and braking thrusters to be deployed prematurely.

"The erroneous information generated an estimated altitude that was negative -- that is, below ground level," the ESA said in a statement.

"This in turn successively triggered a premature release of the parachute and the backshell (heat shield), a brief firing of the braking thrusters and finally activation of the on-ground systems as if Schiaparelli had already landed. In reality, the vehicle was still at an altitude of around 3.7 km."

The 230 million-euro ($251-million) Schiaparelli had travelled for seven months and 496 million kilometres (308 million miles) onboard the so-called Trace Gas Orbiter to within a million kilometres of Mars when it set off on its own mission to reach the surface.

After a scorching, supersonic dash through Mars's thin atmosphere, it was supposed to glide gently towards the planet's surface.

For a safe landing, Schiaparelli had to slow down from a speed of 21,000 kilometres (13,000 miles) per hour to zero, and survive temperatures of more than 1,500 degrees Celsius (2,730 degrees Fahrenheit) generated by atmospheric drag. ...Read More...

Thermoelectric paint enables walls to convert heat into electricity

Thermoelectric paint being applied to an alumina hemisphere. The paint provides closer contact with the heat-emitting surface than conventional planar thermoelectric devices do. Credit: Park et al. ©2016 Nature Communications

Paint these days is becoming much more than it used to be. Already researchers have developed photovoltaic paint, which can be used to make "paint-on solar cells" that capture the sun's energy and turn it into electricity. Now in a new study, researchers have created thermoelectric paint, which captures the waste heat from hot painted surfaces and converts it into electrical energy.

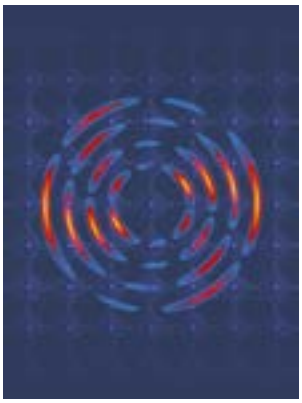
"I expect that the thermoelectric painting technique can be applied to waste heat recovery from large-scale heat source surfaces, such as buildings, cars, and ship vessels," Jae Sung Son, a coauthor of the study and researcher at the Ulsan National Institute of Science and Technology (UNIST), told Phys.org.

"For example, the temperature of a building's roof and walls increases to more than 50 °C in the summer," he said. "If we apply thermoelectric paint on the walls, we can convert huge amounts of waste heat into electrical energy."

The thermoelectric paint looks very different than conventional thermoelectric materials, which are typically fabricated as flat, rigid chips. These devices are then attached to irregular-shaped objects that emit waste heat, such as engines, power plants, and refrigerators. However, the incomplete contact between these curved surfaces and the flat thermoelectric generators results in inevitable heat loss, decreasing the overall efficiency.

In the new study published in Nature Communications, Sung Hoon Park et al., from UNIST, the Korea Institute of Science and Technology (KIST), and the Korea Electrotechnology Research Institute, have addressed this issue of incomplete contact by demonstrating that the thermoelectric paint easily adheres to the surface of virtually any shape. The thermoelectric paint contains the thermoelectric particles bismuth telluride (Bi_2Te_3), which are commonly used in conventional thermoelectric devices. The researchers also added molecular sintering aids which, upon heating, cause the ...Read More...

New clues emerge in 30-year-old superconductor mystery



An artistic representation of the data showing the breaking of spatial inversion and rotational symmetries in the pseudogap region of superconducting materials -- evidence that the pseudogap is a distinct phase of matter. Rings of light reflected from a superconductor reveal the broken symmetries. Credit: Hsieh Lab/Caltech

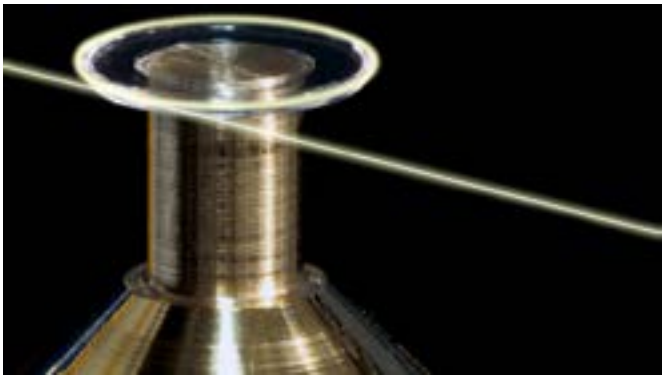
One of the greatest mysteries of experimental physics is how so-called high-temperature superconducting materials work. Despite their name, high-temperature superconductors—materials that carry electrical current with no resistance—operate at chilly temperatures less than minus 135 degrees Celsius. They can be used to make superefficient power cables, medical MRIs, particle accelerators, and other devices. Cracking the mystery of how these materials actually work could lead to superconducting devices that operate at room temperatures—and could revolutionize electrical devices, including laptops and phones.

In a new paper in the journal Nature Physics, researchers at Caltech have at last solved one piece of this enduring puzzle. They have confirmed that a transitional phase of matter called the pseudogap—one that occurs before these materials are cooled down to become superconducting—represents a distinct state of matter, with properties very different from those of the superconducting state itself.

When matter transitions from one state, or phase, to another—say, water freezing into ice—there is a change in the ordering pattern of the materials' particles. Physicists previously had detected hints of some type of ordering of electrons inside the pseudogap state. But exactly how they were ordering—and whether that ordering constituted a new state of matter—was unclear until now.

"A peculiar property of all these high-temperature superconductors is that just before they enter the superconducting state, they invariably first enter the pseudogap state, whose origins are equally if not more mysterious than the superconducting state itself," says David Hsieh, professor of physics at Caltech and principal investigator of the new research. "We have discovered that in the pseudogap state, electrons form a highly unusual pattern that breaks nearly all of the symmetries ...Read More...

Capturing an elusive spectrum of light



A microresonator crystal used in this study . Credit: © T.J. Kippenberg/EPFL

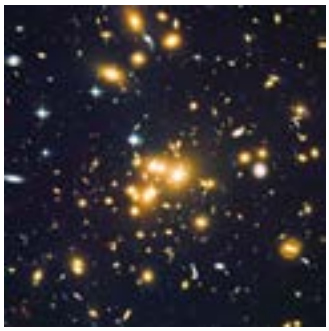
Researchers led by EPFL have built ultra-high quality optical cavities for the elusive mid-infrared spectral region, paving the way for new chemical and biological sensors, as well as promising technologies.

The mid-infrared spectral window, referred to as "molecular fingerprint region," includes light wavelengths from 2.5 to 20 μm. It is a virtual goldmine for spectroscopy, chemical and biological sensing, materials science, and industry, as it is the range where many organic molecules can be detected. It also contains two ranges that allow transmission of signals through the atmosphere without distortion or loss. A way to harness the potential of the mid-infrared spectral window is to use optical cavities, which are micro-devices that confine light for extended amounts of time. However, such devices are currently unexplored due to technological challenges at this wavelength. Researchers led by EPFL have taken on this challenge and successfully shown that crystalline materials can be used to build ultra-high quality optical cavities for the mid-infrared spectral region, representing the highest value achieved for any type of mid-infrared resonator to date and setting a new record in the field.

Caroline Lecaplain and Clément Javerzac-Galy from Tobias J. Kippenberg's lab at EPFL led the research effort, together with colleagues from the Russian Quantum Center. To make these ultra-high quality microcavities, the scientists used alkaline earth metal fluoride crystals that they polished manually. They developed uncoated chalcogenide tapered fibers to efficiently couple mid-infrared light from a continuous wave Quantum Cascade Laser (QCL) into their crystalline microcavities. Finally, cavity ring-down spectroscopy techniques enabled the team to unambiguously demonstrate ultra-high quality resonators deep in the mid-infrared spectral range.

Equally important, the scientists also show that the quality factor of the microcavity is limited by multi-phonon absorption. This is a phenomenon in which phonons – quasiparticles made of energy and vibrations in the cavity's crystal – simultaneously interact and ...Read More...

Large number of dwarf galaxies discovered in the early universe



Massive cluster of galaxies Abell 1689 creates a strong gravitational effect on background and older galaxies, seen as arcs of light. Image courtesy NASA, ESA, B. Siana, and A. Alavi.

A team of researchers, led by University of California, Riverside astronomers, found for the first time a large population of distant dwarf galaxies that could reveal important details about a productive period of star formation in the universe billions of years ago.

The findings, just published in The Astrophysical Journal, build on a growing body of knowledge about dwarf galaxies, the smallest and dimmest galaxies in the universe. Though diminutive, they are incredibly important for understanding the history of the universe.

It is believed that dwarf galaxies played a significant role during the reionization era in transforming the early universe from being dark, neutral and opaque to one that is bright, ionized and transparent.

Despite their importance, distant dwarf galaxies remain elusive, because they are extremely faint and beyond the reach of even the best telescopes. This means that the current picture of the early universe is not complete.

However, there is a way around this limitation. As predicted by Einstein's general theory of relativity, a massive object such as a galaxy located along the line of sight to another distant object, can act as a natural lens, magnifying the light coming from that background source.

This phenomenon, known as gravitational lensing, causes the background object to appear brighter and larger. Therefore, these natural telescopes can allow us to discover unseen distant dwarf galaxies.

As a proof of concept, in 2014, the UC Riverside team, including Brian Siana, an assistant professor in UC Riverside's Department of Physics and Astronomy who is the principal investigator of the observing programs, targeted one cluster of galaxies that produce the gravitational lensing effect and got a glimpse of what appeared to be a large population of distant dwarf galaxies.

The just-published paper, whose lead author was Anahita Alavi, a post-doctoral scholar working with Siana, builds on that work.

The team used the Wide Field Camera 3 on the Hubble Space Telescope to take deep images of three clusters of galaxies. They found the large population of distant dwarf galaxies from when the universe was ...Read More...

A Stellar Circle of Life

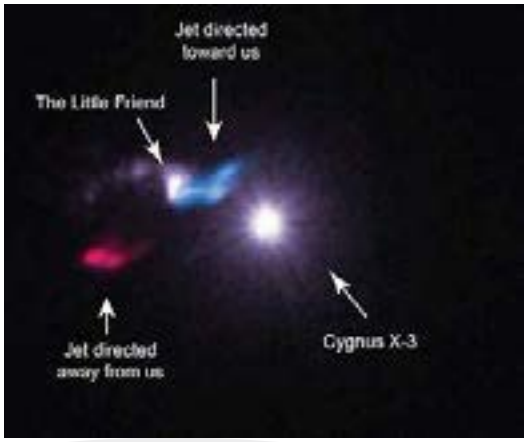


Image courtesy X-ray: NASA/CXC/SAO/M.McCollough et al, Radio: ASIAA/SAO/SMA.

A snapshot of the stellar life cycle has been captured in a new portrait from NASA's Chandra X-ray Observatory and the Smithsonian's Submillimeter Array (SMA). A cloud that is giving birth to stars has been observed to reflect X-rays from Cygnus X-3, a source of X-rays produced by a system where a massive star is slowly being eaten by its companion black hole or neutron star. This discovery provides a new way to study how stars form.

In 2003, astronomers used Chandra's high-resolution X-ray vision to find a mysterious source of X-ray emission located very close to Cygnus X-3. The separation of these two sources on the sky is equivalent to the width of a penny at a distance of 830 feet away. In 2013, astronomers reported that the new source is a cloud of gas and dust.

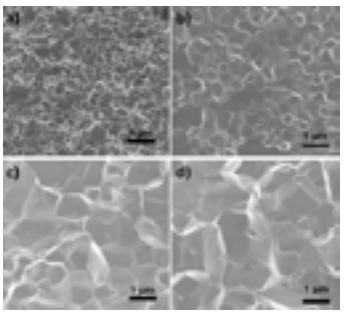
In astronomical terms, this cloud is rather small - about 0.7 light-year in diameter. Astronomers realized that this cloud was acting as a mirror, reflecting some of the X-rays generated by Cygnus X-3 towards Earth.

"We nicknamed this object the 'Little Friend' because it is a faint source of X-rays next to a very bright source that showed similar X-ray variations," said Michael McCollough of the Harvard-Smithsonian Center for Astrophysics (CfA) in Cambridge, Massachusetts, who led the most recent study of this system.

The Chandra observations reported in 2013 suggested that the Little Friend had a mass between two and 24 times that of the Sun. This suggested that the cloud was a "Bok globule," a small dense cloud where infant stars can be born. However, more evidence was needed.

To determine the nature of the Little Friend, astronomers used the SMA, a series of eight radio dishes atop Maunakea in Hawaii. The SMA found molecules of carbon monoxide, an important clue that the Little Friend is indeed a Bok globule. Also, the SMA data reveals the presence of a jet or outflow within the Little Friend, an indication that a star has started to form inside. ...Read More...

Researchers report new thermoelectric material with high power factors



SEM images of the material hot-pressed at a) 1123 K, b)1173 K, c) 1273 K, and d)1373 K. Image courtesy University of Houston.

With energy conservation expected to play a growing role in managing global demand, materials and methods that make better use of existing sources of energy have become increasingly important. Researchers reported this week in the Proceedings of the National Academy of Sciences that they have demonstrated a step forward in converting waste heat - from industrial smokestacks, power generating plants or even automobile tailpipes - into electricity.

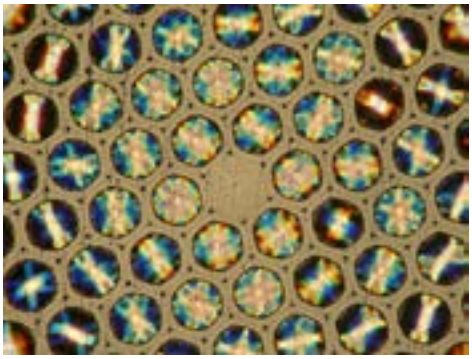
The work, using a thermoelectric compound composed of niobium, titanium, iron and antimony, succeeded in raising the material's power output density dramatically by using a very hot pressing temperature - up to 1373 Kelvin, or about 2,000 degrees Fahrenheit - to create the material. "The majority of industrial energy input is lost as waste heat," the researchers wrote. "Converting some of the waste heat into useful electrical power will lead to the reduction of fossil fuel consumption and CO2 emission."

Thermoelectric materials produce electricity by exploiting the flow of heat current from a warmer area to a cooler area, and their efficiency is calculated as the measure of how well the material converts heat - often waste heat generated by power plants or other industrial processes - into power. For example, a material that takes in 100 watts of heat and produces 10 watts of electricity has an efficiency rate of 10 percent.

That's the traditional way of considering thermoelectric materials, said Zhifeng Ren, MD Anderson Professor of Physics at the University of Houston and lead author of the paper. But having a relatively high conversion efficiency doesn't guarantee a high power output, which measures the amount of power produced by the material rather than the rate of the conversion.

Because waste heat is an abundant - and free - source of fuel, the conversion rate is less important than the total amount of power that can be produced, said Ren, who is also a principal investigator at the Texas Center for Superconductivity at UH. "In the past, that has not been emphasized." ...Read More...

More reliable way to produce single photons



Credit: University of Bath

Physicists at the University of Bath have developed a technique to more reliably produce single photons that can be imprinted with quantum information.

The invention will benefit a variety of processes which rely on photons to carry quantum information, such as quantum computing, secure quantum communication and precision measurements at low light levels.

Photons, particles of light, can be imprinted with information to be used for things like carrying out calculations and transmitting messages. To do this you need to create individual photons, which is a complicated and difficult process.

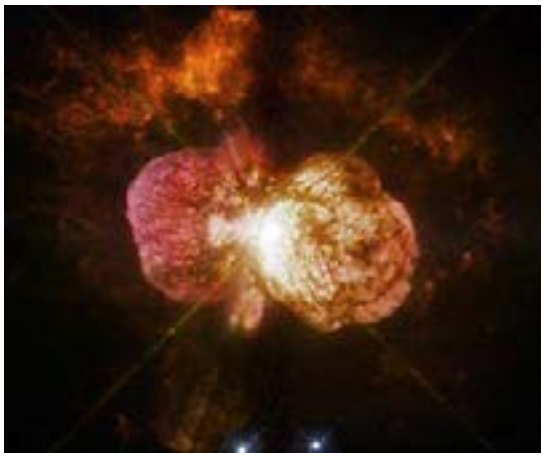
However researchers from the Centre for Photonics and Photonic Materials have implemented a new way to improve the performance of single-photon sources using fibre-optics and fast optical switches.

They combined several individual sources of photons using optical switches, a technique called multiplexing, using fibre optics fabricated at the University. The resulting device not only makes generating single photons more reliable but also allows control of properties of the photons created, including their colour.

Dr Robert Francis-Jones, from the Centre for Photonics and Photonic Materials, said: "Developing improved sources of single photons is one of the most pressing issues in quantum information processing. Through this research we hope to accelerate the transition of quantum-enhanced technologies from the lab to applications such as drug discovery."

The study is published in the journal Optica. ...Read More...

Astronomers unveil 'heart' of Eta Carinae



The raging winds from Eta Carinae are much faster and denser than the solar wind streaming off our own Sun. They collide violently in the zone between the two stars at speeds that can reach 10 million km per hour.

An international team of astronomers has imaged the Eta Carinae star system in the greatest detail ever. Eta Carinae is a colossal binary system that consists of two massive stars orbiting each other. It is found almost 8,000 light years from Earth within the Carina Nebula, a giant star-forming region in the Carina-Sagittarius Arm of the Milky Way.

The images enabled the astronomers to observe unexpected new structures in the binary system, including a region between the two stars in which extremely high-velocity stellar winds are colliding.

"With these observations, we were able to map the zone in which the two stellar winds collide and make sure we genuinely understand the basic parameters of the binary system," said Augusto Damineli, Full Professor at the University of Sao Paulo's Institute of Astronomy, Geophysics and Atmospheric Sciences (IAG-USP) in Brazil.

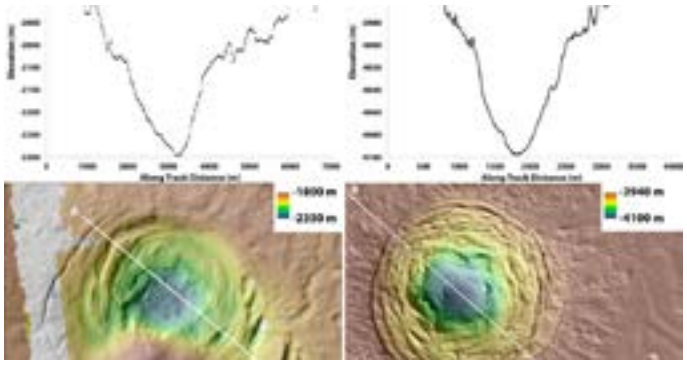
Damineli has studied mysterious phenomena involving Eta Carinae for more than 20 years with FAPESP's support and is one of the three Brazilian authors of the paper published by Astronomy and Astrophysics.

The other two are Mairan Macedo Teodoro, a researcher at NASA's Goddard Space Flight Center, and Jose Henrique Groh de Castro Moura, a professor at Trinity College Dublin in Ireland.

According to the researchers, the Eta Carinae binary pair are so massive and bright that the radiation they produce rips atoms off their surfaces and spews them into space. This expulsion of atomic material is referred to as stellar wind.

The raging winds from Eta Carinae are much faster and denser than the solar wind streaming off our own Sun. They collide violently in the zone between ...Read More...

A funnel on Mars could be a place to look for life



(Left) A graph charting the depth of the Hellas depression at different points, and a topographic map of the depression. (Right) A graph charting the depth of the Galaxias Fossae depression at different points, and a topographic map of the depression. Image courtesy Joseph Levy and NASA.

A strangely shaped depression on Mars could be a new place to look for signs of life on the Red Planet, according to a University of Texas at Austin-led study. The depression was probably formed by a volcano beneath a glacier and could have been a warm, chemical-rich environment well suited for microbial life.

"We were drawn to this site because it looked like it could host some of the key ingredients for habitability - water, heat and nutrients," said lead author Joseph Levy, a research associate at the University of Texas Institute for Geophysics, a research unit of the Jackson School of Geosciences.

The depression is inside a crater perched on the rim of the Hellas basin on Mars and surrounded by ancient glacial deposits. It first caught Levy's attention in 2009, when he noticed crack-like features on pictures of depressions taken by the Mars Reconnaissance Orbiter that looked similar to "ice cauldrons" on Earth, formations found in Iceland and Greenland made by volcanos erupting under an ice sheet. Another depression in the Galaxias Fossae region of Mars had a similar appearance.

"These landforms caught our eye because they're weird looking. They're concentrically fractured so they look like a bulls-eye. That can be a very diagnostic pattern you see in Earth materials," said Levy, who was a postdoctoral researcher at Portland State University when he first saw the photos of the depressions.

But it wasn't until this year that he and his research team were able to more thoroughly analyze the depressions using stereoscopic images to investigate whether the depressions were made by underground volcanic activity that melted away surface ice or by an impact from an asteroid.

Study collaborator Timothy Goudge, a postdoctoral fellow at the institute, used pairs of high-resolution images to create digital elevation models of the ...Read More...

ESA expands space weather services

Space weather is the term used for describing a range of environmental phenomena, primarily in near-Earth space, but also at relatively low altitude, that adversely affect all satellites in near-Earth and geostationary orbits and, more rarely, ground-based infrastructures sensitive to induced currents such as electrical power networks or pipelines. The origin of potentially damaging space weather events is the Sun. Potentially damaging space weather phenomena are caused both by direct radiation and by the very complex interaction of the Earth's magnetosphere with Coronal Mass Ejections, disturbances that propagate from the Sun after solar eruptions. Image courtesy ESA.

A major expansion in the space weather information and services provided by ESA will help satellites in space and networks like power grids on Earth to cope with solar eruptions. Scientists, engineers and researchers across Europe are working with ESA to develop a space weather warning system as part of the Agency's Space Situational Awareness programme.

'Space weather' refers to physical conditions at the Sun, in the solar wind and in near-Earth space that can influence the operation of spaceborne and ground systems and affect human health. The Sun causes 'storms' within Earth's magnetic shield when giant eruptions from its outer atmosphere wash across our planet.

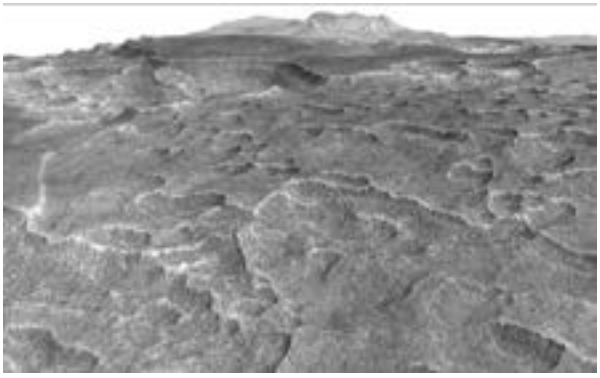
The last period of major storms ended with the Halloween storm of October 2003. A very large solar event in 2012 missed Earth. Smaller eruptions happen regularly and do reach our planet, affecting infrastructure like power grids and networks and interfering with economic activities.

New tools help manage solar effects

In October, ESA's Space Weather Service Network boosted its portfolio of products - including high-quality data and expert analysis - to more than 100. It released the first versions of 17 new Space Weather Services, each a combination of products, software tools, technical reports and associated expert support, tailored to a given type of affected customer.

"Each of our space weather services is tailored to provide a valuable space weather assessment capability for specific customers," says ESA's Juha-Pekka Luntama. ...Read More...

Mars ice deposit holds as much water as Lake Superior



This vertically exaggerated view shows scalloped depressions in a part of Mars where such textures prompted researchers to check for buried ice, using ground-penetrating radar aboard NASA's Mars Reconnaissance Orbiter. They found about as much frozen water as the volume of Lake Superior. Credit: NASA/JPL-Caltech/Univ. of Arizona

Frozen beneath a region of cracked and pitted plains on Mars lies about as much water as what's in Lake Superior, largest of the Great Lakes, a team of scientists led by The University of Texas at Austin has determined using data from NASA's Mars Reconnaissance Orbiter.

Scientists examined part of Mars' Utopia Planitia region, in the mid-northern latitudes, with the orbiter's ground-penetrating Shallow Radar (SHARAD) instrument. Analyses of data from more than 600 overhead passes revealed a deposit more extensive in area than the state of New Mexico. The deposit ranges in thickness from about 260 feet to about 560 feet, with a composition that's 50 to 85 percent water ice, mixed with dust or larger rocky particles.

At the latitude of this deposit—about halfway from the equator to the pole—water ice cannot persist on the surface of Mars today. It turns into water vapor in the planet's thin, dry atmosphere. The Utopia deposit is shielded from the atmosphere by a soil covering estimated to be about 3 to 33 feet thick.

"This deposit probably formed as snowfall accumulating into an ice sheet mixed with dust during a period in Mars history when the planet's axis was more tilted than it is today," said Cassie Stuurman of the University of Texas Institute for Geophysics, a unit of the Jackson School of Geosciences. She is the lead author of a report in the journal Geophysical Research Letters.

The name Utopia Planitia translates loosely as the "plains of paradise." The newly surveyed ice deposit spans latitudes from 39 to 49 degrees within the plains. It represents less than 1 percent of all known water ice on Mars, but it more than doubles the volume of thick, buried ice sheets known in the northern plains. Ice deposits close to the surface are being considered as a resource for astronauts. ...Read More...

This Week's Sky at a Glance - Nov. 26 - Dec. 02

Nov. 28	Moon at Apogee: 406556 km (00:08)
Nov. 29	New Moon (16:18)
Dec. 01	Rabi I 1438 AH

Belgian Astronaut Frank de Winne at SCASS / UoS - Nov. 22, 2016

The Sharjah Center for Astronomy and Space Sciences and the University of Sharjah were very pleased to host the Belgian astronaut Frank de Winne on Tuesday, Nov. 22, 2016. Mr. Frank was accompanied by the Belgian Ambassador to the UAE her HE Dominique Mineur and were received by his HE Prof. Hamid Al-Naimiy, the Chancellor of the University of Sharjah and also by the Dean of the College of Sciences, Prof. Madjid Merabti.

Frank De Winne is a Belgian Air Component Officer and an European Space Agency (ESA) astronaut. He was the first ESA astronaut to command a space mission when he served as commander of the International Space Station Expedition 21. During his 2 space missions Frank's tasks involved replacing the Soyuz TM-34 vehicle attached to the Space Station with the new Soyuz TMA-1, running experiments in life and physical sciences and education including experiments in Europe's Microgravity Science Glovebox and operating the Station's robotic arm to dock Japan's first HTV cargo vehicle. Frank was also the main operator of the Japanese robotic arm used to transfer experiments to Japan's external payload facility on the country's Kibo Laboratory. Frank is currently Head of the European Astronaut Centre.