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مركز الشارقة لعلوم الفضاء والفلك

Sharjah Center for Astronomy & Space Sciences

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Nobel physics prize awarded to three for topology work

The Royal Academy of Sciences members, from left, Professor Nils Martensson, Professor Goran K Hansson and Professor Thomas Hans Hansson reveal the winners of the Nobel Prize in physics, at the Royal Swedish Academy of Sciences, in Stockholm, Sweden, Tuesday, Oct. 4, 2016. David Thouless, Duncan Haldane and Michael Kosterlitz have won the Nobel physics prize. Nobel jury praises physics winners for 'discoveries of topological phase transitions and topological phases of matter'. (Anders Wiklund /TT via AP)

How is a doughnut like a coffee cup? The answer helped three British-born scientists win the Nobel prize in physics Tuesday. Their work could help lead to more powerful computers and improved materials for electronics.

David Thouless, Duncan Haldane and Michael Kosterlitz, who are now affiliated with universities in the United States, were honored for work in the 1970s and '80s that shed light on strange states of matter.

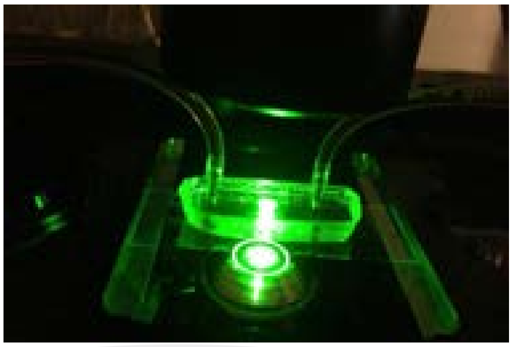
"Their discoveries have brought about breakthroughs in the theoretical understanding of matter's mysteries and created new perspectives on the development of innovative materials," the Royal Swedish Academy of Sciences said.

Thouless, 82, is a professor emeritus at the University of Washington. Haldane, 65, is a physics professor at Princeton University in New Jersey. Kosterlitz, 73, is a physics professor at Brown University in Providence, Rhode Island, and currently a visiting lecturer at Aalto University in Helsinki.

The 8 million kronor ($930,000) award was divided with one half going to Thouless and the other to Haldane and Kosterlitz. They investigated strange states of matter like superconductivity, the ability of a material to conduct electricity without resistance.

Their work called on an abstract mathematical field called topology, which presents a particular way to describe some properties of matter. In this realm, a doughnut and a coffee cup are basically the same thing because each contains precisely one hole. Topology describes properties that can only change in full steps; ...Read More...

When push comes to shove: Size matters for particles in our bloodstream



University of Connecticut researchers used a fluorescence microscope to illuminate a microfluidic device that simulates a blood vessel. The research team was able to observe and measure how particles of different sizes behave in the bloodstream. Their finding, that particle size matters, could aid the development of more effective cancer drugs. Credit: Anson Ma/University of Connecticut

Researchers at the University of Connecticut have uncovered new information about how particles behave in our bloodstream, an important advancement that could help pharmaceutical scientists develop more effective cancer drugs.

Making sure cancer medications reach the leaky blood vessels surrounding most tumor sites is one of the critical aspects of treatment and drug delivery. While surface chemistry, molecular interactions, and other factors come into play once drug-carrying particles arrive at a tumor, therapeutic medication doesn't do very much good if it never reaches its intended target.

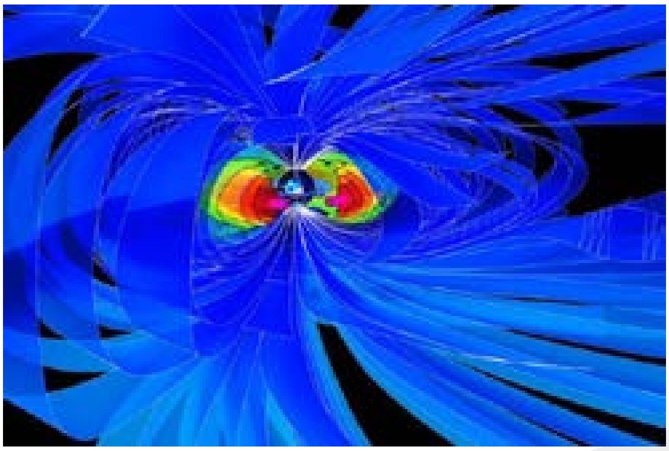
Anson Ma, an assistant professor of chemical and biomolecular engineering at UConn, used a microfluidic channel device to observe, track, and measure how individual particles behaved in a simulated blood vessel.

The research team's goal: to learn more about the physics influencing a particle's behavior as it travels in our blood and to determine which particle size might be the most effective for delivering drugs to their targets. The team's experimental findings mark the first time such quantitative data has been gathered. The study was published Oct. 4 in the Biophysical Journal.

"Even before particles reach a target site, you have to worry about what is going to happen with them after they get injected into the bloodstream," Ma says. "Are they going to clump together? How are they going to move around? Are they going to get swept away and flushed out of our bodies?"

Using a high-powered fluorescence microscope in UConn's Complex Fluids Lab, Ma was able to observe particles being carried along in the simulated blood ...Read More...

Physicists quench their thirst for modeling superfluids



The blue and green images (bottom) are simulation results on Titan. The colors identify separate superfluid puddles coexisting in a trap. The horizontal axis measures the strength of disorder within the trap. The top and bottom figure show different measurements characterizing the state of the system. At a disorder strength of .4, the system fragments from having a single superfluid puddle to multiple. The image series (above right) show experimental measurements while the colored images (below right) show the corresponding simulations on Titan. Credit: C. Meldgin, U. Ray, P. Russ, D. Chen, D. Ceperley, B. DeMarco. "Probing the Bose-Glass–Superfluid Transition Using Quantum Quenches of Disorder." Nature Physics (2016). DOI: 10.1038/nphys3695

Simply put, physicists study energy, matter, and how the two interact. Through the years researchers have cataloged countless phenomena relating to these complex interactions.

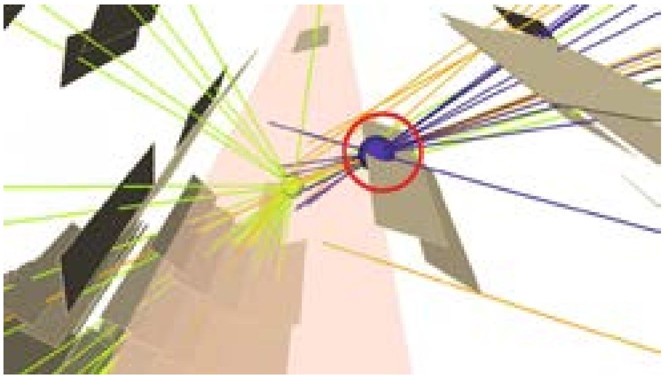
As science has advanced, researchers have come upon the next frontier of physics research—understanding materials at the most fundamental level and how changes in temperature or pressure can elicit unique, valuable properties in certain materials.

However, studying material properties and interactions under extreme temperature and pressure conditions poses challenges for researchers, as even world-class experimental facilities are unable to recreate sufficiently extreme conditions.

In an effort to improve insight into a broad range of materials exhibiting unique properties, a multi-institution team led by University of Illinois at Urbana-Champaign (UIUC) professor David Ceperley is using high-performance computing resources at the US Department of Energy's (DOE's) Oak Ridge National Laboratory (ORNL) to compare and corroborate experimental findings pertaining to a variety of such materials.

"Our research is fundamental science, helping us understand the origins of planets, among other things," Ceperley said. "This research also has a societal impact on designing new batteries, solar cells, and alloys. There are thousands of applications for this work." In addition, delving more deeply into this state of matter will help ...Read More...

The secret lives of long-lived particles



Credit: ATLAS collaboration

The universe is unbalanced. Gravity is tremendously weak. But the weak force, which allows particles to interact and transform, is enormously strong. The mass of the Higgs boson is suspiciously petite. And the catalog of the makeup of the cosmos? Ninety-six percent incomplete.

Almost every observation of the subatomic universe can be explained by the Standard Model of particle physics—a robust theoretical framework bursting with verifiable predictions. But because of these unsolved puzzles, the math is awkward, incomplete and filled with restrictions.

A few more particles would solve almost all of these frustrations. Supersymmetry (nicknamed SUSY for short) is a colossal model that introduces new particles into the Standard Model's equations. It rounds out the math and ties up loose ends. The only problem is that after decades of searching, physicists have found none of these new friends.

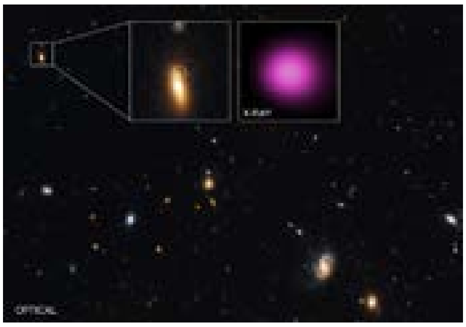
But maybe the reason physicists haven't found SUSY (or other physics beyond the Standard Model) is because they've been looking through the wrong lens.

"Beautiful sets of models keep getting ruled out," says Jessie Shelton, a theorist at the University of Illinois, "so we've had to take a step back and consider a whole new dimension in our searches, which is the lifetime of these particles."

In the past, physicists assumed that new particles produced in particle collisions would decay immediately, almost precisely at their points of origin. Scientists can catch particles that behave this way—for example, Higgs bosons—in particle detectors built around particle collision points. But what if new particles had long lifetimes and traveled centimeters—even kilometers—before transforming into something physicists could detect?

This is not unprecedented. Bottom quarks, for instance, can travel a few tenths of a millimeter before decaying into more stable particles. And muons can travel several kilometers (with the help of special ...Read More...

X-ray telescopes find evidence for wandering black hole



Credit: X-ray: NASA/CXC/UNH/D.Lin et al; Optical: NASA/STScI

Astronomers have used NASA's Chandra X-ray Observatory and ESA's XMM-Newton X-ray observatory to discover an extremely luminous, variable X-ray source located outside the center of its parent galaxy. This peculiar object could be a wandering black hole that came from a small galaxy falling into a larger one.

Astronomers think that supermassive black holes, with some 100,000 to 10 billion times the Sun's mass, are in the centers of most galaxies. There is also evidence for the existence of so-called intermediate mass black holes, which have lower masses ranging between about 100 and 100,000 times that of the Sun.

Both of these types of objects may be found away from the center of a galaxy following a collision and merger with another galaxy containing a massive black hole. As the stars, gas and dust from the second galaxy move through the first one, its black hole would move with it.

A new study reports the discovery of one of these "wandering" black holes toward the edge of the lenticular galaxy SDSS J141711.07+522540.8 (or, GJ1417+52 for short), which is located about 4.5 billion light years from Earth. This object, referred to as XJ1417+52, was discovered during long observations of a special region, the so-called Extended Groth Strip, with XMM-Newton and Chandra data obtained between 2000 and 2002. Its extreme brightness makes it likely that it is a black hole with a mass estimated to be about 100,000 times that of the Sun, assuming that the radiation force on surrounding matter equals the gravitational force.

The main panel of this graphic has a wide-field, optical light image from the Hubble Space Telescope. The black hole and its host galaxy are located within the box in the upper left. The inset on the left contains Hubble's close-up view of GJ1417+52. Within this inset the circle shows a point-like source on the northern outskirts of the galaxy that may be associated with XJ1417+52.

The inset on the right is Chandra's X-ray image of XJ1417+52 in purple, covering the same ...Read More...

Detonating white dwarfs as supernovae

Hubble Space Telescope image of supernova 1994D in galaxy NGC 4526. Credit: NASA/ESA

A new mathematical model created by astrophysicists at the American Museum of Natural History details a way that dead stars called white dwarfs could detonate, producing a type of explosion that is instrumental to measuring the extreme distances in our universe. The mechanism, described in the Monthly Notices of the Royal Astronomical Society, could improve our understanding of how Type Ia supernovae form.

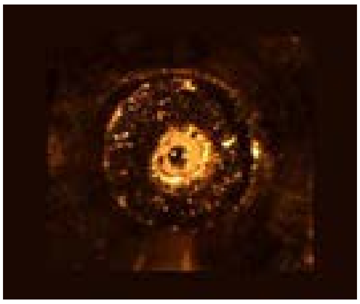
"Type Ia supernovae are extremely important objects in physics, best known for their role in revealing that the expansion of the universe is accelerating," said paper co-author Saavik Ford, who is a research associate in the Museum's Department of Astrophysics as well as a professor at the Borough of Manhattan Community College, CUNY; a faculty member at CUNY's Graduate Center; and a Kavli Scholar at the Kavli Institute for Theoretical Physics. "The problem is that people do not agree on exactly how Type Ia supernovae come to be."

Current research indicates that Type Ia supernova explosions originate from binary star systems—two stars orbiting one another—in which at least one star is a white dwarf, the dense remains of a star that was a few times more massive than our Sun. For this study, the scientists investigated how two white dwarfs might form a supernova.

"The simplest way to create a Type Ia supernova is to run two white dwarfs into one another," Ford said. "In our local universe, there are very few white dwarf binaries that are close enough to collide. Yet we see lots of supernovae lighting up our universe, so we know that something else is probably going on to cause those explosions."

Ford and co-author Barry McKernan, who is also a research associate in the Museum's Department of Astrophysics, a professor at the Borough of Manhattan Community College, CUNY, a faculty member at CUNY's Graduate Center, and a Kavli Scholar at the Kavli Institute for Theoretical Physics, propose the following: ...Read More...

Diamond proves useful material for growing graphene



File Image.

Graphene is the stuff of the future. For years, researchers and technologists have been predicting the utility of the one-atom-thick sheets of pure carbon in everything from advanced touch screens and semiconductors to long-lasting batteries and next-generation solar cells.

But graphene's unique intrinsic properties - supreme electrical and thermal conductivities and remarkable electron mobility, to name just a few - can only be fully realized if it is grown free from defects that disrupt the honeycomb pattern of the bound carbon atoms.

A team led by Materials Scientist Anirudha Sumant with the U.S. Department of Energy's (DOE) Argonne National Laboratory's Center for Nanoscale Materials (CNM) and Materials Science Division, along with collaborators at the University of California-Riverside, has developed a method to grow graphene that contains relatively few impurities and costs less to make, in a shorter time and at lower temperatures compared to the processes widely used to make graphene today.

Theoretical work led by Argonne nanoscientist Subramanian Sankaranarayanan at the CNM helped researchers understand the molecular-level processes underlying the graphene growth.

The new technology taps ultrananocrystalline diamond (UNCD), a synthetic type of diamond that Argonne researchers have pioneered through years of research. UNCD serves as a physical substrate, or surface on which the graphene grows, and the source for the carbon atoms that make up a rapidly produced graphene sheet.

"When I first looked at the [scanning electron micrograph] and saw this nice uniform, very complete layer, it was amazing," said Diana Berman, the first author of the study and former postdoctoral research associate who worked with Sumant and is now an Assistant Professor at the University of North Texas. "I'd been dealing with all these different techniques of growing graphene, and you never see such a uniform, smooth surface." Current graphene fabrication protocols introduce impurities during the etching process itself, which involves adding acid ...Read More...

Study solves 50-year-old puzzle tied to enigmatic, lone wolf waves

File Image

Solitary waves called solitons are one of nature's great curiosities: Unlike other waves, these lone wolf waves keep their energy and shape as they travel, instead of dissipating or dispersing as most other waves do.

In a new paper in Physical Review Letters (PRL), a team of mathematicians, physicists and engineers tackles a famous, 50-year-old problem tied to these enigmatic entities.

The puzzle dates back to 1965, when physicists Norman Zabusky and Martin Kruskal came up with a surprising solution to the Korteweg-de Vries equation, which serves as a mathematical model for describing nonlinear waves in shallow water.

Using a computer, Zabusky and Kruskal generated an approximate solution to the equation that featured eight independent, particle-like waves. Each of these waves retained its form and speed over time and distance—even after colliding with other such waves. The colleagues coined the term "soliton" to describe these unusual entities, giving birth to modern research in this field.

Kruskal and others then went on to invent a new mathematical method to solve the Korteweg-de Vries equation exactly. However, the calculations needed to obtain concrete answers are complex, typically requiring the use of a computer to complete—thus limiting scientists' ability to understand phenomena, including Zabusky and Kruskal's 1965 solution, says University at Buffalo mathematician Gino Biondini.

Moreover, to Biondini's knowledge, the original wave pattern that Zabusky and Kruskal described in 1965 has never been fully reproduced in the physical world (though earlier experiments have managed to generate portions of the solution). The new PRL study, published Sept. 28, addresses both of these problems, says Biondini, a co-author on the paper. ...Read More...

A Second Look at Plumes and the Search for life on Europa

This composite image shows suspected plumes of water vapor erupting at the 7 o'clock position off the limb of Jupiter's moon Europa. Image courtesy NASA/ESA/W. Sparks (STScI)/USGS Astrogeology Science Center.

Once can be a coincidence. Twice can be luck. Seeing a hundred-mile-high column of water spew out of Jupiter's icy moon Europa three times in a row has been cited as a good reason to get excited.

Plumes - great jets of subsurface water forced through the moon's thick ice sheet - were first spotted spraying out of Europa's southern pole in December 2012. At least, that's what the scientific community hoped was going on when Hubble first captured images of something bright in the ultraviolet spectrum "shooting" out of an area known to have fissures, or cracks that arise as Europa is deformed by Jupiter's gravity.

In the hopes of finding more evidence that this image was, indeed, a plume, not some other phenomenon, a separate team of scientists started watching Europa as it passed between Earth and Jupiter. The idea was this: if a liquid is being squeezed out of a solid body into space, it should spray cross Jupiter's face, leaving a shadow.

The plan panned out beautifully. Ten times over fifteen months, scientists from the Space Telescope Science Institute watched Europa cut across the gas giant. Thirty percent of the time, Jupiter's glow dimmed slightly: in the same place as the potential plume from 2012.

The importance of plumes and the role they might play in finding life beyond Earth was described in this 2014 article. To sum it up: if these images reflect the presence of plumes, it means that we can explore the subsurface of Europa without having to dig, drill, or even land. Europa's water, and whatever may be living in it, will come to us: we simply have to fly to it and through it.

Sampling run to Jupiter, anyone? The Importance of Plumes - The Hubble Space Telescope is famous for finding black holes. It can pick out thousands of galaxies in a patch of sky the size of a thumbprint. ...Read More...

Milkway's most-mysterious star is even stranger than astronomers thought

This artist's conception shows a star behind a shattered comet. One of the theories for KIC 8462852's unusual dimming is the presence of debris from a collision or breakup of a planet or comet in the star's system, creating a short-term cloud that blocks some starlight. Credit: Image is courtesy of NASA/JPL-Caltech.

A star known by the unassuming name of KIC 8462852 in the constellation Cygnus has been raising eyebrows both in and outside of the scientific community for the past year. In 2015 a team of astronomers announced that the star underwent a series of very brief, non-periodic dimming events while it was being monitored by NASA's Kepler space telescope, and no one could quite figure out what caused them. A new study from Carnegie's Josh Simon and Caltech's Ben Montet has deepened the mystery.

Simon and Montet's findings caused a stir in August, when they were posted on a preprint server while their paper was being reviewed. Now their work is now accepted for publication by The Astrophysical Journal.

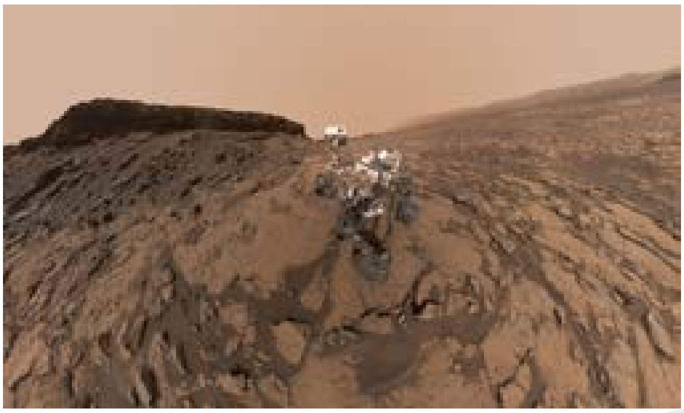
The researchers analyzed further Kepler observations of the puzzling star and showed that in addition to its rapid unexplained brightness changes, the star also faded slowly and steadily during the four years it was watched by Kepler.

Speculation to explain KIC 8462852's dips in brightness has ranged from an unusually large group of comets orbiting the star to an alien megastructure. In general, stars can appear to dim because a solid object like a planet or a cloud of dust and gas passes between it and the observer, eclipsing and effectively dimming its brightness for a time. But the erratic pattern of abrupt fading and re-brightening in KIC 8462852 is unlike that seen for any other star.

Spurred by a controversial claim that the star's brightness gradually decreased by 14 percent from 1890 to 1989, Montet and Simon decided to investigate its behavior in a series of Kepler calibration images that had not previously been used for scientific measurements.

"We thought that these data could confirm or refute the star's long-term fading, and hopefully clarify what was causing the extraordinary dimming events observed in KIC 8462852," explained Simon. ...Read More...

NASA's Curiosity Rover Begins Next Mars Chapter



This September 2016 self-portrait of NASA's Curiosity Mars rover shows the vehicle at the "Quela" drilling location in the scenic "Murray Buttes" area on lower Mount Sharp. The panorama was stitched together from multiple images taken by the MAHLI camera at the end of the rover's arm. Image courtesy NASA/JPL-Caltech/MSSS.

After collecting drilled rock powder in arguably the most scenic landscape yet visited by a Mars rover, NASA's Curiosity mobile laboratory is driving toward uphill destinations as part of its two-year mission extension that commenced Oct. 1. The destinations include a ridge capped with material rich in the iron-oxide mineral hematite, about a mile-and-a-half (two-and-a-half kilometers) ahead, and an exposure of clay-rich bedrock beyond that.

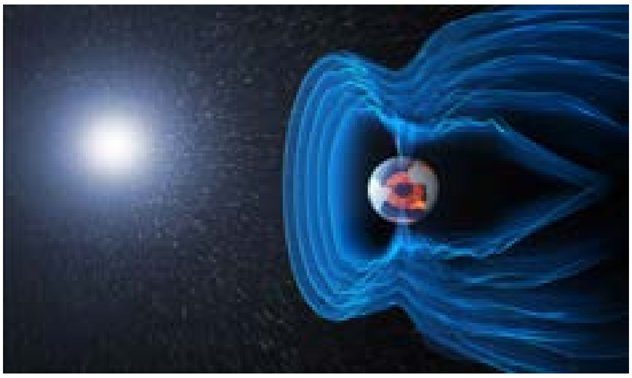
These are key exploration sites on lower Mount Sharp, which is a layered, Mount-Rainier-size mound where Curiosity is investigating evidence of ancient, water-rich environments that contrast with the harsh, dry conditions on the surface of Mars today.

"We continue to reach higher and younger layers on Mount Sharp," said Curiosity Project Scientist Ashwin Vasavada, of NASA's Jet Propulsion Laboratory, Pasadena, California. "Even after four years of exploring near and on the mountain, it still has the potential to completely surprise us."

Hundreds of photos Curiosity took in recent weeks amid a cluster of mesas and buttes of diverse shapes are fresh highlights among the more than 180,000 images the rover has taken since landing on Mars in August 2012. Newly available vistas include the rover's latest self-portrait from the color camera at the end of its arm and a scenic panorama from the color camera at the top of the mast.

"Bidding good-bye to 'Murray Buttes,' Curiosity's assignment is the ongoing study of ancient habitability and the potential for life," said Curiosity Program Scientist Michael Meyer at NASA Headquarters, Washington. "This mission, as it explores the succession of rock layers, is reading the 'pages' of Martian history - changing our understanding of Mars and how the planet has evolved. ...Read More...

Magnetic oceans and electric Earth



The magnetic field and electric currents in and around Earth generate complex forces that have immeasurable impact on every day life. The field can be thought of as a huge bubble, protecting us from cosmic radiation and charged particles that bombard Earth in solar winds.

Oceans might not be thought of as magnetic, but they make a tiny contribution to our planet's protective magnetic shield. Remarkably, ESA's Swarm satellites have not only measured this extremely faint field, but have also led to new discoveries about the electrical nature of inner Earth.

The magnetic field shields us from cosmic radiation and charged particles that bombard Earth from the Sun. Without it, the atmosphere as we know it would not exist, rendering life virtually impossible.

Scientists need to learn more about our protective field to understand many natural processes, from those occurring deep inside the planet, to weather in space caused by solar activity. This information will then yield a better understanding of why Earth's magnetic field is weakening.

Although we know that the magnetic field originates in different parts of Earth and that each source generates magnetism of different strengths, exactly how it is generated and why it changes is not fully understood.

This is why, in 2013, ESA launched its trio of Swarm satellites.

While the mission is already shedding new light on how the field is changing, this latest result focuses on the most elusive source of magnetism: ocean tides.

When salty ocean water flows through the magnetic field, an electric current is generated and this, in turn, induces a magnetic response in the deep region below Earth's crust - the mantle. Because this response is such a small portion of the overall field, it was always going to be a challenge to measure it from space.

Last year, scientists from the Swiss Federal Institute of Technology, ETH Zurich, showed that if ...Read More...

This Week's Sky at a Glance
Oct. 08 - 14

Oct 09	First Quarter Moon (08:32) - Meridian passage (18:37) – Altitude: 47°
Oct 13	Moon at descending node (Local Time: 13:43)

World Space Week Program
Oct. 08, 2016 – 16:00 – 20:30

16:00	General Tour
17:00	Planetarium Show
18:00	Lecture – Remote Sensing
19:00	Planetarium Show
20:00	Star Gazing – Visiting the Observatory

WSW 2016 Side Activities: 17:00 - 19:00

Sundial Workshop
Telescope Workshop
Astro Face Painting