Nov. 10, 2018 Rabi I 02, 1440 AH Volume 8, Issue 45

Astronomy & Physics Weekly News

Dept. of Applied Physics & Astronomy - University of Sharjah
Compiled by **Dr. Ilias Fernini**

مركز الشارقة لعلوم الفضاء والفلك
Sharjah Center for Astronomy & Space Sciences

Top News

جامعة الشارقة
UNIVERSITY OF SHARJAH

IT Support Issam Jami Design by Mohamed Bakir

Scientists theorize new origin story for Earth's water

Through a process called isotopic fractionation, hydrogen was pulled towards the young Earth's center. Hydrogen, which is attracted to iron, was delivered to the core by the metal, while much of the heavier isotope, deuterium, remained in the magma which eventually cooled and became the mantle, according to the study's authors. Impacts from smaller embryos and other objects then continued to add water and overall mass until Earth reached its final size.

Earth's water may have originated from both asteroidal material and gas left over from the formation of the Sun, according to new research. The new finding could give scientists important insights about the development of other planets and their potential to support life.

In a new study in the Journal of Geophysical Research: Planets, a journal of the American Geophysical Union, researchers propose a new theory to address the long-standing mystery of where Earth's water came from and how it got here.

The new study challenges widely-accepted ideas about hydrogen in Earth's water by suggesting the element partially came from clouds of dust and gas remaining after the Sun's formation, called the solar nebula.

To identify sources of water on Earth, scientists have searched for sources of hydrogen rather than oxygen, because the latter component of water is much more abundant in the solar system.

Many scientists have historically supported a theory that all of Earth's water came from asteroids because of similarities between ocean water and water found on asteroids. The ratio of deuterium, a heavier hydrogen isotope, to normal hydrogen serves as a unique chemical signature of water sources. In the case of Earth's oceans, the deuterium-to-hydrogen ratio is close to what is found in asteroids.

But the ocean may not be telling the entire story of Earth's hydrogen, according to the study's authors.

"It's a bit of a blind spot in the community," said Steven Desch, a professor of astrophysics in the School of Earth and Space Exploration at Arizona State University in Tempe, Arizona and co-author of the new study, led by Peter Buseck, Regents' Professor in the School of Earth and Space Exploration and School of Molecular Sciences ...Read More...

Four base units of measure in the metric system about to be changed

Credit: CC0 Public Domain

Officials with the General Conference on Weights and Measures (CGPM) have announced that at a meeting to be held next week, four of the base units used in the metric system will be redefined. The four units under review are the ampere, kilogram, mole and kelvin.

Currently, the kilogram is officially defined as the mass of a cylinder made of a platinum-iridium alloy housed in a bell jar in France—it has been removed from its protected spot every 40 years to serve as a calibration tool for other weights. But according to officials with CGPM, its days are numbered. This is because the 60 member nations that make up the body will be voting to change to a system in which the kilogram will be defined indirectly—by using the Planck constant.

The tool used to provide the new base unit is the Kibble balance—a very complex piece of equipment that first measures the amount of electric current necessary to create an electromagnetic force that is equal to a force acting on a given mass. It is during the second stage that the Plank constant comes into play. The reason for the changeover is to reference a more stable basis of measurement and to allow for the development of more precise measuring devices. Several metrologists involved in bringing the changes to a vote have acknowledged that most people will neither understand the changes that have taken place, nor notice that a change has occurred.

The metric system is part of the International System of Units, and in places other than the United States, is commonly called SI. Efforts to make it more precise have been underway for years. The speed of light, for example, was updated in 1983, and is now defined as 299,792,458 meters per second.

For those interested in the proceedings, the CGPM will be streamed live on the internet. Officials have described the meeting as marking the end of SI measurements based on objects. Prior meetings have already resulted in updating the other three base units in the system: the second, meter and candela. If the measures pass, the changes will take effect in May of next year. ...Read More...

New Horizons On Approach to the First Exploration of a Kuiper Belt Object

The New Horizons spacecraft flies by the Kuiper Belt Object 2014 MU69, in this artist's illustration. NASA / JHU-APL / SwRI / S. Gribben

Take a look behind the scenes as the New Horizons team gears up for the historic first flyby of a body in the remote Kuiper Belt, in this first of a four-part series from the mission's Principal Investigator Alan Stern.

As I write these words, NASA's New Horizons spacecraft, which explored the Pluto system in 2015, is now almost a billion miles beyond Pluto and bearing down on its next flyby target at a rate of over 1 million kilometers per day. The target is the Kuiper Belt object (KBO) 2014 MU69, nicknamed Ultima Thule. That name, pronounced "Ultima Tooly," is Latin for "beyond the farthest frontiers" and was chosen in a public naming contest because its meaning represents what we are doing: exploring the farthest (and likely the most primitive) object ever visited in space.

Our team discovered Ultima (as I usually call our target) in 2014, using the Hubble Space Telescope. Ultima's orbit, which is nearly circular and at a distance of 44 a.u. (6.6 billion kilometers) from the Sun, is in a special region of the Kuiper Belt called the cold classical belt. Whereas most objects in the Kuiper Belt formed among the giant planets and later moved outward to their current orbits, bodies in the cold classical region actually formed at their current location. As such, its members, like Ultima, represent a valuable bedrock sample of the ancient outer solar nebula.

With a diameter of just 25 or 30 kilometers (16 or 19 miles), Ultima is an order of magnitude larger and about 1,000 times more massive than typical comets from the Kuiper Belt. As such, it could reveal important aspects of the planet-building process by showing us the next step up the ladder of accretion that built still larger KBOs and small planets such as Pluto.

When NASA called for proposals to explore the Pluto system back in 2001, each proposing team was required to demonstrate that their spacecraft and instruments were capable of also going on to explore a Kuiper Belt object after investigating Pluto. ...Read More...

Speeding White Dwarfs May Point to Past Explosions

A new study suggests that binary white dwarfs be the key to understanding Type Ia supernovae like the explosion featured in this artist's impression.
ESO/M. Kornmesser

A recent study has discovered three of the fastest stars known in the Milky Way. But these stars may be more than just speeders – they might also be evidence of how Type Ia supernovae occur.

Seeking a Source

Given the extent to which we rely on Type Ia supernovae as standard candles used to measure vast distances, you might think that we've got them fairly well figured out. But these stellar explosions are complicated, and it turns out that we don't know some of the most fundamental things about them! Scientists are still working hard to find answers about what systems Type Ia supernovae originate from, and how the explosions are caused.

Led by astronomer Ken Shen (University of California, Berkeley), a team of astronomers has explored one particular model for Type Ia supernovae further: the "dynamically driven double-degenerate double-detonation" model – or D6, for short. In this scenario, a pair of white dwarfs orbit each other in a binary system. Two back-to-back detonations then cause one of the white dwarfs to explode as a supernova while the other white dwarf survives and is flung free of the explosion site.

Shen and collaborators note that if the D6 model proves to be the primary means of producing Type Ia supernovae, then there's an observable outcome: there should be white dwarfs speeding throughout our galaxy that were suddenly liberated by the supernova explosions of their companions.

Hunt for Speeders

Based on the estimated supernova rate in our galaxy and the properties of binary white dwarfs, Shen and collaborators predict that there should be ~30 hypervelocity white dwarfs within ~3,000 light-years of us. But how to spot these compact stars speeding across the sky? With one of the best tools in the business: Gaia. Shen and collaborators combed through the numbers from the Gaia mission's second data release, which presents the ...Read More...

Cosmic Detective Work: Why We Care About Space Rocks

This video clip was compiled from images taken by NASA's EPOXI mission spacecraft during its flyby of comet Hartley 2 on Nov. 4, 2010. During the encounter, the spacecraft and comet whisked past each other at a speed of 12.3 kilometers per second (27,560 miles per hour). The spacecraft came within about 700 kilometers (435 miles) of the comet's nucleus at the time of closest approach.

The entire history of human existence is a tiny blip in our solar system's 4.5-billion-year history. No one was around to see planets forming and undergoing dramatic changes before settling in their present configuration. In order to understand what came before us - before life on Earth and before Earth itself - scientists need to hunt for clues to that mysterious distant past.

Those clues come in the form of asteroids, comets and other small objects. Like detectives sifting through forensic evidence, scientists carefully examine these small bodies for insights about our origins. They tell of a time when countless meteors and asteroids rained down on the planets, burned up in the Sun, shot out beyond the orbit of Neptune or collided with one another and shattered into smaller bodies. From distant, icy comets to the asteroid that ended the reign of the dinosaurs, each space rock contains clues to epic events that shaped the solar system as we know it today - including life on Earth.

NASA's missions to study these "non-planets" help us understand how planets including Earth formed, locate hazards from incoming objects and think about the future of exploration. They have played key roles in our solar system's history, and reflect how it continues to change today.

"They might not have giant volcanoes, global oceans or dust storms, but small worlds could answer big questions we have about the origins of our solar system," said Lori Glaze, acting director for the Planetary Science Division at NASA Headquarters in Washington.

NASA has a long history of exploring small bodies, beginning with Galileo's 1991 flyby of asteroid Gaspra. The first spacecraft to orbit an asteroid, Near Earth Asteroid Rendezvous (NEAR) Shoemaker, also successfully landed on asteroid Eros in 2000 and took measurements that originally hadn't been planned. ...Read More...

Astronomers unveil growing black holes in colliding galaxies

When the two supermassive black holes in each of these systems finally come together in millions of years, their encounters will produce strong gravitational waves. Gravitational waves produced by the collision of two stellar-mass black holes have already been detected by the Laser Interferometer Gravitational-Wave Observatory (LIGO).

Peering through thick walls of gas and dust surrounding the messy cores of merging galaxies, astronomers are getting their best view yet of close pairs of supermassive black holes as they march toward coalescence into mega black holes.

A team of researchers led by Michael Koss of Eureka Scientific Inc., in Kirkland, Washington, performed the largest survey of the cores of nearby galaxies in near-infrared light, using high-resolution images taken by NASA's Hubble Space Telescope and the W. M. Keck Observatory in Hawaii. The Hubble observations represent over 20 years' worth of snapshots from its vast archive.

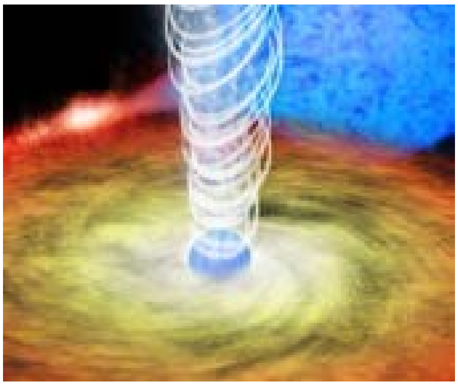
"Seeing the pairs of merging galaxy nuclei associated with these huge black holes so close together was pretty amazing," Koss said. "In our study, we see two galaxy nuclei right when the images were taken. You can't argue with it; it's a very 'clean' result, which doesn't rely on interpretation."

The images also provide a close-up preview of a phenomenon that must have been more common in the early universe, when galaxy mergers were more frequent. When galaxies collide, their monster black holes can unleash powerful energy in the form of gravitational waves, the kind of ripples in space-time that were just recently detected by ground-breaking experiments.

The new study also offers a preview of what will likely happen in our own cosmic backyard, in several billion years, when our Milky Way combines with the neighboring Andromeda galaxy and their respective central black holes smash together.

"Computer simulations of galaxy smashups show us that black holes grow fastest during the final stages of mergers, near the time when the black holes ...Read More...

Turbulence in space might solve astrophysical mystery



File Illustration.

Contrary to what many people believe, outer space is not empty. In addition to an electrically charged soup of ions and electrons known as plasma, space is permeated by magnetic fields with a wide range of strengths. Astrophysicists have long wondered how those fields are produced, sustained, and magnified.

Now, scientists at the U.S. Department of Energy's (DOE) Princeton Plasma Physics Laboratory (PPPL) have shown that plasma turbulence might be responsible, providing a possible answer to what has been called one of the most important unsolved problems in plasma astrophysics.

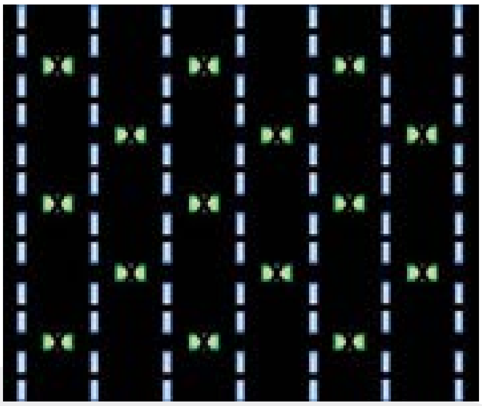
The researchers used powerful computers at the Princeton Institute for Computational Science and Engineering (PICSciE) and the National Energy Research Scientific Computing Center (NERSC) at the DOE's Lawrence Berkeley National Laboratory to simulate how the turbulence could intensify magnetic fields through what is known as the dynamo effect, in which the magnetic fields become stronger as the magnetic field lines twist and turn.

"This work constitutes an important step toward answering for the first time the question of whether turbulence can amplify magnetic fields to dynamical strengths in a hot, dilute plasma, such as that residing within clusters of galaxies," said Matthew Kunz, an astrophysics professor at Princeton University and an author of the paper, which was published in The Astrophysical Journal Letters.

Past research has focused on dynamos as they might occur in so-called collisional plasmas, in which particles collectively behave as a fluid. But intergalactic plasmas are collisionless, so past experiments are not necessarily relevant.

This new research is meant to address that gap. "We wanted to see how the dynamo would behave in the collisionless regime," said Denis St-Onge, graduate student in the Princeton Program in Plasma Physics at PPPL and lead author of the paper. St-Onge and Kunz focused on the ways in which the ...Read More...

Scientists shuffle the deck to create materials with new quantum behaviors



file illustration only

Layered transition metal dichalcogenides or TMDCs - materials composed of metal nanolayers sandwiched between two other layers of chalcogens - have become extremely attractive to the research community due to their ability to exfoliate into 2D single layers.

Similar to graphene, they not only retain some of the unique properties of the bulk material, but also demonstrate direct-gap semiconducting behavior, excellent electrocatalytic activity and unique quantum phenomena such as charge density waves (CDW).

Generating complex multi-principle element TMDCs essential for the future development of new generations of quantum, electronic, and energy conversion materials is difficult.

"It is relatively simple to make a binary material from one type of metal and one type of chalcogen," said Ames Laboratory Senior Scientist Viktor Balema.

"Once you try to add more metals or chalcogens to the reactants, combining them into a uniform structure becomes challenging. It was even believed that alloying of two or more different binary TMDCs in one single-phase material is absolutely impossible."

To overcome this obstacle, postdoctoral research associate Ihor Hlova used ball-milling and subsequent reactive fusion to combine such TMDCs as MoS_2, WSe_2, WS_2, TaS_2 and $NbSe_2$. Ball-milling is a mechanochemical process capable of exfoliating layered materials into single- or few-layer-nanosheets that can further restore their multi-layered arrangements by restacking.

"Mechanical processing treats binary TMDCs like shuffling together two separate decks of cards, said Balema. "They are reordered to form 3D-heterostructured architectures - an unprecedented phenomenon first observed in our work." Heating of the resulting 3D-heterostructures brings them to the edge of their stability, reorders atoms within and between their layers, resulting in ...Read More...

A faster, cheaper path to fusion energy

This is a rendition of the SPARC high-field tokamak experiment, which would produce the first fusion plasma to have a net energy gain.

Scientists are working to dramatically speed up the development of fusion energy in an effort to deliver power to the electric grid soon enough to help mitigate impacts of climate change. The arrival of a breakthrough technology - high-temperature superconductors, which can be used to build magnets that produce stronger magnetic fields than previously possible - could help them achieve this goal.

Researchers plan to use this technology to build magnets at the scale required for fusion, followed by construction of what would be the world's first fusion experiment to yield a net energy gain.

The effort is a collaboration between Massachusetts Institute of Technology's Plasma Science and Fusion Center and Commonwealth Fusion Systems, and they will present their work at the American Physical Society Division of Plasma Physics meeting in Portland, Ore.

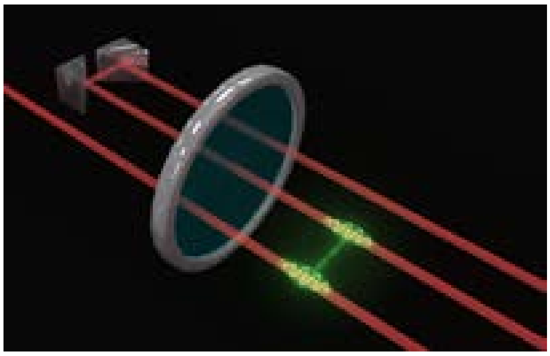
Fusion power is generated when nuclei of small atoms combine into larger ones in a process that releases enormous amounts of energy. These nuclei, typically heavier cousins of hydrogen called deuterium and tritium, are positively charged and so feel strong repulsion that can only be overcome at temperatures of hundreds of millions of degrees. While these temperatures, and thus fusion reactions, can be produced in modern fusion experiments, the conditions required for a net energy gain have not yet been achieved.

One potential solution to this could be increasing the strength of the magnets. Magnetic fields in fusion devices serve to keep these hot ionized gases, called plasmas, isolated and insulated from ordinary matter. The quality of this insulation gets more effective as the field gets stronger, meaning that one needs less space to keep the plasma hot.

Doubling the magnetic field in a fusion device allows one to reduce its volume - a good indicator of how much the device costs - by a factor of eight, while achieving the same performance. Thus, stronger magnetic fields make fusion smaller, faster and cheaper.

A breakthrough in superconductor technology could allow fusion power plants to come to fruition. ...Read More...

Griffith precision measurement takes it to the limit



Griffith University researchers have demonstrated a procedure for making precise measurements of speed, acceleration, material properties and even gravity waves possible, approaching the ultimate sensitivity allowed by laws of quantum physics. Credit: Griffith University

Griffith University researchers have demonstrated a procedure for making precise measurements of speed, acceleration, material properties and even gravity waves possible, approaching the ultimate sensitivity allowed by laws of quantum physics.

Published in Nature Communications, the work saw the Griffith team, led by Professor Geoff Pryde, working with photons (single particles of light) and using them to measure the extra distance travelled by the light beam, compared to its partner reference beam, as it went through the sample being measured—a thin crystal.

The researchers combined three techniques—entanglement (a kind of quantum connection that can exist between the photons), passing the beams back and forth along the measurement path, and a specially-designed detection technique.

"Every time a photon passes through the sample, it makes a kind of mini-measurement. The total measurement is the combination of all of these mini-measurements," said Griffith's Dr. Sergei Slussarenko, who oversaw the experiment. "The more times the photons pass through, the more precise the measurement becomes.

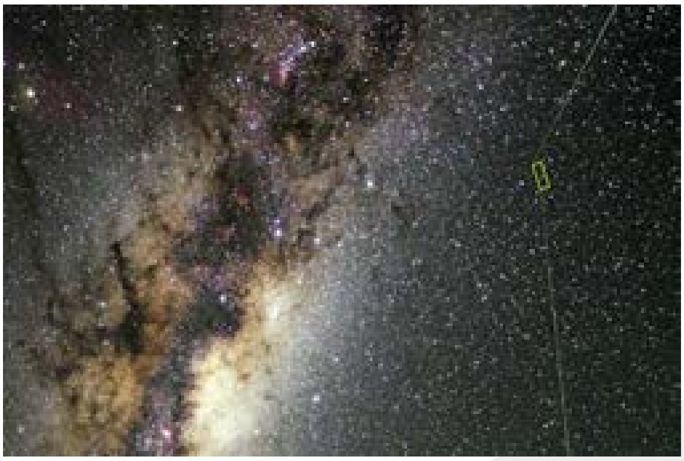
"Our scheme will serve as a blueprint for tools that can measure physical parameters with precision that is literally impossible to achieve with the common measurement devices.

Lead author of the paper Dr. Shakib Daryanoosh said this method can be used to investigate and measure other quantum systems.

"These can be very fragile, and every probe photon we send it would disturb it. In this case, using few photons but in the most efficient way possible is critical and our scheme shows how do exactly that," he said.

While one strategy is to just use as many photons as possible, that's not enough to reach the ultimate performance. For that, it is necessary to also extract the maximum amount of measurement information per ...Read More...

This 13.5-Billion-Year-Old Star Is a Tiny Relic from Just After the Big Bang



The newly identified star located within the yellow box of this image is half of a binary. Credit: ESO/BELETSKY/DSS1 + DSS2 + 2MASS

Astronomers think they have identified a star they believe to be about 13.5 billion years old, which would place its birth just after the Big Bang — and it's surprisingly close to us.

The new discovery suggests that our own corner of the galaxy may be older than previously calculated, and scientists hope that studying the star, called 2MASS J18082002-5104378 B, may teach us more about the early days of the universe.

"This star is maybe one in 10 million," lead author Kevin Schlaufman, an astronomer at Johns Hopkins University, said in a release. "It tells us something very important about the first generations of stars."

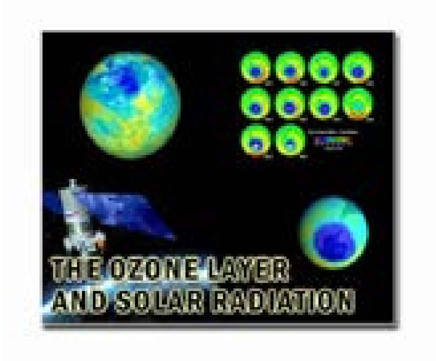
It's also an unusual star in terms of its orbit: It is tucked in the thin disk of the Milky Way and remains within the galactic plane, like our sun does, rather than orbiting away from the plane, as most stars short of metals do.

Such metal-poor stars are highly sought after by astronomers because they were formed shortly after the Big Bang, before many stars could explode in supernovas and scatter heavier elements across the universe. While scientists have identified a few handfuls of these incredibly old stars, the newly identified one is much smaller, with just 14 percent the mass of our sun. They hope that the new discovery will be the first of many more observations of incredibly old stars.

"If our inference is correct, then low-mass stars that have a composition exclusively the outcome of the Big Bang can exist," Schlaufman said in the release. "Even though we have not yet found an object like that in our galaxy, it can exist."

The new research is described in a paper published Nov. 5 in The Astrophysical Journal. ...Read More...

Ozone hole in northern hemisphere to recover completely by 2030



File Image.

Scientists expect the Northern hemisphere and mid-latitude ozone holes to be completely repaired some time in the 2030s, according to the first assessment of the ozone hole since 2014.

The study, "Scientific Assessment of Ozone Depletion: 2018," published Monday by the United Nations and the World Meteorological Organization, highlighted the decrease of ozone-depleting substances as the cause for the ozone's rebound. The study, which is conducted every four years, monitors ozone activity and represents the latest ozone assessment since 2014.

The ozone is a protective layer that shields life on Earth from dangerous, ultraviolet sun rays.

The recovery rate of the ozone has ranged from one to three percent since 2000. Scientists credit those gains to the Montreal Protocol, a 30-year old international agreement aimed at reducing the use of chlorofluorocarbons, or CFCs, and other ozone-depleting substances that come from aerosol cans, cooling and refrigeration systems and other objects.

Next year, the impacts of the Montreal Protocol are expected to grow with the ratification of the Kigali Amendment, which is designed to cut even further the use ozone-eroding gases in refrigerators, air conditioners and products.

Scientists said the Southern Hemisphere ozone should fully recover some time in the 2050s, and polar regions will be recovered in the 2060s.

The findings come along nearly a month after the release of an Intergovernmental Panel on Climate Change report describing the destructive impact of a two-degree Celsius temperature rise on the environment. United Nations chief António Guterres called the revelation an "ear-splitting wake-up call."

Scientists said the Kigali Amendment could help lower the Earth's temperature by 0.4 degree, keeping under the dangerous two degree mark. ...Read More...

Special Read:

NASA looks to university researchers for innovative space tech solutions

Close-up view of a friction stir weld tack tool used to manufacture external tanks of the space shuttle. Friction stir welding is different from traditional fusion welding in that the materials are not melted.

University-led research could transform the future of space exploration, from small spacecraft to "smart" systems for the Moon, Mars and beyond. NASA has selected 14 proposals for the study of innovative, early stage technologies that address high-priority needs of America's space program.

The universities will work on their proposed research and development projects for up to three years and will receive as much as $500,000 each in Early Stage Innovations grant funding from NASA's Space Technology Research Grants program.

"Early Stage Innovations utilize the nation's brightest minds in academia to advance mission capabilities," said Jim Reuter, acting associate administrator of NASA's Space Technology Mission Directorate in Washington. "This research will help solve complex challenges facing future exploration of the Moon, Mars and beyond."

The proposals, selected under the Early Stage Innovations 2018 solicitation, address unique, disruptive or transformational technologies in a variety of areas. The 14 selected proposals, which fall under five categories, are:

Topic 1: Modeling for Small Spacecraft Electric Propulsion
Future exploration missions will carry small spacecraft as secondary payloads. This topic aims to mature small electric propulsion systems for those spacecraft, using models to reduce risk and help increase flight readiness.

+ Data-Driven Predictive Modeling of Small Spacecraft Electric Propulsion Systems; University of Michigan
+ Multi-scale Modeling of Plume-Spacecraft Interactions for Novel Propellants; University of Illinois at Urbana-Champaign
+ Simulating the Operational Local Volume for Electrospray ion Thrusters (SOLVEiT); Massachusetts Institute of Technology

Topic 2: Smart and Autonomous Systems for Space
Future exploration missions will require spacecraft, robots and habitats that operate autonomously for extended periods of time. These proposals will help advance research of smart systems, specifically employing methods for machine learning and adapting over time.

+ A Control Framework for Autonomous Physical Systems: Observation, Modeling, Prediction and Planning; University of Massachusetts, Amherst
+ Autonomous Maneuvering within Chaotic Multi-Body Systems; University of Colorado, Boulder
+ Risk-Sensitive Learning and Decision Making for Autonomous Space Robots; Stanford University
+ Safety-Constrained and Efficient Learning for Resilient Autonomous Space Systems; University of Illinois at Urbana-Champaign

Topic 3: Omni-Optical Antennas and Optical-Multiple-Access Technologies for Free-Space Near-Earth Satellite Communication ..Read More...

This Week's Sky at a Glance - Nov. 10-16, 2018

Nov 11	Su	19:46	Moon-Saturn: 1.6° S
Nov 12	Mo	06:21	Moon South Dec.: 21.4° S
		20:48	North Taurid Shower: ZHR = 15
Nov 13	Tu	18:04	Moon Descending Node
Nov 14	We	19:57	Moon Apogee: 404300 km
Nov 15	Th	03:14	Venus-Spica: 1.5° S
		18:54	First Quarter
Nov 16	Fr	08:16	Moon-Mars: 1.1° N

The First Sharjah International Conference on Particle Physics, Astrophysics and Cosmology (FISICPAC)
University of Sharjah (UoS) - November 11 to 13, 2018.

SCASS Organizes 1st Week of a CubeSat Course (Nov. 04-08, 2018)

During the period Nov. 04, 08, the Sharjah Center for Astronomy and Space Sciences organized the first week of a series of a six-week CubeSat course organized in collaboration with the Istanbul Technical University, one of the leading European universities in space technologies. More than 20 students from the University of Sharjah, the American University of Sharjah, and five IASTE students attended this course. The topic was the SHARJAH-SAT-1 3U CubeSat that is planned to be launched in the first quarter of 2020. The CubeSat will carry a state of the art x-ray detector and a high-resolution camera. The students were exposed to the CubeSat technology in all of its aspects. For each session, the students went through a theoretical lecture part, then a hands-on practice session. During this five-day first week program, the students had to build a non-flying system using of the shelves components to simulate a real CubeSat. The remaining five-week of the program will be given in the coming weeks.