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Astronomy & Physics Weekly News

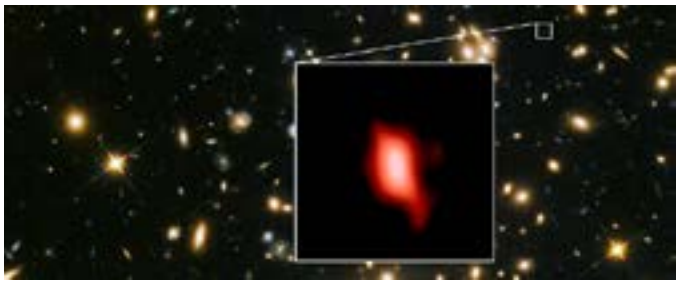
Dept. of Applied Physics & Astronomy - University of Sharjah
Compiled by Dr. Ilias Fernini

Top News

IT Support Issam Jami

Designed by Mohamed Bakir

The first stars formed when the universe was less than 2% its current age



With the help of the Atacama large Millimeter/submillimeter Array, astronomers have detected the earliest signs of oxygen (red) distributed in the galaxy MACS1149-JD1. The discovery provides the strongest evidence yet that stars in the fledgling universe started forming earlier than previously thought — when it was less than 2 percent its current age. ALMA (ESO/NAOJ/NRAO), NASA/ESA Hubble Space Telescope, W. Zheng (JHU), M. Postman (STScI), the CLASH Team, Hashimoto et al.

The Atacama Large Millimeter/submillimeter Array (ALMA) is not your standard, run-of-the-mill telescope. Instead, ALMA, which is located in the high-and-dry Atacama Desert of northern Chile, is a radio telescope made up of 66 high-precision antennas that operate in perfect harmony. When ALMA's antennas (which range from 7 to 12 meters in diameter) are configured in different ways, the array is capable of zooming in on some of the most distant cosmic objects in the universe, as well as capturing images that are clearer than those produced by the Hubble Space Telescope.

First starlight

In a new study set for publication tomorrow in the journal Nature, an international team of astronomers used this impressive array to observe an extremely distant galaxy called MACS1149-JD1. Within the galaxy, the team was surprised to discover faint signals of ionized oxygen that were emitted almost 13.3 billion years ago (or 500 million years after the Big Bang).

This is not only the most distant detection of oxygen ever made by any telescope, but more importantly, the discovery of the ancient oxygen serves as clear evidence that stars began forming just 250 million years after the Big Bang, when the universe was less than 2 percent its current age.

Before the first stars kicked on, the universe was a relatively boring place, consisting primarily of radiation left-over from the Big Bang, as well as hydrogen, helium, and a trace amount of lithium. However, many of the heavier elements we take for granted today (such as carbon and oxygen) did not exist before the first stars. This is because stars are the burning crucibles that convert hydrogen and helium into larger elements, so without stars, there is no oxygen. ..Read More...

The first carbon-rich asteroid found in the Kuiper Belt

An international team of astronomers was able to determine the chemical composition of Kuiper Belt Object 2004 EW95, an asteroid 2.5 billion miles (4 billion kilometers) away from Earth. Its makeup revealed elements that are prominent in the inner solar system, suggesting a significant outward migration.
ESO/M. Kornmesser

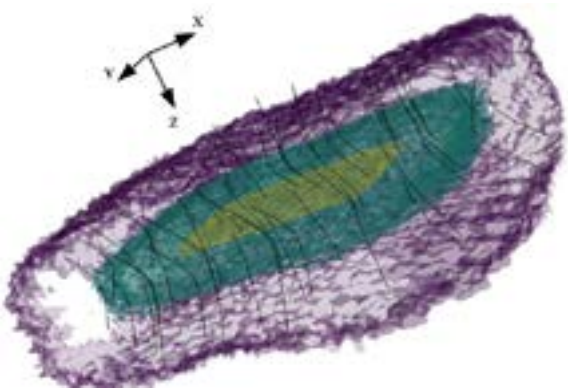
It's believed that our solar system's gas giants caused quite a ruckus in their infancies. As they exited their tight orbits and began their outward migrations, their forceful journeys caused small, rocky bodies in the inner solar system to be ejected from their homes, with some making their way all the way out to the Kuiper Belt — a thick and extended ring of comets, asteroids, and other small objects that surrounds the outer solar system. However, due to the billions of miles that lie between Earth and the Kuiper Belt, identifying an inner solar system asteroid in our icy outskirts was far from easy. But now, an international team of astronomers has discovered Kuiper Belt Object 2004 EW95 — a carbon-rich asteroid that supports our gas giants' destructive tendencies.

The outward migration of Jupiter, Saturn, Uranus, and Neptune is a critical element to our current solar system formation theory. Multiple models suggest that after these gas giants formed, they began rampaging away from the Sun until they hit their current orbital locations, causing carbon-rich rocky pieces in the inner solar system to scatter about. Most of these asteroids were ejected toward the Sun, where other carbon-rich objects reside, but some were sent in the opposite direction, toward the outer edge of our solar system. Since objects high in carbon aren't common out in the Kuiper Belt — an icy region past Neptune — verifying their distant existence could further support the current formation theory.

Using NASA's Hubble Space Telescope, astronomer and research team member Wesley Fraser first spotted Kuiper Belt Object 2004 EW95 while conducting routine observations of the Kuiper Belt. The strong spectral lines radiating from this unusual asteroid caused it to stand out from its peers, which have relatively dim spectra.

"The reflectance spectrum of 2004 EW95 was clearly distinct from the other observed outer Solar System objects," said lead researcher, Tom Seccull ...Read More...

3D View of Star-Forming Cloud & A Cloud-Free Exo-planet



3D model of Musca molecular cloud. Aris Tritsis / ANU

A dense, gaseous filament, called Musca after its namesake constellation, is shaped more like a a edge-on pancake than a needle, find Aris Tritsis (University of Crete, Greece and Australian National University) and Konstantinos Tassis (University of Crete, Greece). They published their conclusions in the May 11th Science.

The Herschel satellite had imaged far-infrared radiation (250 microns) from the cloud years ago as part of its Gould Belt Survey. Now, Tritsis and Tassis have examined hair-thin stripes that appear at the edge of the cloud in these observations, where molecular hydrogen had piled due to vibrations passing through the structure. Other observations had shown that these stripes are aligned with magnetic field lines that cross the cloud. The duo measured the distance between the stripes of denser gas, and then modeled those separations using a computer simulation. But to reproduce the observations, the simulation required a cloud that was not needle-shaped at all; instead it had to be flatter, like a piece of futomaki.

"This is a cloud in space that is singing to us – all we had to do was listen," says Tritsis.

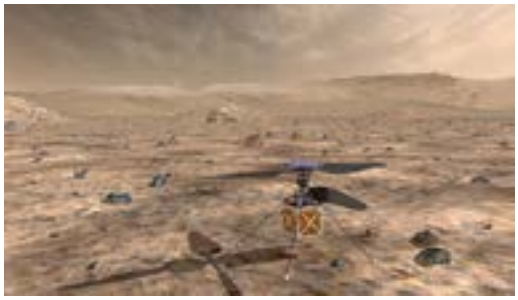
Musca has long been a prototypical filament used to study the early stages of star formation. Now that researchers know it's not actually a filament, they can more accurately test their ideas of how gas comes together to make stars.

WASP-96b: A Cloud-Free "Hot Saturn" Exoplanet

Researchers appear to have found the first cloud-free exoplanet: WASP-96b, a Saturn-mass, Jupiter-size gas giant in a close, 3.5-day orbit around its Sun-like star.

Nikolay Nikolov (University of Exeter, UK) led a team that measured the spectrum of starlight passing through the planet's atmosphere as it passed in front of its star. In the May 7th Nature, the team report the chemical fingerprint of neutral sodium, which indicates that the hot Saturn is free of clouds. ...Read More...

Helicopter to Hitch a Ride with Mars 2020 Rover



An artist's conception of the Mars Helicopter on the Red Planet. NASA/JPL-Caltech

A small helicopter will soon be making its way to Martian skies.

NASA recently announced that a small autonomous helicopter will make the journey with the Mars 2020 Rover. The Mars Helicopter Scout will be the first mission to fly on another planet. The drone-style helicopter will pave the way for future aerial scouts on Mars and other worlds.

Weighing in at 2.2 lbs (1 kg), the baseball-size helicopter will use a pair of 3-foot, 7-inch (1.1-meter) rotor blades. Powered by solar cells and a rechargeable lithium ion battery, these blades will beat at 3,000 rpm to create lift in the tenuous Martian atmosphere.

The altitude record for a helicopter here on Earth is about 40,000 feet. On Mars, the surface density of the thin atmosphere is equivalent to 100,000 feet above sea level on Earth. "To make it fly at that low atmospheric density, we had to scrutinize everything, make it as light as possible while being strong and as powerful as it can possibly be," says Mimi Aung (NASA-JPL) in a recent press release. A prototype demonstrated its flying capability in a simulated Mars environment here on Earth.

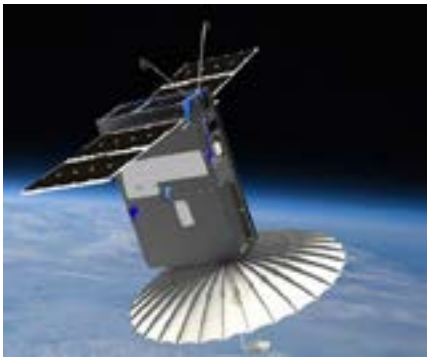
Tucked away in the belly pan on the underside of the Mars 2020 rover, the Mars Helicopter Scout will be deposited on the Martian surface shortly after the sky crane landing. The helicopter will be autonomous, owing to the 3- to 22-minute communications lag between Mars and Earth. It will also incorporate a heating element to keep it warm on cold Martian nights.

Soaring Through Alien Skies

The Mars Helicopter mission was funded for $23 million early this year, and is expected to last about 30 days. NASA plans to complete at least five short flights with the Mars Helicopter.The first flight will make an initial vertical climb of 10 feet (3 meters). Journeys up to 90 seconds in duration will range over several hundred meters on subsequent sorties.

"There are no science instruments aboard the Mars Helicopter – it is a technology demonstrator," ..Read More...

Small Packages to Test Big Space Technology Advances



The RainCube 6U CubeSat with fully-deployed antenna.

This weekend, when the next cargo resupply mission to the International Space Station lifts off from NASA Wallops Flight Facility in Virginia, it will be carrying among its supplies and experiments three cereal box-sized satellites that will be used to test and demonstrate the next generation of Earth-observing technology.

NASA has been increasing its use of CubeSats - small satellites based on several configurations of approximately 4 x 4 x 4-inch cubes - to put new technologies in orbit where they can be tested in the harsh environment of space before being used as part of larger satellite missions or constellations of spacecraft.

The three CubeSat missions launching on Orbital ATK's ninth commercial resupply mission represent a broad range of cutting-edge technologies housed in very small packages.

RainCube - a Radar in a CubeSat - is just that: a miniaturized precipitation-studying radar instrument that weighs just over 26 pounds. RainCube is smaller, has fewer components, and uses less power than traditional radar instruments. NASA's Earth Science Technology Office (ESTO) In-Space Validation of Earth Science Technologies (InVEST) program selected the project to demonstrate that such a diminutive radar can be operated successfully on a CubeSat platform.

This mission marks the first time an active radar instrument has been flown on a CubeSat.

If successful, RainCube could open the door for lower-cost, quick-turnaround constellation missions, in which multiple CubeSats work together to provide more frequent observations than a single satellite.

"A constellation of RainCube radars would be able to observe the internal structure of weather systems as they evolve according to processes that need to be better characterized in weather and climate forecasting models," said RainCube Principal Investigator Eva Peral of NASA's Jet Propulsion Laboratory in Pasadena, California. .Read More...

Magnonic interferometer paves way toward energy-efficient information processing devices

Illustration of the magnon interferometer with interference patterns. Credit: Li et al. ©2018 American Chemical Society

Researchers have designed an interferometer that works with magnetic quasiparticles called magnons, rather than photons as in conventional interferometers. Although magnon signals have discrete phases that normally cannot be changed continuously, the magnonic interferometer can generate a continuous change of the magnon signal. In the future, this ability could be used to design magnonic integrated circuits and other magnonic devices that overcome some of the limitations facing their electronic counterparts.

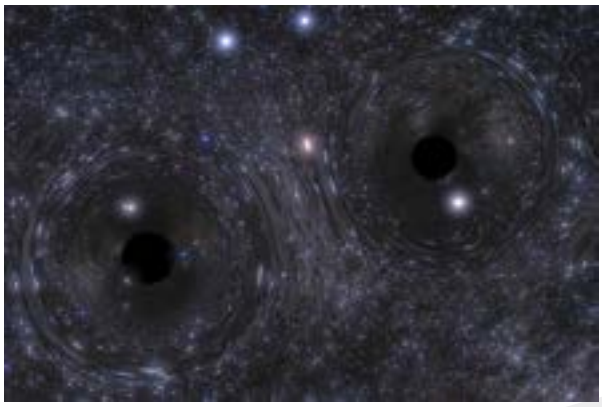
The researchers, Yun-Mei Li, Jiang Xiao, and Kai Chang, have published a paper on their work with magnons in a recent issue of Nano Letters.

One of the characteristic features of magnons is their discrete and topological nature, as they carry a fixed amount of energy and can be thought of as quantized spin waves. This characteristic of magnons makes them robust against local perturbations and forbidden backscattering processes, such as Joule heating and local defects, which often cause losses in electronic devices. For this reason, researchers are investigating the possibility of using magnon currents instead of electric currents to transfer and process information in highly efficient information processing systems.

Controlling magnons, however, requires the ability to continuously change the magnon signal, which has been challenging. In the new paper, the researchers achieve this by fabricating a waveguide made of artificial magnonic crystals composed of the magnetic insulator yttrium-iron garnet, which is patterned with triangular holes. They showed that magnonic modes emerge from the interface between two of these magnonic crystals that have opposite rotation directions of triangular holes. These magnonic modes have the desirable properties of being immune to backscattering and remaining highly coherent during propagation, making it possible to use them in a magnonic interferometer capable of continuously changing the magnonic signal.

To demonstrate, the researchers used the magnonic interferometer to split a magnonic ...Read More...

Black Hole Traffic Accidents May Produce Monster Mergers



A snapshot of a simulation showing the binary black hole formed in the heart of a dense cluster of stars. Credit: Northwestern Visualization/Carl Rodriguez

New research reveals that some black hole collisions may cascade, with the dense objects crashing into one another to create even more-massive black holes. This runaway growth may happen within groups of stars known a globular clusters.

"We think these clusters formed with hundreds to thousands of black holes that rapidly sank down in the center," Carl Rodriguez, a theoretical astrophysicist at the Massachusetts Institute of Technology, said in a statement. Working with an international team of scientists, Rodriguez modeled how black hole collisions should function according to Albert Einstein's theory of general relativity. The researchers found that black holes initially created by stars within globular clusters should grow more to be than 50 times as massive as Earth's sun if they collide with other black holes.

"These kinds of clusters are essentially factories for black hole binaries, where you've got so many black holes hanging out in a small region of space that two black holes could merge and produce a more massive black hole. Then, that new black hole can find another companion and merge again."

In 2016, the Laser Interferometer Gravitational-Wave Observatory (LIGO) made the first detection of the signatures of gravitational waves. According to Einstein's theory of general relativity, gravitational waves are released as energy when two black holes merge. LIGO's observations not only provided proof of gravitational waves, but they also confirmed the existence of stellar-binary black holes.

At the end of its lifetime, a massive star can blow off its material in a spectacular supernova. This can leave behind a stellar black hole at the stellar heart. Weighing in at around 10 times the mass of the sun, a stellar black hole can stretch just a few tens of kilometers across. Rodriguez and his colleagues decided to investigate how black holes behave within globular ...Read More...

Jupiter's Great Red Spot Could Disappear Within 20 Years

An enhanced image of Jupiter's Great Red Spot, as seen by NASA's Voyager 2 probe on July 7, 1979. Credit: NASA/JPL/Björn Jónsson/Seán Doran/Flickr (CC BY-NC-ND 2.0)

The iconic Great Red Spot of Jupiter may disappear in the next 20 years, according to a researcher at NASA's Jet Propulsion Laboratory (JPL) in California.

The massive storm — larger than Earth itself — was first spotted in 1830, and observations from the 1600s also revealed a giant spot on Jupiter's surface that may have been the same storm system. This suggests Jupiter's Great Red Spot (GRS) has been raging for centuries.

According to Orton, the storm's vortex has maintained strength because of Jupiter's 300-400 mph (483-640 km/h) jetstreams, but like any storm, it won't go on forever. "In truth, the GRS has been shrinking for a long time," Orton told Business Insider.

"The GRS will in a decade or two become the GRC (Great Red Circle)," Orton said. "Maybe sometime after that the GRM," by which he means the "Great Red Memory." ess Insider spoke with Glenn Orton, a lead Juno mission team member and planetary scientist at NASA Jet Propulsion Laboratory (JPL), about the giant storm's fate.

In the late 1800s, the storm was perhaps as wide as 30 degrees longitude, Orton said. That works out to more than 35,000 miles — four times the diameter of Earth. When the nuclear-powered spacecraft Voyager 2 flew by Jupiter in 1979, however, the storm had shrunk to a bit more twice the width of our own planet.

Data on Jupiter's crimson-colored spot reveals that this shrinking is still occurring. As of April 3, 2017, the GRS spanned the width of 10,159 miles (16,350 kilometers), less than 1.3 times Earth's diameter.The longest storm on Earth lasted 31 days, but Jupiter can sustain longer storms because the gas planet has tens of thousands of miles of atmosphere, and spins much faster than Earth. ..Read More...

Researchers create a quantum entanglement between two physically separated ultra-cold atomic clouds

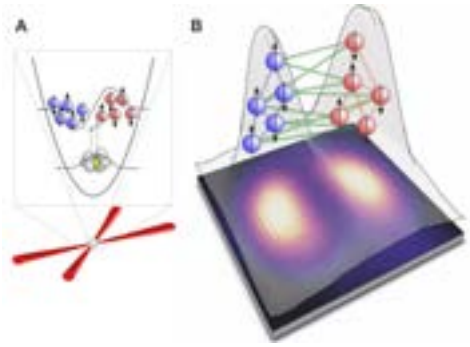


Illustration of the quantum entanglement achieved between the two clouds of atoms starting from a single Bose-Einstein condensate. Credit: Iagoba Apellaniz. UPV/EHU

Members of the Department of Theoretical Physics and History of Science of the UPV/EHU's Faculty of Science and Technology together with researchers from the University of Hannover have achieved quantum entanglement between two spatially separated Bose-Einstein condensates, ultra-cold atomic ensembles. Led by Géza Tóth, Ikerbasque Research Professor, the study is published in Science.

Quantum entanglement was discovered by Schrödinger and later studied by Einstein and other scientists in the 20th century. It is a quantum phenomenon with no counterparts in classical physics. The groups of entangled particles lose their individuality and behave as a single entity. Any change in one of the particles leads to an immediate response in the other, even if they are spatially separated. "Quantum entanglement is essential in applications such as quantum computing, since it enables certain tasks to be performed much faster than in classical computing," explained Toth.

Unlike previous methods of quantum entanglement involving incoherent and thermal clouds of particles, in this experiment, the researchers used a cloud of atoms in the Bose-Einstein condensate state. Tóth said, "Bose-Einstein condensates are achieved by cooling down the atoms to very low temperatures, close to absolute zero. At that temperature, all the atoms are in a highly coherent quantum state; in a sense, they all occupy the same position in space. In that state, quantum entanglement exists between the atoms of the ensemble." Subsequently, the ensemble was split into two atomic clouds. "We separated the two clouds from each other by a distance, and we were able to demonstrate that the two parts remained entangled with each other," he continued.

The demonstration that entanglement can be created between two ensembles in the Bose-Einstein condensate state could lead to an improvement in many fields in which quantum technology is used, such as quantum computing, quantum simulation and quantum ..Read More...

First measurement of subatomic particle's mechanical property reveals distribution of pressure inside proton

Nuclear physicists have found that the proton's building blocks, the quarks, are subjected to a pressure of 100 decillion Pascal (1035) near the center of a proton, which is about 10 times greater than the pressure in the heart of a neutron star. Credit: DOE's Jefferson Lab

Inside every proton in every atom in the universe is a pressure cooker environment that surpasses the atom-crushing heart of a neutron star. That's according to the first measurement of a mechanical property of subatomic particles, the pressure distribution inside the proton, which was carried out by scientists at the Department of Energy's Thomas Jefferson National Accelerator Facility.

The nuclear physicists found that the proton's building blocks, the quarks, are subjected to a pressure of 100 decillion Pascal (10^{35}) near the center of a proton, which is about 10 times greater than the pressure in the heart of a neutron star. The result was recently published in the journal Nature.

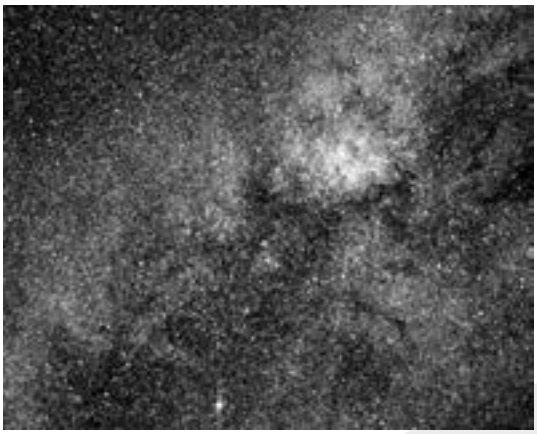
"We found an extremely high outward-directed pressure from the center of the proton, and a much lower and more extended inward-directed pressure near the proton's periphery," explains Volker Burkert, Jefferson Lab Hall B Leader and a co-author on the paper.

Burkert says that the distribution of pressure inside the proton is dictated by the strong force, the force that binds three quarks together to make a proton.

"Our results also shed light on the distribution of the strong force inside the proton," he said. "We are providing a way of visualizing the magnitude and distribution of the strong force inside the proton. This opens up an entirely new direction in nuclear and particle physics that can be explored in the future." Once thought impossible to obtain, this measurement is the result of a clever pairing of two theoretical frameworks with existing data.

First, there are the generalized parton distributions. GPDs allow researchers to produce a 3-D image of the proton's structure as probed by the electromagnetic force. The second are the gravitational form factors ...Read More...

NASA's new planet hunter snaps initial test image, swings by Moon toward final orbit



This test image from one of the four cameras aboard the Transiting Exoplanet Survey Satellite (TESS) captures a swath of the southern sky along the plane of our galaxy. More than 200,000 stars are visible in this image. TESS is expected to cover more than 400 times the amount of sky shown in this image when using all four of its cameras during science operations. The image, which is centered in the constellation Centaurus, includes dark tendrils from the Coalsack Nebula and the bright emission nebula Ced 122 (upper right).The bright star at bottom center is Beta Centauri. Credit: NASA/MIT/TESS

NASA's next planet hunter, the Transiting Exoplanet Survey Satellite (TESS), is one step closer to searching for new worlds after successfully completing a lunar flyby on May 17. The spacecraft passed about 5,000 miles from the Moon, which provided a gravity assist that helped TESS sail toward its final working orbit.

As part of camera commissioning, the science team snapped a two-second test exposure using one of the four TESS cameras. The image, centered on the southern constellation Centaurus, reveals more than 200,000 stars. The edge of the Coalsack Nebula is in the right upper corner and the bright star Beta Centauri is visible at the lower left edge. TESS is expected to cover more than 400 times as much sky as shown in this image with its four cameras during its initial two-year search for exoplanets. A science-quality image, also referred to as a "first light" image, is expected to be released in June.

TESS will undergo one final thruster burn on May 30 to enter its science orbit around Earth. This highly elliptical orbit will maximize the amount of sky the spacecraft can image, allowing it to continuously monitor large swaths of the sky. TESS is expected to begin science operations in mid-June after reaching this orbit and completing camera calibrations.

Launched from Cape Canaveral Air Force Station in Florida on April 18, TESS is the next step in NASA's search for planets outside our solar system, known as exoplanets. The mission will observe nearly the entire sky to monitor nearby, bright stars in search of transits—periodic dips in a star's brightness caused by a planet ...Read More...

New views of Sun: Two missions will go closer to our star than ever before

The NASA/ESA Solar Orbiter will capture the very first images of the Sun's polar regions, where magnetic tension builds up and releases in a lively dance. Launching in 2020, Solar Orbiter's study of the Sun will shed light on its magnetic structure and the many forces that shape solar activity. Credit: Spacecraft: ESA/ATG medialab; Sun: NASA/SDO/P. Testa (CfA)

As we develop more and more powerful tools to peer beyond our solar system, we learn more about the seemingly endless sea of faraway stars and their curious casts of orbiting planets. But there's only one star we can travel to directly and observe up close—and that's our own: the Sun.

Two upcoming missions will soon take us closer to the Sun than we've ever been before, providing our best chance yet at uncovering the complexities of solar activity in our own solar system and shedding light on the very nature of space and stars throughout the universe.

Together, NASA's Parker Solar Probe and ESA's (the European Space Agency) Solar Orbiter may resolve decades-old questions about the inner workings of our nearest star. Their comprehensive, up-close study of the Sun has important implications for how we live and explore: Energy from the Sun powers life on Earth, but it also triggers space weather events that can pose hazard to technology we increasingly depend upon. Such space weather can disrupt radio communications, affect satellites and human spaceflight, and—at its worst—interfere with power grids. A better understanding of the fundamental processes at the Sun driving these events could improve predictions of when they'll occur and how their effects may be felt on Earth.

"Our goal is to understand how the Sun works and how it affects the space environment to the point of predictability," said Chris St. Cyr, Solar Orbiter project scientist at NASA's Goddard Space Flight Center in Greenbelt, Maryland. "This is really a curiosity-driven science."

Parker Solar Probe is slated to launch in the summer of 2018, and Solar Orbiter is scheduled to follow in 2020. These missions were developed independently, but their coordinated science objectives are no coincidence: Parker Solar Probe and Solar Orbiter ...Read More...

Special Read:

When Is A Planet A Planet?

Igor ZH/Shutterstock

On a basic level, it seems that most of the universe can be divided into two kinds of big objects: stars and planets.

A star is a massive ball of burning gas whose main function is fusing hydrogen into helium. They are formed by huge clouds of gas that eventually come together in sufficient quantities to kick off nuclear reactions.

Planets, in turn, come from the material left around the star after its formation. They form from small bits that clump together into protoplanets which in turn smash together to form the large objects we see today. Most other objects in our solar system—asteroids, dwarf planets, comets, and the like—are leftover building blocks of planets that never quite came together.

"Large objects that are formed from dust clouds around a star" is usually the quickest, dirtiest way to define a planet. Except when it isn't. Some objects fall in an odd in-between—not big enough to be a star, but too big to be planet. And other planets might never have formed around a star at all.

The In-Between

The absolute lowest mass we believe a star can be while still being a helium-fusing cauldron is around 7 percent the mass of the Sun, which is roughly 73 Jupiter-masses. Similarly, the upper limit of an object that forms like a planet, at least as we understand it thus far, is about 13 Jupiter-masses, or 0.012 solar masses. (Jupiter is almost 1 percent the mass of the Sun, but not quite.)

In the territory between 14 and 72 Jupiter masses are objects that astronomers call brown dwarfs, and they are neither stars nor planets. Scientists believe they form like stars, but never gain enough mass to begin the hydrogen-to-helium fusion process. Instead, they convert hydrogen into a heavier isotope called deuterium, a process that produces far less energy. Brown dwarfs have been found at a range of temperatures—up to about 1,900 degrees Fahrenheit and dipping down to several degrees below zero—and give off very little light, so most telescopes hunt for them in infrared rather than visible light.

The first official published literature seeking to explain the divide between stars and planets came in a 1962 paper by Shiv Kumar, who wanted to explore what happens with very low mass stars—those below 0.1 solar masses. He determined the 0.07 solar mass limit and termed everything else a "black dwarf." Other early literature clumps in everything below the helium-fusion limit as a "substellar object." ...Read More...

ISS Caught by Sharjah Observatory

Image Credit: Mohamed Talafha (SCASS)

SCASS Observatory specialist Mr. Mohamed Fadil Talafha was able to get a rare glimpse view at the International Space Station as it crossed the Sun early morning on Tuesday, May 15, 2018. Using the 18 cm SCASS telescope in white light, Talafha caught ISS crossing the Sun aroun 06:38 am. Seeing was a little bit bad and the Sun was only about 13 dgrees above the eastern horizon. What made this picture exceptional is that the duration of the transit was only 1.83 seconds.

This Week's Sky at a Glance
May 19 - 25, 2018

May 20	Su	15:57	Moon-Beehive: 1.7° N
		17:13	Moon Ascending Node
May 22	Tu	04:53	Moon-Regulus: 1.5° S
		07:49	First Quarter