Aug. 18, 2018 Dhu'l Hijjah 07, 1439 AH Volume 8, Issue 33

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

Astronomers identify some of the oldest galaxies in the universe

'The distribution of satellite galaxies orbiting a computer-simulated galaxy, as predicted by the Lambda-cold-dark-matter cosmological model. The blue circles surround the brighter satellites, the white circles the ultrafaint satellites (so faint that they are not readily visible in the image). The ultrafaint satellites are amongst the most ancient galaxies in the Universe; they began to form when the Universe was only about 100 million years old (compared to its current age of 13.8 billion years). The image has been generated from simulations from the Auriga project carried out by researchers at the Institute for Computational Cosmology, Durham University, UK, the Heidelberg Institute for Theoretical Studies, Germany, and the Max Planck Institute for Astrophysics, Germany.' Credit: Institute for Computational Cosmology, Durham University, UK/ Heidelberg Institute for Theoretical Studies, Germany / Max Planck Institute for Astrophysics, Germany.

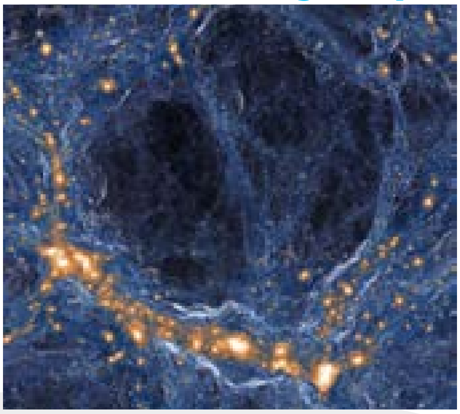
Astronomers have identified some of the earliest galaxies in the Universe. The team from the Institute for Computational Cosmology at Durham University and the Harvard-Smithsonian Center for Astrophysics, has found evidence that the faintest satellite galaxies orbiting our own Milky Way galaxy are amongst the very first galaxies that formed in our Universe.

Scientists working on this research have described the finding as "hugely exciting" explaining that that finding some of the Universe's earliest galaxies orbiting the Milky Way is "equivalent to finding the remains of the first humans that inhabited the Earth." The research group's findings suggest that galaxies including Segue-1, Bootes I, Tucana II and Ursa Major I are in fact some of the first galaxies ever formed, thought to be over 13 billion years old.

When the Universe was about 380,000 years old, the very first atoms formed. These were hydrogen atoms, the simplest element in the periodic table. These atoms collected into clouds and began to cool gradually and settle into the small clumps or "halos" of dark matter that emerged from the Big Bang.

This cooling phase, known as the "Cosmic dark ages", lasted about 100 million years. Eventually, the gas that had cooled inside the halos became unstable and began to form stars—these objects are the very first galaxies ever to have formed. With the formation of the first galaxies, the Universe burst into light, bringing the cosmic dark ages to an end. ..Read More...

In a massive region of space, astronomers find far fewer galaxies than they expected



Computer simulation of the distribution of matter in the universe. Orange regions host galaxies; blue structures are gas and dark matter. A University of California study demonstrated that opaque regions of the universe are like the large voids in the galaxy distribution in this image because too little light from the galaxies is able to reach such regions and render them transparent. Credit: TNG Collaboration

University of California astronomers, including three from UCLA, have resolved a mystery about the early universe and its first galaxies.

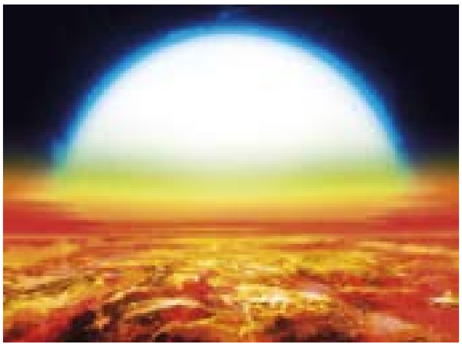
Astronomers have known that more than 12 billion years ago, about 1 billion years after the Big Bang, the gas in deep space was, on average, much more opaque than it is now in some regions, although the opacity varied widely from place to place. But they weren't sure about what caused those variations.

To learn why the differences occurred, the astronomers used one of the world's largest telescopes, the Subaru telescope on Mauna Kea in Hawaii, to search for galaxies of young stars in an exceptionally large region of space—500 million light-years across—where they knew the intergalactic gas was extremely opaque.

If the region had an unusually small number of galaxies, the scientists would be able to conclude that starlight could not penetrate as far as expected through the intergalactic gas; if it had an unusually large number of galaxies, the implication would be that the region had cooled significantly over the previous several hundred million years. (Having few galaxies in a region would mean not only that there was less light created by those galaxies, but also that even more opaque gas was being formed, so the light could not travel as far as astronomers had expected.)

"It was a rare case in astronomy where two competing models, both of which were compelling in their own way, offered precisely opposite predictions, and we were lucky that those predictions were testable," said Steven Furlanetto, a UCLA professor of astronomy and a co-author of the research. The researchers found that region contains far fewer galaxies than expected ..Read More...

Hottest exoplanet ever discovered has metallic skies, rain like lava



Kelt-9b is more than 600 light-years away and is the hottest planet ever observed.Denis Bajram / Geneva University

Kelt-9b is so hot because it's 30 times closer to its star than we are to the sun.

One day in the distant future, a team of intrepid humans might board a starship and set out for a world beyond our solar system — maybe one of the exoplanets of Alpha Centauri, the nearby star system.

One place we'll never set foot on is Kelt-9b. In addition to being a gas giant without a solid surface, Kelt-9b lies hundreds of light-years away and is the hottest planet ever observed. Temperatures on its outer layer can exceed 4,000 degrees Celsius (7,000 degrees Fahrenheit) — hotter than some stars — and a new study shows that its superheated atmosphere contains vaporized heavy metals.

"Metals have been thought to be an important ingredient in forming exoplanets, but they were never directly detected," study co-author Kevin Heng, a professor of astrophysics at the University of Bern in Switzerland, told NBC News MACH in an email. "Our result is the first robust, direct detection."

For the research, published Aug. 15 in the journal Nature, an international team of scientists used computer simulations to predict the presence of vaporized iron and titanium in Kelt-9b's atmosphere. Then they compared their prediction to observational data already collected by the Galileo National Telescope in the Canary Islands — and saw that the prediction matched the data.

The match was "spot on," Heng said. The same research methods might be used "to detect molecules that hint at biology (biosignatures) in future, yet-to-be-detected exoplanets," he added. "In this way, these hot exoplanets are simply training grounds for us to battle-test our techniques for future detections of biosignatures" — that is, for finding evidence of extraterrestrial life.

Kelt-9b is more than 600 light-years from Earth in the constellation Cygnus. Discovered last year by American astronomers, it's about twice the size of Jupiter and about three times as massive. The planet's orbit ..Read More...

Finding the Happy Medium of Black Holes

Credit: X-ray: NASA/CXC/ICE/M.Mezcua et al.; Infrared: NASA/JPL-Caltech; Illustration: NASA/CXC/A.Hobart
Press Image, Caption, and Videos

Scientists have taken major steps in their hunt to find black holes that are neither very small nor extremely large. Finding these elusive intermediate-mass black holes could help astronomers better understand what the "seeds" for the largest black holes in the early Universe were.

The new research comes from two separate studies, each using data from NASA's Chandra X-ray Observatory and other telescopes.

Black holes that contain between about one hundred and several hundred thousand times the mass of the Sun are called "intermediate mass" black holes, or IMBHs. This is because their mass places them in between the well-documented and frequently-studied "stellar mass" black holes on one end of the mass scale and the "supermassive black holes" found in the central regions of massive galaxies on the other.

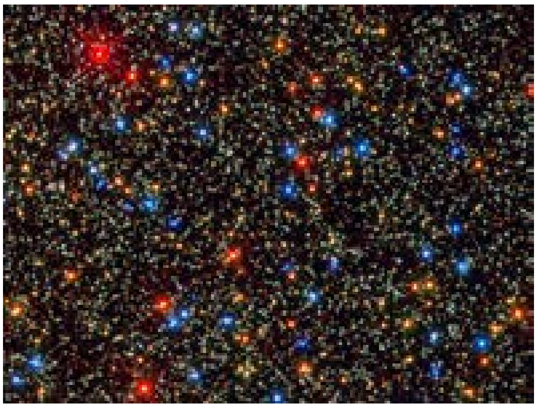
While several tantalizing possible IMBHs have been reported in recent years, astronomers are still trying to determine how common they are and what their properties teach us about the formation of the first supermassive black holes.

One team of researchers used a large campaign called the Chandra COSMOS-Legacy survey to study dwarf galaxies, which contain less than one percent the amount of mass in stars as our Milky Way does. (COSMOS is an abbreviation of Cosmic Evolution Survey.) The characterization of these galaxies was enabled by the rich dataset available for the COSMOS field at different wavelengths, including data from NASA and ESA telescopes.

The Chandra data were crucial for this search because a bright, point-like source of X-ray emission near the center of a galaxy is a telltale sign of the presence of a black hole. The X-rays are produced by gas heated to millions of degrees by the enormous gravitational and magnetic forces near the black hole.

"We may have found that dwarf galaxies are a haven for these missing middleweight black holes," said Mar Mezcua of the Institute of Space Sciences in Spain ..Read More...

Sorry, neighboring Omega Centauri is probably uninhabitable



A close-up of Omega Centauri's core shows some of the 10 million stars that lie within its borders. NASA, ESA, and the Hubble SM4 ERO Team.

The massive globular cluster is likely too disruptive a place for habitable planets to remain. Well, it looks like we're going to have to look farther than we thought for intergalactic extraterrestrial life.

Astronomers have long held out hope that Omega Centauri, a massive globular cluster just 16,000 light years away, harbors habitable exoplanets. Researchers estimate that 10 million densely packed stars lie within the cluster's borders, so statistically speaking, it must house some habitable planets, right? Wrong. In fact, Omega Centauri's stellar density is the reason why some scientists now suspect life doesn't exist on any of its planets.

A study submitted to The Astrophysical Journal July 31 highlights prominent exoplanet hunter, Stephen Kane, and his search for habitability in this compact sea of stars. But even though it's the largest globular cluster in the Milky Way and relatively nearby, surprisingly little is known about its planetary population.

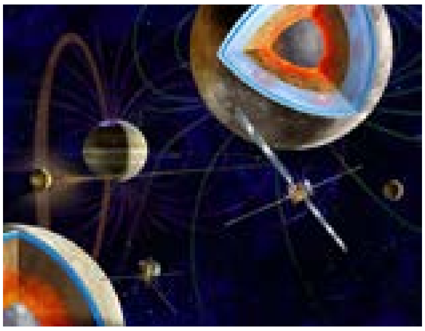
"Despite the large number of stars concentrated in Omega Centauri's core, the prevalence of exoplanets remains somewhat unknown," said Kane, who teaches planetary astrophysics at the University of California, Riverside, in a press release. "However, since this type of compact star cluster exists across the universe, it is an intriguing place to look for habitability."

Kane, along with San Francisco State graduate student Sarah Deveny, used data from the Hubble Space Telescope to study 350,000 red dwarfs in the center of Omega Centauri. These stars are around the right age and temperature for exoplanets to exist within their habitable zones – the region where liquid water can be sustained on a planet's surface.

Too Close For Comfort

The duo calculated the habitable zone for each of these stars and found that, like the cluster itself, it's a pretty tight squeeze. ...Read More...

Why is Europa whistling?



Jupiter's moons put out "whistler" radio waves. Future spacecraft could help unravel their cause. ESA/NASA, Artist M. Carrol

Finding the cause of this moon's strange phenomenon may solve a magnetic mystery.

Jupiter's moons "hum" – and researchers are trying to figure out why.

New research published Tuesday in Nature Communications details the discovery of "whistler" radio waves coming from two of the moons: Ganymede and Europa. The other two large moons, Io and Callisto, aren't subject to this phenomenon.

The finding is interesting because both Europa and Ganymede – the largest moon in the solar system – have subsurface oceans.

"Jupiter's magnetic field is huge, so it provides us a laboratory test," says study lead author Yuri Shprits of GFZ German Research Centre for Geosciences. "It's kind of a mini solar system, where you have objects similar to planets that live in the magnetic field of Jupiter similar to planets that live in the magnetosphere of the sun."

In the rest of the solar system, these kinds of whistler waves have various causes. On Earth, the "hum" of the whistlers – which translate to sound you can hear when properly processed – are caused by the Van Allen radiation belts. Earth's radiation belts accelerate the particles to high energies, something not seen in the data used in the paper.

Instead, on Jupiter, they're produced by massive lightning storms.

The astronomers used data from NASA's now-defunct Galileo space probe, which explored Jupiter and its moons from 1995 to 2003. That means the data is old and at times incomplete. It also makes it impossible to follow up on what's causing the whistler waves. But the existing data suggest that both Europa and Ganymede have some kind of magnetic field coming from within them.

These magnetic fields would vie against the massive magnetic field of Jupiter, providing an interesting environment far different than the interactions between Earth and the Sun's magnetic fields. ..Read More...

The behavior of water—scientists find new properties of H_2O

Credit: CCO Public Domain

A team of scientists has uncovered new molecular properties of water—a discovery of a phenomenon that had previously gone unnoticed.

A team of scientists has uncovered new molecular properties of water—a discovery of a phenomenon that had previously gone unnoticed.

Liquid water is known to be an excellent transporter of its own autoionization products; that is, the charged species obtained when a water molecule (H_2O) is split into protons (H+) and hydroxide ions (OH−). This remarkable property of water makes it a critical component in emerging electrochemical energy production and storage technologies such as fuel cells; indeed, life itself would not be possible if water did not possess this characteristic.

Water is known to consist an intricate network of weak, directional interactions known as hydrogen bonds. For nearly a century, it was thought that the mechanisms by which water transports the H+ and OH− ions were mirror images of each other - identical in all ways except for directions of the hydrogen bonds involved in the process.

Current state-of-the-art theoretical models and computer simulations, however, predicted a fundamental asymmetry in these mechanisms. If correct, this asymmetry is something that could be exploited in different applications by tailoring a system to favor one ion over the other.

Experimental proof of the theoretical prediction has remained elusive because of the difficulty in directly observing the two ionic species. Different experiments have only provided glimpses of the predicted asymmetry.

A team of scientists at New York University, led by Professor Alexej Jerschow and including Emilia Silletta, an NYU postdoctoral fellow, and Mark Tuckerman, a professor of chemistry and mathematics at NYU, devised a novel experiment for nailing down this asymmetry. The experimental approach involved cooling water down to its so-called temperature of maximum density, where ..Read More...

Researcher accurately determines energy difference between two quantum states

Credit: CCO Public Domain

A kiwi physicist has discovered the energy difference between two quantum states in the helium atom with unprecedented accuracy, a ground-breaking discovery that contributes to our understanding of the universe and space-time and rivals the work of the world's most expensive physics project, the Large Hadron Collider.

Our understanding of the universe and the forces that govern it relies on the Standard Model of particle physics. This model helps us understand space-time and the fundamental forces that hold everything in the universe in place. It is the most accurate scientific theory known to humankind.

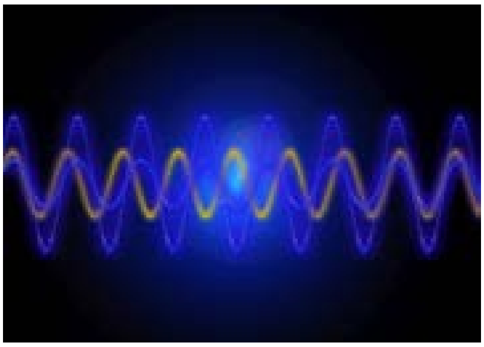
But the Standard Model does not fully explain everything, for example it doesn't explain gravity, dark matter, dark energy, or the fact that there is way more matter than antimatter in the universe.

So scientists are continually testing the model by manipulating and controlling matter at the atomic level, looking for effects that cannot be explained directly. The research team's experiment involved the helium atom, the second-simplest atom after hydrogen.

The latest experiment, carried out by Dr. Maarten Hoogerland from the University of Auckland and the Dodd-Walls Centre for Photonic and Quantum Technologies and Dr. Wim Vassen from Vrije University in the Netherlands, was to test the helium atom's transition between two states of energy. This is sometimes referred to as a quantum jump, or leap.

This significant change in energy in the helium atom was precisely measured to estimate the diameter of the nucleus. This is done in an experiment that could fit on a table top with ultra-cold gas using an ultra-stable laser, accurate to a million times a million or, if you were using this level of measurement to measure the distance from Earth to the moon, it would be accurate to within a fraction of a millimetre. ...Read More...

Researchers suggest phonons may have mass and perhaps negative gravity



Credit: CC0 Public Domain

A trio of physicists with Columbia University is making waves with a new theory about phonons—they suggest they might have negative mass, and because of that, have negative gravity. Angelo Esposito, Rafael Krichevsky and Alberto Nicolis have written a paper to support their theory, including the math, and have uploaded it to the xrXiv preprint server.

Most theories depict sound waves as more of a collective event than as physical things. They are seen as the movement of molecules bumping against each other like balls on a pool table—the energy of one ball knocking the next, and so on—any motion in one direction is offset by motion in the opposite direction. In such a model, sound has no mass, and thus cannot be impacted by gravity. But there may be more to the story. In their paper, the researchers suggest that the current theory does not fully explain everything that has been observed.

In recent years, physicists have come up with a word to describe the behavior of sound waves at a very small scale—the phonon. It describes the way sound vibrations cause complicated interactions with molecules, which allows the sound to propagate. The term has been useful because it allows for applying principles to sound that have previously been applied to actual particles. But no one has suggested that they actually are particles, which means they should not have mass. In this new effort, the researchers suggest the phonon could have negative mass, and because of that, could also have negative gravity.

To understand how this is possible, the researchers use a fluid-filled container as an example. In a cup of water, the water particles are denser in the bottom of the cup than are those at the top—this is because gravity is pulling them down. But it is also commonly known that sound moves faster when moving through denser material. So what happens to the phonon as it encounters this difference? The researchers suggest it would deflect upward, exhibiting qualities of negative gravity. They suggest further that the same thing could be happening with sound in the air around us, causing it to rise slightly. They acknowledge that such a rise would be too small for current equipment to measure, but note that improvements ...Read More...

Gravitational wave detectors to search for dark matter

Sky with stars. Credit: Felix Mittermeier, Pexels.com

Gravitational wave detectors might be able to detect much more than gravitational waves. According to a new study, they could also potentially detect dark matter, if dark matter is composed of a particular kind of particle called a "dark photon." In the future, LIGO (Laser Interferometer Gravitational Wave Observatory) scientists plan to implement a search for dark photons, which will include certain previously unexplored regions of the dark photon parameter space.

A team of physicists, Aaron Pierce, Keith Riles, and Yue Zhao from the University of Michigan, have reported their proposal for using gravitational wave detectors to search for dark matter in a recent paper published in Physical Review Letters.

"This proposal nicely bridges the newly born field of gravitational wave astronomy with that of particle physics," Zhao told Phys.org. "Without any modifications, a gravitational wave detector can be used as a very sensitive direct dark matter detector, with the potential for a five-sigma discovery of dark matter."

As the physicists explain in their paper, if dark photons have a very light mass, then they can be considered to behave like an oscillating background field, with the oscillation frequency determined by their mass. Gravitational wave detectors could potentially detect these oscillations because the oscillations may affect test objects placed in the gravitational wave detectors. For example, if two test objects located at different positions in the detector experience different displacements, this difference may be due to the relative phase of the dark photon field's oscillations at these different positions.

The physicists expect that both present Earth-based gravitational wave detectors such as LIGO, as well as future space-based gravitational wave detectors such as LISA (Laser Interferometer Space Antenna), will have the ability to search for dark photon dark matter. Using more than one detector would allow for cross-checking and better sensitivity.

In the future, the scientists plan to work on further developing the new dark matter search method ...Read More...

A faint glow found between galaxies could be a beacon for dark matter

LIGHTING THE DARK A feeble glare known as intracluster light traces the location of dark matter within galaxy clusters such as Abell S1063 (shown).

Dim light emanating from the purgatory between galaxies could illuminate the most shadowy constituents of the cosmos.

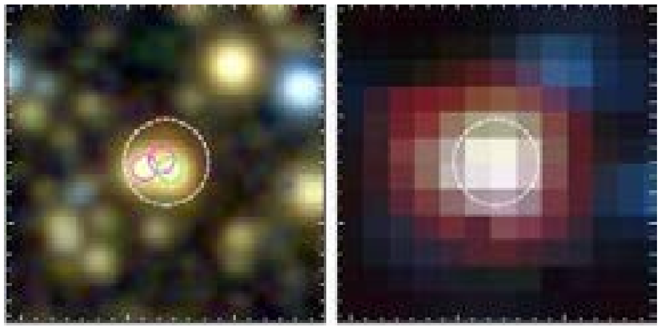
Dark matter, an unidentified type of particle that interacts gravitationally but otherwise shuns normal matter, lurks throughout clusters of galaxies. Because the elusive substance emits no light, it's difficult to pin down how it is distributed, even though it makes up the majority of a cluster's mass. But a feeble glow known as intracluster light could reveal dark matter's whereabouts, researchers suggest July 30 at arXiv.org. The intermediary could eventually help scientists get a better handle on what dark matter is and how it behaves.

Galaxy clusters grow by swallowing up additional galaxies. As galaxies are assimilated, they can be torn apart and their stars scattered. It's those stars that produce intracluster light. And where there's intracluster light, there's dark matter, the team found. "The shape of this very diffuse light traces very nicely the shape of the total mass of the cluster," says study coauthor Mireia Montes, an astrophysicist at the University of New South Wales in Sydney. Once stripped from their galaxies, the stars are tugged by the dark matter's gravity and thereby end up concentrated in the same regions as it resides.

Typically, scientists use an effect called gravitational lensing to map dark matter. A galaxy cluster's mass acts like a lens, bending light from more distant objects. By measuring that bending, scientists can see how the dark matter's mass is distributed within the cluster. However, "that is an incredibly hard measurement to make," says astrophysicist Stacy Kim of Ohio State University, who was not involved with the research. Measuring intracluster light is easier, Kim says, but teasing out the faint light is still challenging, requiring extended observations with a powerful telescope.

Scientists sometimes use another proxy for dark matter: X-rays emitted by hot gas within a cluster. ...Read More...

Unraveling the stellar content of young clusters



A region of clustered star formation. The left frame shows a high spatial resolution infrared image of the cluster; three young stars are seen in the colored circles, with the white circle showing a fiducial size. The right frame is the same cluster seen at longer wavelengths with a different instrument. The three stars are blended together. A new technique determines the most likely contribution each of the stars makes to this and other long-wavelength images, and uses that to infer the stars' properties. Credit: Martinez-Galarza et al 2018

About twenty-five percent of young stars in our galaxy form in clustered environments, and stars in a cluster are often close enough to each other to affect the way they accrete gas and grow. Astronomers trying to understand the details of star formation, for example the relative abundance of massive stars to low mass ones, must take such complicated clustering effects into account. Measuring the actual demographics of a cluster is not easy either.

Young stars are embedded within obscuring clouds of natal material. Infrared radiation can escape, however, and astronomers probe these regions at infrared wavelengths using the shape of the spectral energy distribution (the SED—the relative amounts of flux emitted at different wavelengths) to diagnose the nature of the young star: its mass, age, accretion activity, developing disk, and similar properties. One major complication is that the various telescopes and instruments used to measure an SED have large and different-sized beams that encompass multiple objects in a cluster. As a result, each point in an SED is a confused blend of emission from all the constituent stars, with the longest wavelength datapoints (from the largest beams) covering a spatial region perhaps ten times larger than the shortest wavelength points.

CfA astronomers Rafael Martinez-Galarz and Howard Smith and their two colleagues have developed a new statistical analysis technique to address the problem of confused SEDs in clustered environments. Using the highest spatial resolution images for each region, the team identifies the distinguishable stars (at least this many are in the cluster) and their emission at those wavelengths. They combine a Bayesian statistical approach with a large grid of modeled young stellar SEDs to determine the most probable continuation of each individual SED into the blended, longer-...Read More...

Special Read:

The microlaunch space race has begun

The ELaNa IV launch, containing 11 Cubesat missions, on November 19 , 2013. NASA

In the vastness of space, unfathomable size is generally the norm. But when Jordi Puig-Suari, an aerospace engineering professor, began looking at the stars, he started thinking small. Together with Bob Twiggs, a professor at Stanford University, they developed the CubeSat, a tissue box-sized satellite that has intensified interest in space and revolutionized satellite communication.

When Puig-Suari worked at California Polytechnic State University in 1999, he was unimpressed with the typical size of satellites – "kind of overkill," as he puts it. Satellites of the day could often be larger than a grand piano, and weighed thousands of pounds. So, he helped blueprint a spacecraft measuring 10 centimeters on each side and weighing less than 1.33 kilograms (2.93 pounds.) That's about the size and mass of a human brain. At first, the only goal with this device was to train students how to build satellites, which are historically expensive to assemble, let alone launch.

Unexpectedly, the CubeSat was a runaway success, leading to what some are now calling the "microlaunch space race." Today, nearly two thousand miniature spacecraft have been hurled into Earth's orbit, with hundreds more on the way. Dozens of tech startups have gotten into the tiny satellite game, while established zero gravity companies like Rocket Lab, Boeing, SpaceX, and numerous universities and military branches regularly make use of these so-called nanosats.

NASA recently chose two Cubesats as part of its InSight Mars lander mission, where they'll function as a communications relay. The CubeSat design is now standard across dozens of company prototypes, and even elementary schools have built CubeSats. They're useful not only for observing the atmosphere and monitoring Earth, but also help us study everything from the effects of radiation on electronics to plasma bubbles near Earth's geomagnetic equator.

The whole thing has left Puig-Suari somewhat shocked. "We have to pinch ourselves sometimes," he says. "We're very proud. All the new players that have been able to get into space and fly satellites are creating new companies in places that never considered themselves in a position to play in the space market."

It's coming at the same time as a surge in investment in the space industry writ large. According to the most recent report from Space Investment Quarterly, nearly $1 billion was invested in space startups – including 290 satellite companies – in the first quarter of 2018 alone. That's part of $14.8 billion invested in space corporations since 2009. There's a lot of money to be made in this rapidly expanding industry – if you can get off the ground.

Getting to Space, Cheaply
Since Sputnik 1 launched in 1957, 8650 satellites of all sizes have been put into space. By now, most have fried up in the atmosphere, but some do survive and crash back to Earth. In the past, some have been small as well – Sputnik was about 58 centimeters in diameter. But it's taken some time for CubeSats to become trendy. Despite being first designed in 1999, the first CubeSat launch didn't happen until 2003, when a Russian rocket first ejected around a half dozen units. ..Read More...

This Week's Sky at a Glance - Aug. 18-24, 2018

Aug 18	Sa	11:49	First Quarter
Aug 21	Tu	06:09	Mercury-Beehive: 5.9° S
		13:55	Moon-Saturn: 2.4° S
Aug 22	We	06:58	Moon South Dec.: 20.8° S
Aug 23	Th	15:23	Moon Apogee: 405700 km
Aug 24	Fr	08:51	Moon Descending Node

A Trio: Jupiter - Moon - Venus on Aug. 15, 2018, just after sunset (Khemis-Miliana, Algeria).