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A STEM NEWSLETTER

LabLinks

ISSUE 2 - Astrophysics and Space Exploration

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THIS MONTHS TOPIC (A BREIF OVERVIEW)

Astrophysics, the study of the physical properties of celestial objects and the processes that govern the universe, has made remarkable strides in recent decades. Space exploration, is the physical exploration of space beyond Earth's atmosphere. This endeavor has explored and understood the unknown but has also led to numerous technological advancements that have revolutionized our lives on Earth.

A MESSAGE FROM THE FOUNDERS AND EDITOR IN CHEIF

Dear Readers,

Once again we are proud to share with you our second edition of our STEM newsletter, this time reaching to the stars to talk about astrophysics and the universe beyond. As we delve into the new and upcoming technologies regarding the world beyond, we hope you enjoy this edition of our newsletter and would love to hear from you on your thoughts!

Regards, Nitya Kashyap, Tara Pratapa and Anwitha Srivasta

CSIRO's Next-Gen Printed Flexible Solar Cells: Pioneering Innovation in Astrophysics

By Aagam Jain

Sunlight is abundant in space, yet ordinary solar panel technology poses a challenge and limits space missions. This led to the development of modern, upcoming solar cells. These solar cells hold high promises to develop our cosmos and further our understanding of the universe. CSIRO, Australia's national science agency, is among the pioneers in developing printed flexible solar cells.

Bulky solar panels conventionally conduct space exploration missions to harness solar energy to power their space vehicles and instruments. However, these traditionally used solar panels could pose limitations in terms of their size, weight, and flexibility, altogether acting against the efficiency of the mission. This is where CSIRO's breakthrough approach comes into play. Their method utilises advanced printing techniques and materials to create a lightweight and flexible solar cell that can be flawlessly implemented into the space mission with inconceivable versatility. The approach taken by CSIRO lies in the usage of new and upcoming materials, such as perovskite and organic photovoltaics, which offer higher efficiency and flexibility when compared to a traditional silicon-based solar cell. CSIRO's research has provided critical insights into harnessing the power of printing technology. This form of solar cells reduces the weight and size of solar panels and opens up exciting opportunities for further space exploration.

Perovskite is a crystalline mineral structure with unique properties that can be used while making printable solar cells. Perovskite's high absorption coefficient coefficient and commendable charge transport properties make perovskite ideal for converting solar energy into electrical energy. Moreover, perovskite can be synthesized in a lab setting. Additionally, perovskite uses low-cost printing techniques to create printed flexible solar cells, which makes this option cost-effective. One of the most significant benefits of using CSIRO's printed flexible solar cells is their ability to withstand conditions even in the harshest temperatures in space and seemingly provide reliable and sustainable power. On the other hand, hand traditional solar panels are prone to damage from micrometeoroids and radiation.

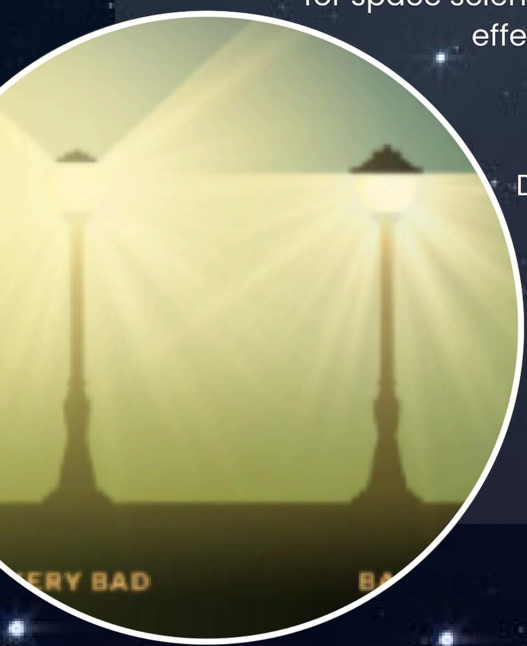
As we approach the future of space exploration and astrophysics, CRIRO's generation of printed flexible solar cells plays a vital role in shaping our upcoming future with space exploration. With their extraordinary design, advanced material, and unique process, these solar cells are set to revolutionize how we explore and understand the universe, paving the path for discoveries and breakthroughs in astrophysics.

Light Pollution: Astronomical Impact
By Maya Yadlapalli

Astronomy, a branch of science that helps us to study all extraterrestrial objects and phenomena, is a subject that combines multiple topics about outer space and objects from space. Astronomy allows us to look at the sky differently; all we think of when we see the sky are stars, but we can see much more when delving into astronomy. We can see nebulae, galaxies, celestial objects, and much more with a simple object like the telescope. Studying astronomy satisfies curiosity and develops critical thinking, analytical, and research skills that can lead to careers in data analysis, scientific writing, research, astronomy education, and more.

Pollution is a rising problem on our planet today, affecting humans and the environment as well as studies such as Astronomy, which help build our future. One such type of pollution is Light Pollution, which is the excessive or poor use of artificial outdoor lighting. This type of pollution is unique as it indirectly affects humans and animals by wreaking havoc on their natural body rhythms. Light pollution can also significantly impact astronomical studies by hindering observations.

The increasing artificial light at night, radio interference, and the proliferation of satellite constellations pose challenges to studying the night sky. Many astronomers have also voiced their concerns regarding light pollution, which impacts observations. One such study talks about how light pollution can also affect observations on satellite mega-constellations such as Space X's Starlink, impacting valuable observations on deep-space objects, which are considered very beneficial for space science but negatively impacted by light pollution. The detrimental effects of Light Pollution are evident as nearly 80% of us live under Light-Polluted Skies, and contamination rates also increase rapidly by almost 10% annually



Does Light Pollution have a significant impact on Astronomy? Yes, it does. Light Pollution poses a severe threat to astronomical observations, and so far, there are no definitive cures; there are certain things that we can implement to lessen our impact on light pollution, such as light fixtures, regular checks for lights, ensuring outdoor lights are shielded, etc. We must change how we use our resources to improve our society.

Q&A Session with C.H Bhavani Prasad
By Gayatri Papagari

Mr C.H Bhavani Prasad studied mechanical engineering at Sri Venkateswara University in 1964 and graduated with a master's degree in machine design from IIT Madras. He went on to study at Virginia Polytechnic University for a master's in engineering mechanics and then got his PhD at Old Dominion University, Norfolk.

He worked as a contractor at NASA for 3 years and focused on the testing and analysis of composite metals that are used in rockets and planes since they are stronger but 1/3 of the weight. These metals can be made with materials like carbon fibers. They are used because they reduce the friction between the materials and the atmosphere, which means less fuel is needed to fly the same distance. We engineered him on his experience with NASA and what it was like working in that field.

Q: What was it like working with NASA, and what were the specificities of your job as a contractor?
A: Let me put it this way, it is not a run-of-the-mill job. Like just reading data and entering it kind of thing. I was a contractor, I worked under a civil servant in my 3 years (of working for NASA). Mostly they all have projects that they will be working (on). I worked initially and mostly on testing the articles.

Q: Can you give examples of challenges that you faced?
A: In my PhD, it was analysis. But my first job was as a testing engineer. It was a big challenge for me. I didn't know anything about the testing machines: how they operate, and how the specimens are made, and how you make the drawings. I didn't know anything about how the testing was done, or how the specimens were fabricated. I learned on the job mostly and I had the fortune of working with excellent technicians.

Q: What was one of the driving factors that made you join this field?
A: There (in Virginia Tech), I had to choose a branch. Engineering mechanics is what they call the branch. My advisor with whom I have worked for 2 years, was a composite materials specialist. So he gradually asked me to help him in his research on composite materials. While helping with his research, I also had to do my research. He suggested that I also select composite material.

Q: What advice would you give to others who want to join this field?
A: My advice is, if you have the attitude if you like doing research and finding out things, taking your knowledge frontiers forward and expanding it, you should do it.

Going back in time - Solar Storms
By Saketh Kollipara

More than 9000 years ago, for a few dreary days, during a neolithic era, while our ancestors were hunting for food, the northern skies would have been bright with flickering lights.

New research published by Sweden's Lund University recently states that "telltale chemical isotopes in ancient ice cores suggest one of the most massive solar storms ever took place around 7176 B.C". A solar storm is essentially, multiple solar flares happening at the same, solar flares are intense and localized emissions of electromagnetic radiation in the sun's atmosphere. In some cases, these solar flares can reach Earth, harming its satellites, and have the ability to damage biological DNA and electrical circuits on Earth.

Research shows that the massive celestial event created various radioactive isotopes of beryllium and chlorine. Those isotopes then fell to Earth's crust and were preserved in layers of ancient ice due to the annual snowfall in the area. Levels of radiation of beryllium and chlorine were identified to determine how strong the solar storm had been, if the same storm happened today, it could eliminate power grids all over the world removing electricity and data for billions of people around the world.

According to astrophysicists and geologists working on drilling projects in Greenland and Antarctica, cases like this have happened before. According to them, " three SEP events that are known to have occurred in A.D. 993 or 994, in A.D. 774 or 775, and in 660 B.C. and are all associated with solar storms". Analyzing these trends in solar storms can lead to scientists being able to predict the future behavior of space weather, it can help us prevent significant damage to technological infrastructure, including satellites, communication systems, and power grids.

With more information on ancient solar storms coming to light, we can advance scientific research and knowledge about space exploration. This information could help gain a deeper understanding of solar activity and how it has been affecting our solar system for billions of years.

Revolutionising Space Exploration: The Dawn of CubeSat Technology

By Saanvi Maguluri

In the ever-evolving landscape of space exploration, innovation is the driving force propelling mankind toward new frontiers. Among the myriad advancements, CubeSat technology stands out as a game-changer, revolutionising how we explore and understand the cosmos.

CubeSats, miniature satellites typically with dimensions of 10x10x10 centimetres, have surged in popularity since their inception in the early 2000s. Their compact size, low cost, and versatility have democratised access to space, enabling universities, research institutions, and even private companies to participate in space missions.

The significance of CubeSats in space exploration cannot be overstated. In 2019, NASA's MarCO CubeSats made history by providing real-time communication during the InSight Mars mission, showcasing their potential for interplanetary exploration. Similarly, the European Space Agency's OPS-SAT, launched in 2019, serves as a platform for testing new software and hardware in space in real-time.

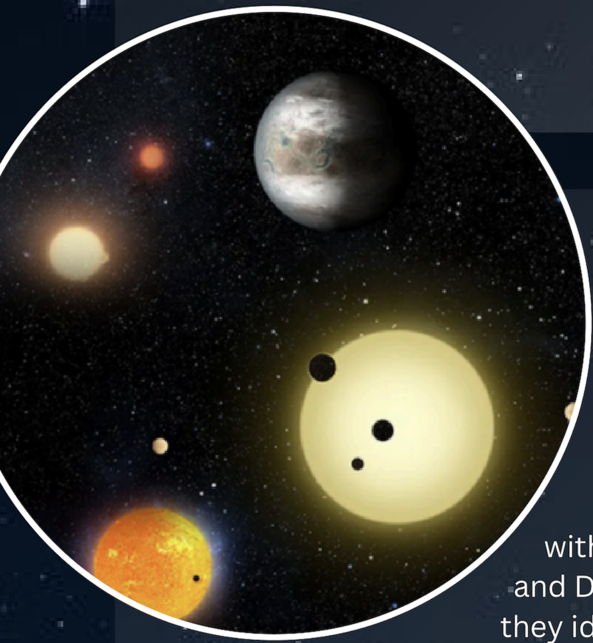
Looking ahead, CubeSats are poised to play an even more prominent role in space exploration. By 2025, the number of CubeSats launched annually is projected to surpass 1,000, according to the Small Satellite Market Analysis by Euroconsult. These tiny satellites are instrumental in monitoring climate change, studying Earth's atmosphere, and probing distant celestial bodies.

The implications of CubeSat technology extend far beyond the realm of space exploration. Their affordability and accessibility empower researchers worldwide to conduct experiments and gather data in ways previously unimaginable. From monitoring deforestation and urban development to tracking wildlife migration patterns, CubeSats offer invaluable insights into our planet's dynamics.

As we stand on the cusp of a new era in space exploration, CubeSats epitomise the spirit of innovation driving mankind toward a deeper understanding of the cosmos. With their continued advancement and proliferation, these miniature satellites hold the key to unlocking the mysteries of the universe while simultaneously enriching life here on Earth.

Astronomy, Unveiling the Universe: The Discovery of Exoplanets

By Ishanvi Tupilli



In the field of astrophysics, finding exoplanets has been a major breakthrough that has changed how we view the universe. Exoplanets are planets that orbit stars outside of our own solar system, and the search for these new planets has required creativity and determination.

The journey to discovering exoplanets began in the 1990s with the groundbreaking research of astronomers Michel Mayor and Didier Queloz. Through precise spectroscopic measurements, they identified the first exoplanet orbiting a star similar to our Sun, known as 51 Pegasi b. This discovery was ground-breaking as it confirmed the existence of planets beyond our solar system and sparked a wave of further exoplanet findings in the years that followed. The key discovery behind exoplanets has led to a new understanding of the vastness of the universe and the possibilities it holds.

The success in discovering exoplanets was mainly due to the advancement of sensitive astronomical tools, such as the radial velocity method. This method detects small movements in a star's path caused by the gravitational pull of an orbiting planet. By observing slight changes in a star's spectrum because of the planet's influence, astronomers can indirectly identify exoplanets.

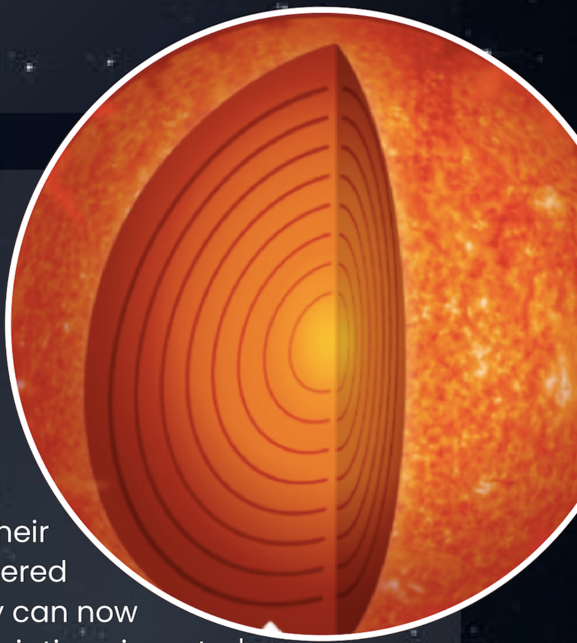
The investigation of exoplanets has grown into a lively area of study, with thousands of exoplanets confirmed so far. These discoveries have broadened our understanding of the universe and sparked questions about how common and varied planetary systems are in the cosmos.

In addition, the quest for exoplanets has sparked the creation of innovative technologies and observation methods, like the Kepler space telescope and the soon-to-be-launched James Webb Space Telescope, which are designed to analyze exoplanetary atmospheres and search for indications of habitable conditions.

The detection of exoplanets symbolizes the insatiable curiosity and ingenuity that propels the field of astrophysics forward. It highlights humanity's desire to uncover the secrets of the cosmos and determine our place in the universe. As we persist in investigating and comprehending these far-off planets, the legacy of this groundbreaking discovery continues to shape the future of astrophysics and space exploration.

Music x Stars - The unlikely pairing

By Tara Pratapa



During the Gaia mission, observatory of the European Space Agency, astronomers used asteroseismology to accurately measure the distance of stars from Earth. Asteroseismology is the study of stellar oscillations, it can be derived from "Astero" - refers to stars, from the Greek word "aster" meaning star. "Seismology" - refers to the study of vibrations or oscillations

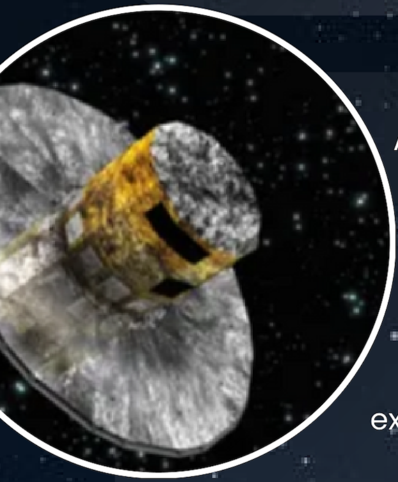
Stars make "music" when they expand and contract, and their brightness varies in conjunction. Because scientists discovered these minor brightness changes in captured starlight, they can now 'hear' the song. Astronomers may analyse these minute variations in a star's brightness and convert them into "sound waves" or a "frequency spectrum" of the star's oscillations. These frequencies are then translated into distance measurements. The frequency spectrum of a star's oscillations, like the sound waves produced by a musical instrument, is determined by the temperature, density, and other physical features of the star's interior. We can infer information about these details from analysing their frequencies. By analysing the "music" or frequency spectrum of the oscillations of thousands of stars, they were able to determine how far away the stars are, some as far as 15,000 light-years. This technique, known as asteroseismic parallax, allows for the measurement of star distances that is independent of the Gaia mission's typical stellar parallax method.

The key differences between the two methods are that stellar parallax, used by the Gaia mission, measures the apparent shift in a star's position over the course of a year as the Earth orbits the Sun, relying on triangulation(forming triangles from known points to find distances) to calculate the distance. This procedure becomes increasingly complex for more distant stars as the parallax angle(difference in position from varied points of sight) gets smaller.

In contrast, the asteroseismic parallax technique determines stars' physical attributes by analysing their "music" or oscillations. This approach can be used to measure more distant stars, up to 15,000 light- years away, which are difficult to measure with classical parallax. The asteroseismic parallax method is regarded as being better and more effective because it allows for independent verification and enhances the accuracy of Gaia's parallax measurements, particularly for more distant stars, and it can probe the entire sky, whereas Gaia's parallax measurements have some limitations. Additionally, the asteroseismic approach will be critical in enhancing Gaia's parallax, shaping future discoveries.

Revolutionizing Astrophysics with The Gaia Spacecraft

By Saanvi Parige



A groundbreaking achievement for astrophysics – the Gaia spacecraft continues to revolutionize unknowns of the cosmos. It aims to shed light on the intricacies of our universe. The European Space Agency (ESA) launched the spacecraft in 2013. It is designed to measure the positions, distances, and motions of stars with precision and the position of exoplanets by measuring the attributes of the stars they orbit, including their apparent magnitude and colour. This article will explore how this mission has flipped our understanding of the Milky Way.

Determining the mass of the Milky Way is tricky due to its complex structure and various methods of measurement – however – the Gaia spacecraft did not fail to surprise us. The spacecraft studies the galaxy's dark matter halo (a vast region dominated by invisible dark matter) to further understand its composition and distribution. By examining objects within this halo, like star clusters and dwarf galaxies, the spacecraft provides precise astrometric data essential for understanding their positions and motions. Gaia's observations (supplemented by the Hubble Space Telescope) revealed new insights into the Milky Way's neighboring neighboring galaxies – the Large Magellanic Cloud, a galaxy much more significant than previously imagined.

Contrary to previous beliefs of the Milky Way's spherical and homogeneous halo, Gaia's observations depict an elongated, tilted, and stretched halo resembling a rugby ball. Gaia has unveiled the cause behind the Milky Way's warped and asymmetrical disc – a series of collisions with the Sagittarius dwarf galaxy. These collisions (occurring over billions of years) triggered disruptive waves throughout the galaxy. The data also hints that these collisions could have formed the Sun and Solar System.

Further, in 2020, the spacecraft identified the largest gaseous structure in the galaxy. Gaia also elucidated the origins of the Local Bubble. The spacecraft, equipped with cutting-edge instruments, detected spinning filaments believed to be remnants of past spiral arms influenced by interactions with satellite galaxies. The spacecraft's observations have also led to the discovery of thousands of new star clusters, emphasizing its role in expanding our knowledge of the galaxy's stellar populations. Although a few questions remain unanswered, the spacecraft stands as the face of scientific exploration and will continue to revolutionize our understanding of the universe.

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