AMRITA VISHWA VIDYAPEETHAM
DEEMED TO BE UNIVERSITY UNDER SECTION 3 OF UGC ACT, 1956
School of Nanosciences and Molecular Medicine

ASTRA

ASTRA FRONTIERS

Alzheimer's: Are We Closer to a Cure Than We Think?

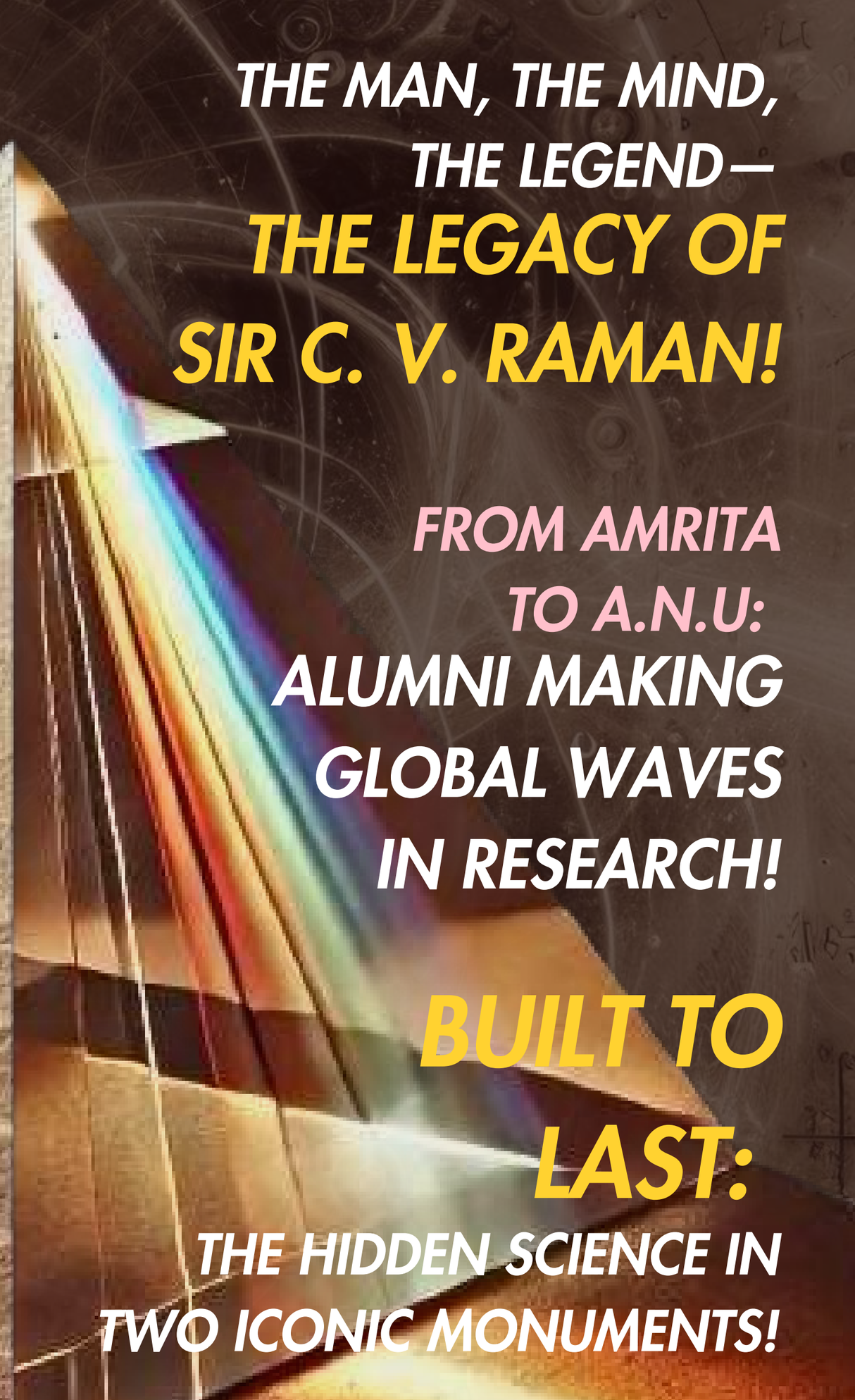
THE SCIENCE OF SUCCESS:
DR. ALEENA CHERIAN ON RESEARCH & RESILIENCE

IS YOUR X-CHROMOSOME PICKING SIDES?
THE SCIENCE BEHIND SKEWED INACTIVATION

THE MAN, THE MIND, THE LEGEND—
THE LEGACY OF SIR C. V. RAMAN!

FROM AMRITA TO A.N.U:
ALUMNI MAKING GLOBAL WAVES IN RESEARCH!

BUILT TO LAST:
THE HIDDEN SCIENCE IN TWO ICONIC MONUMENTS!



EDITION:002

FROM THE EDITOR'S DESK

DEAR READERS,

Astra is a student-driven club that aims to foster a passion for scientific inquiry among students by providing them a platform for exploring beyond their curriculum. We aim to enhance our students' understanding of ongoing scientific incidents and develop awareness of contemporary scientific issues, instilling a sense of responsibility towards environmental and technological challenges. The club will also provide them with a dais for illustrating their ideas and nurturing curiosity and creativity. Astra aspires to prepare students for future careers in STEM fields and cultivates a lifelong interest in science. It invites eminent scientists to share their experiences, inspiring students to explore diverse fields of science and technology. The club also emphasizes the importance of collaboration, problem-solving, and effective communication through group projects and presentations, ultimately nurturing independent thinkers within the scientific community. The Astra Frontiers division of the science club aims to engage students in various scientific disciplines through a range of activities to foster a deeper understanding of scientific concepts and methodologies. Its primary objective is to provide valuable content that resonates with the courses offered by our Department of Molecular Medicine and Nanosciences and build a bridge toward the world of research.

This month, we are excited to feature an insightful interview with Dr. Aleena Cherian, Manager of R&D at Proto9 Materials, who shares her expertise on the industrial applications of research. Additionally, we are honoured to present an interview with Dr. Gaganashree S and Preetham Permude, alumni of ASNSMM, now at the Australian National University. They share valuable advice on navigating scholarships and perseverance. Lastly, explore with us the Science Behind Monuments, uncovering the engineering and architectural marvels that have stood the test of time.

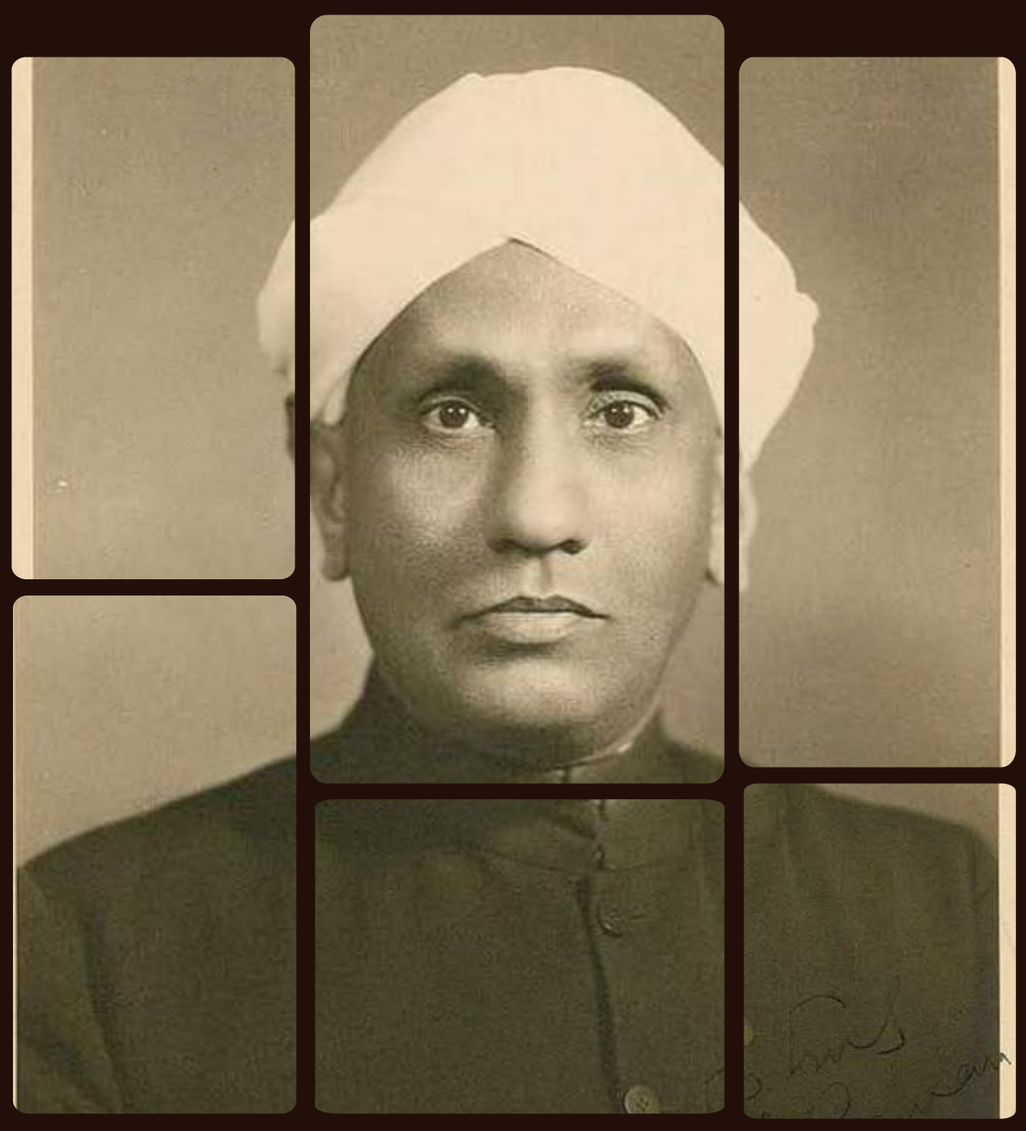
We hope you had as much fun reading this edition as we did creating it! Now, we can't wait to see what amazing ideas you'll bring to life in our next issue! Your energy is contagious, and we're super excited to see even more of your creativity shine through!

Yours in discovery,
Team ASTRA

THE RAMAN EFFECT: ILLUMINATING INDIAN SCIENCE

By Samirdhi Susan Maju

“The essence of Science is independent thinking, hard work, and not equipment”
- C. V Raman.



Sir Chandrasekhara Venkata Raman also known as C. V. Raman

Scientific discoveries have the power to redefine our perception of the natural world and few discoveries have had as profound an impact as the Raman effect. The Raman effect discovered by Professor C.V Raman resulted from a deceptively simple experiment. Conducted far from the renowned scientific hubs of the Western world, this breakthrough captured global attention and earned their discoverer several accolades including the Nobel Prize. As we observe the National Science Day on 28th February 2025 under the theme “ Empowering Indian Youth for Global Leadership in Science and Innovation for Viksit Bharat”, we reflect on how Raman’s groundbreaking work continues to light the path for scientific excellence and progress in the nation.

Born on November 7, 1888, in Tiruchirapalli, Tamil Nadu, Sir Chandrashekar Venkata Raman was immersed in an academic atmosphere from an early age. Raman’s passion for physics blossomed as he excelled in physics in school and later at the University of Madras where he topped the bachelor's degree examination with honors in physics at 16. He published his first paper in 1906 while he was still a graduate student. Despite taking a detour into the Indian Finance Service as an Assistant General accountant at 19, his heart remained with research. He became acquainted with the Indian Association for the Cultivation of Science (IACS), where he began his true scientific journey and made major contributions to the field of acoustics and optics.

Raman’s fascination with light scattering began on the return trip from his first journey to Europe aboard the SS Narkunda. During the voyage, he became fascinated with the deep blue colour of the Mediterranean which motivated him to identify the prevailing explanation for the blue colour of the sea as incorrect. In 1928, as Raman and his diligent student K. S Krishnan delved deeper into the phenomenon of light scattering, they observed that when a monochromatic beam of light passed through a transparent medium, most of it scattered unchanged.

Except for a small fraction of the light that emerged with a different wavelength, a subtle shift that could not be explained by prevailing scattering theories. This inelastic scattering later dubbed the Raman effect, revealed that energy exchanged between photons and molecules of a medium provides a unique fingerprint of the materials' vibrational and rotational properties. This breakthrough, achieved with minimal resources and entirely within India, provided the world with a powerful analytical tool and earned Raman the Nobel Prize for physics in 1930.

Sir C.V Raman’s pioneering spirit and unwavering determination laid down the foundation for India’s modern scientific infrastructure. Raman founded the Indian Journal of Physics in 1926. He became the first Indian director of the Indian Institute of Science in 1933, where he recruited G.N Ramachandran who went on to become a distinguished X-ray Crystallographer. In the same year he founded the Indian Academy of Sciences. He pioneered the foundation of Travancore Chemical and Manufacturing Co. Ltd along with his former student Panchapakesa Krishnamurti, one of the first organic and inorganic chemical manufacturers in India. Professor Raman retired from IISC in 1948 and established the Raman Research Institute, where he served as director till his death in 1970.

Professor C.V Raman’s legacy is not confined to his scientific acclaim rather it is reflected in the thriving scientific community he helped cultivate. The Raman effect does not symbolize only a scientific breakthrough but also his unwavering determination, perseverance, and passion for science that has inspired countless young Indians to embark on their scientific journey. His life is a powerful reminder that innovation can flourish even in the modest of settings and that the pursuit of science begins with a spark of curiosity and the courage to pursue it.

The X-Factor in Aging: When Your Chromosomes Play Favorites

By Anupama P

X-inactivation is a pivotal process observed in female mammals that makes certain that only one of the two X chromosomes is active in each cell. This is to prevent the doubling of X-linked gene products compared to males, thereby leading to cellular mosaicism, where some cells express the maternal X (Xm) and others the paternal X (Xp). Although this mosaicism pledges genetic and epigenetic diversity, skewing towards one parental X can increase the chances of vulnerability to dysregulation.

Recent studies showed a comparison between mice with only an active Xm to those with both active Xm and active Xp. (Abdulai-Saiku et al, 2025) Astonishingly, no remarkable differences were found in fasting blood glucose levels or cardiac function across the young and old mice. Nonetheless, when it comes to cognitive functions, they showed signs of cognitive impairment and accelerated brain aging. Mice with only an active Xm showed impaired memory in the probe trials during Morris water maze experiments. As they aged, this impairment was observed to have worsened compared to mosaic Xm + Xp controls. The hippocampus of Xm mice has appeared biologically older as compared to those with both Xm and Xp active, proposing that the brain functions are more sensitive to variations in X-chromosome expression.

RNA sequencing also revealed that the Xm chromosome silences several genes, including Sash3, Tlr7, and Cysltr1. These genes, involved in immune-related processes, were nearly undetectable from Xm but highly expressed on the Xp chromosome.

Using CRISPR activation (CRISPRa), researchers strengthened the expression of these silenced genes in neurons. In vivo, experiments showcased boosted spatial learning and memory in old female mice without exerting influence on anxiety-like behaviors.

These findings suggest that veering towards an active maternal X could increase cognitive decline risk even without mutations due to its influence on brain aging and gene silencing.

Understanding these mechanisms may help in developing strategies against cognitive deficits and neurodegenerative diseases like Alzheimer's disease. Thus, this research throws light on the significance of considering epigenetic influences when studying aging processes, particularly how they affect brain health over time.

Abdulai-Saiku, S., Gupta, S., Wang, D. Et al. The maternal X chromosome affects cognition and brain ageing in female mice. Nature 638, 152–159 (2025).

WHAT'S IN A NAME

Remember the Wizard of Oz character "Tinman" whose wish was to have a heart? Drosophila flies with a mutated Tinman gene fail to develop a heart.

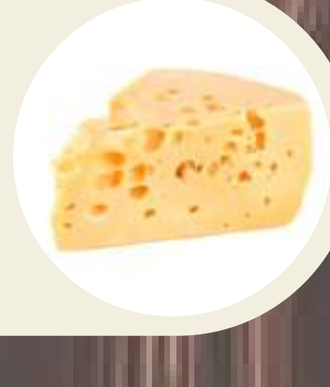
Mutation in the Ken and Barbie gene results in malformation of Terminalia in adult drosophila, male and female genitalia often remain inside the body/without external genitalia mirroring the plastic dolls.

The hedgehog gene - The gene was first identified in Drosophila melanogaster. Typically, regularly spaced denticles (bristles) outline the segments of the Drosophila embryo. Flies with mutated hedgehog genes result in clumping of denticles giving the embryo a 'spiny and prickly' phenotype, resembling a hedgehog.

In vertebrates at least three hedgehog genes have been reported - sonic hedgehog, Indian hedgehog, and desert hedgehog. In humans, the sonic hedgehog gene plays a key role in proper limb and digit formation as well as neural development. It helps in the development of precisely 5 fingers, not 4 or 6. Determines which will become the pinky, which is the thumb. Mutations in this gene have been found to cause failure in the division of the brain into two hemispheres(Holoprosencephaly).

Genes of the grim-reaper locus (Drosophila melanogaster)
Well, you already would have guessed what these genes do. Yup, you are spot on! The Drosophila reaper, head involution defective, and grim genes play key roles in regulating the activation of programmed cell death.

Swiss cheese (Drosophila melanogaster)
Swiss cheese mutant flies develop normally during the larval stage but show progressive neurodegeneration (neuronal and glial) in the pupal and adult stages, characterized by the formation of spongiform lesions/vacuoles/"holes" within the CNS.



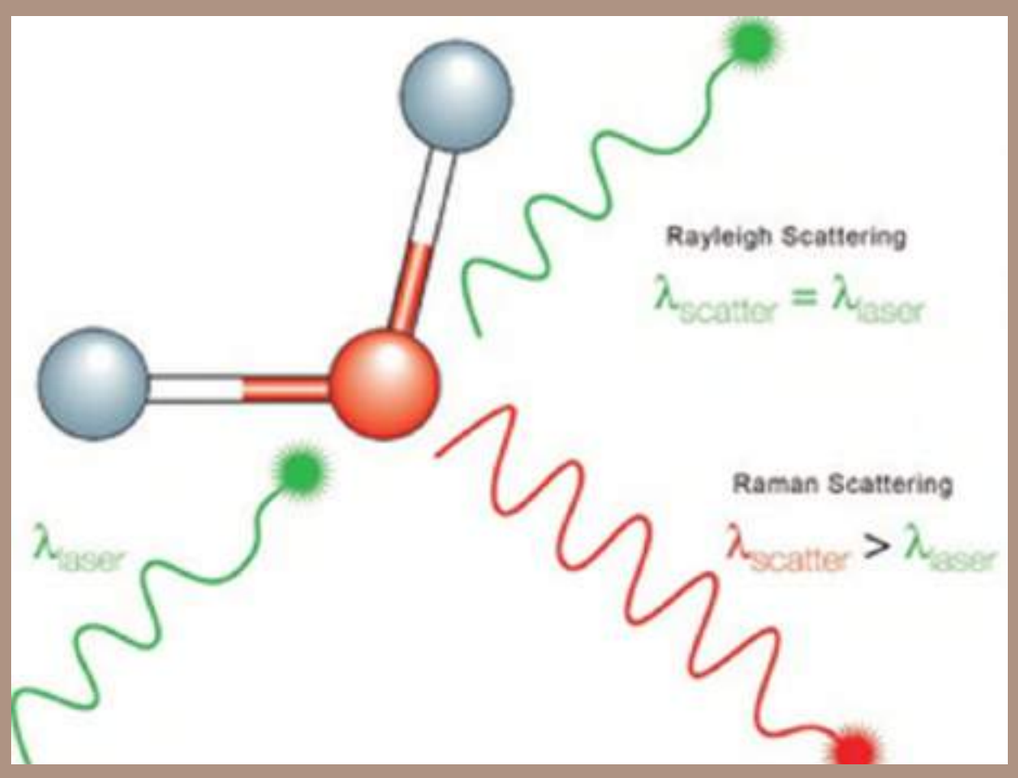
Dracula (Zebrafish)
What's one thing "Count Dracula" fears the most? Compelling him to emerge only at night.
Zebrafish with a mutated Dracula gene make red blood cells highly light sensitive, leading to their lysis.

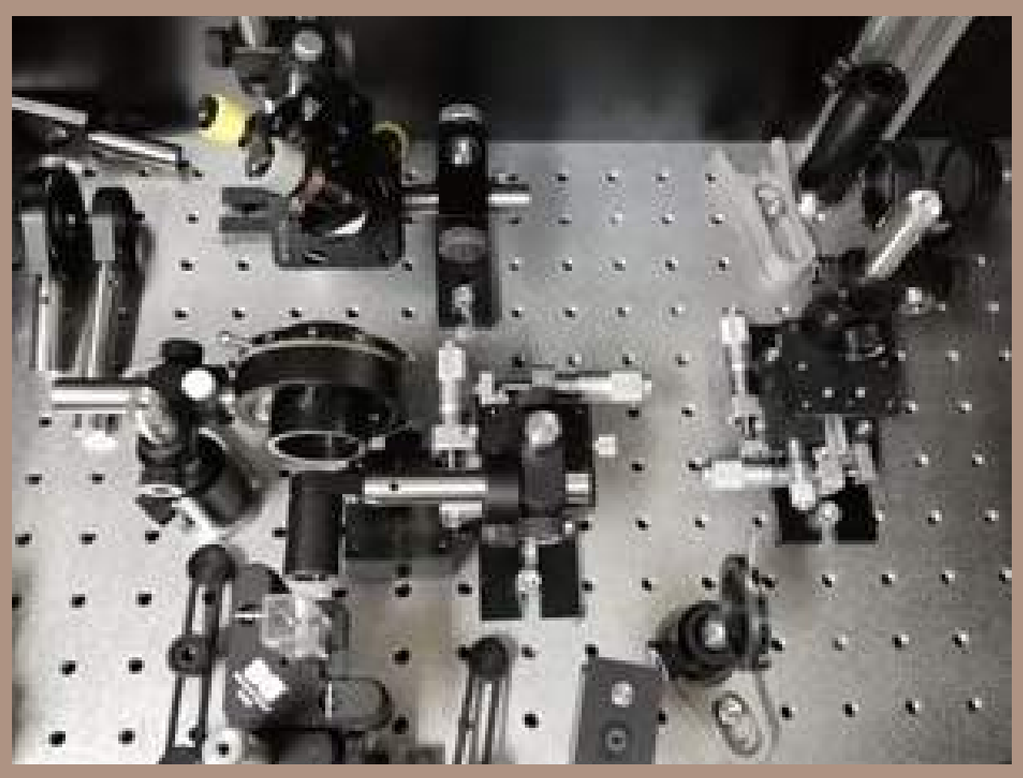
Coherent Anti-Stokes Hyper-Raman Spectroscopy

By Richard Jome

The famous Indian physicist Professor Sir Chandrasekhara Venkata Raman and his student K.S. Krishnan showed that light changes color when it passes through a transparent material. This color change is caused by molecular vibrations. If you were to shine green light onto a material, you might expect just to see green light reflected from it this is because most of the light that scatters remains unchanged in energy (Rayleigh scattered). Only around 1 part in 10 million of the scattered light is Raman scattered. We can use a Raman spectrometer to measure this inelastically scattered light and gain information about the sample.

Coherent Raman scattering spectroscopies have been established as a powerful tool for investigating molecular systems with high chemical specificity and have many applications in the gas phase, molecular dynamics in condensed phases, and molecular imaging. However, the present CRS techniques provide only information on Raman active vibrations, identical to spontaneous Raman scattering in principle. One needs other types of vibrational spectroscopy to obtain further vibrational information unobtainable from Raman/CRS spectroscopy. To combat the above limitations, the scientists Kazuki Inoue & Masanari Okuno from the Department of Basic Science at the University of Tokyo report a new Coherent Raman Spectroscopy, Coherent Anti-Stokes Hyper-Raman Scattering (CAHRS) spectroscopy experimentally for the first time.



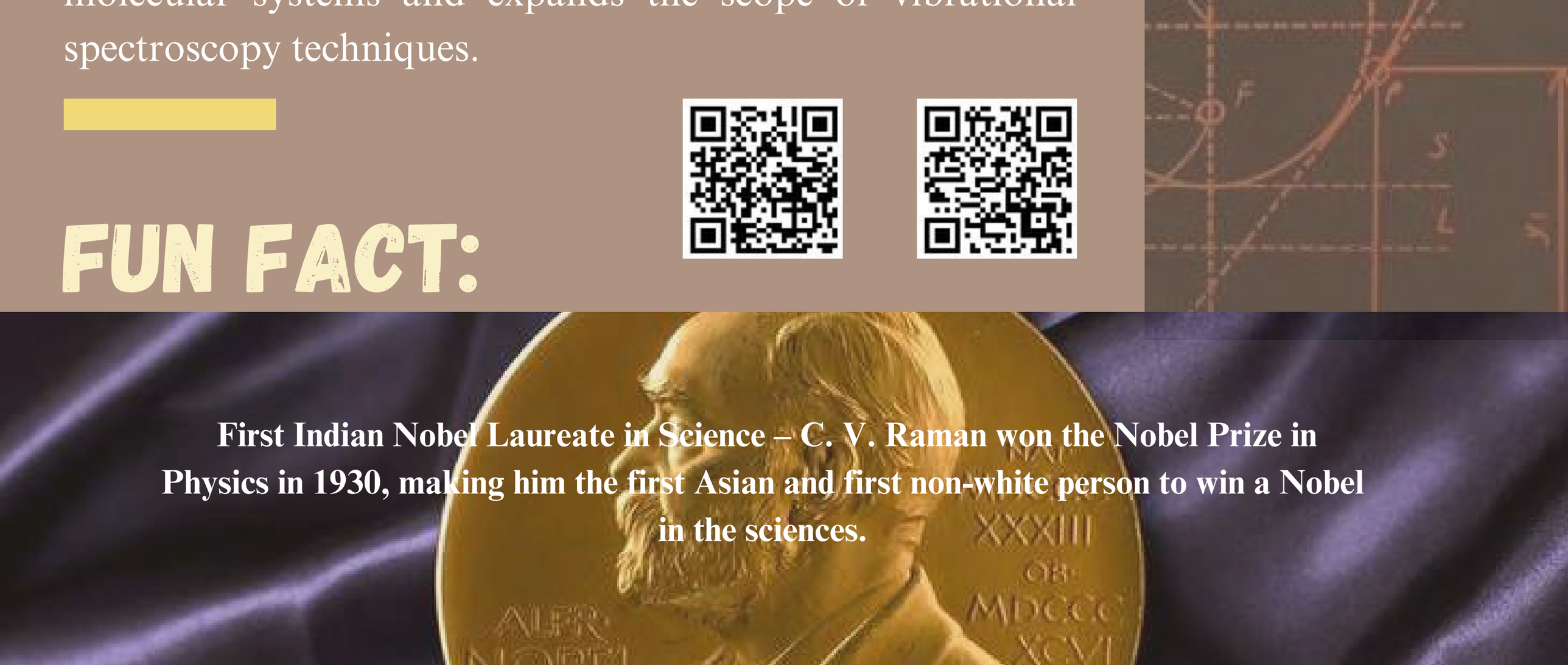


The CAHRS process is based on the fifth-order nonlinear susceptibility and six-wave mixing, giving spectral information identical to the spontaneous hyper-Raman (HR) process and different from the usual Raman one. Key features include:

- Improved Signal Quality: CAHRS achieves higher signal-to-noise ratios (SNRs) compared to spontaneous HR spectroscopy. Example: A para-nitroaniline (PNA) solution showed CAHRS signals with SNRs 100 times greater than HR signals.
- Silent Mode Detection: CAHRS successfully detected Raman-inactive but IR-active vibrations in benzene, showcasing its ability to discover molecular vibrations inaccessible by other methods.
- Fast Data Acquisition: CAHRS decreased the amount of time required for obtaining HR spectral data, enabling faster and more efficient analyses.
- Potential for Imaging: The spatial resolution of CAHRS microscopy could exceed that of IR-based techniques because of its use of visible and near-IR light.

CAHRS could be transformative for fields with detailed vibrational information, for instance, chemical structure analysis and biological imaging. It also represents a pivotal advancement in nonlinear optical spectroscopy. Additionally, it offers new possibilities for studying complex molecular systems and expands the scope of vibrational spectroscopy techniques.

FUN FACT:



First Indian Nobel Laureate in Science – C. V. Raman won the Nobel Prize in Physics in 1930, making him the first Asian and first non-white person to win a Nobel in the sciences.

Innovate, Lead, Inspire: Dr. Aleena Cherian's Story at Proto 9

"It has been quite a wonderful journey," she said, with a faraway smile steeped in nostalgia. "I'm not sure I can do it justice in such a short time." Starting from the Amrita School of Nanosciences and Molecular Medicine in 2012, where she initially joined as an MTech student in Nanomedicine, Dr. Aleena Cherian's journey has been unexpected, yet transformative. She previously envisioned pursuing her PhD abroad, however, inspired by her mentor, Dr. Deepthy Menon, she engaged in challenging research at ASNSMM. Overcoming various hurdles and roadblocks both in research and life, she earned her PhD in Nanotechnology in 2021. Though this set her path as an academic, her post-PhD results changed everything. Today she is the Manager of the Research and Development team at Proto9 Materials, a company focused on delivering high-performance nanomaterials for sustainable innovation.

Q: Could you share some of the innovative projects you are working on at Proto9 Materials?

A: Proto9, initially nanotechnology-focused, has evolved into a biotech-nanotech company. I lead the Agro-Input Division, developing organic, bio, and nano-fertilizers. While nano-fertilizers await regulatory approval, other products are market-ready. We also explore specialty fertilizers, emphasizing efficiency and sustainability in agriculture.
a little bit of body text

Q: How did your experience at Amrita influence your research journey?

A: Amrita implanted a translational research mentality in me; it's the real world instead of papers. My PhD focused on animal models, aligning more closely with industry challenges. Adapting to the industry after staying in the academies, which normally takes years, was different. From science to the marketplace, there needed to be scalable efficiency, not to forget a clear channel for communication between research and the marketplace.

"An impact can only be achieved through a marathon, not a sprint."

Q: How was your transition from academia to industry, and what key skills helped you in this shift?

A: A big mindset shift was required in moving to industry. In academia, research takes years, but in industry, results are expected quickly. Scalability is important—products have to be mass-producible. Effective communication helps translate complex research into marketable solutions. Efficiency, adaptability, and cross-functional collaboration are some of the things I learned during my transition.

Q: What do you consider some of the most defining moments in your career?

A: Completing my PhD was, to say the least, the biggest achievement for me during such difficult personal times. I focused on my research with resilience and perseverance. And it eventually paved my path to Proto9 Materials.

Q: What exciting breakthroughs are on the horizon for materials science?

A: Nanotechnology is a game-changer, particularly in agriculture, with nano-fertilizers showing disruptive potential. While still in the early stages, increased research and commercialization will expand nanotechnology's applications across industries.

Q: What are the essential skills required to lead research teams successfully?

A: Leadership is about empowering the team. I avoid micromanaging and encourage innovation and ownership. Recognizing achievements builds a motivated work environment. Trust and autonomy drive creativity and productivity.

Q: What advice would you give to students who have the dream to make an impact in science?

A: Start small—consistent efforts lead to success. Collaboration is key; don't limit yourself to your institution. Conversations with diverse individuals can spark breakthroughs. Stay open-minded and persistent in your journey.

> "Innovation is the ability to see change as an opportunity and not a threat."
>
> **- Steve Jobs**

FUN FACT:

Some of the Best Leaders Have Failed First – Abraham Lincoln lost multiple elections before becoming the 16th President of the U.S. and leading the country through one of its toughest times.

Science Behind Monuments

JANTAR MANTAR

The famous Jantar Mantar in Delhi, Jaipur, Mathura, Varanasi, and Ujjain is an Architectural Astronomy instrument, that was used to measure time, track celestial bodies, and predict solar eclipses. These structures were designed based on the principle of Vastu Shastra. The name "Jantar Mantar," is derived from the Sanskrit words "yantra" (instrument) and "mantra" (formula or calculation), which aptly captures the essence of this site as a place where science met spirituality and mathematics converged with mysticism. This was built by Maharaja Sawai Jai Singh Il of Jaipur, during the 18th century. Jai Singh drew inspiration from ancient Indian texts such as the Surya Siddhanta, as well as Persian and European astronomical works. The instruments at Jantar Mantar were crafted using local materials like stone, marble, and brass. Their large size ensured greater accuracy, as larger instruments reduced observational errors that smaller tools might encounter.

Jai Singh also consulted and collaborated with scholars from across the world, blending traditional Indian knowledge with advanced ideas from Islamic and European astronomy. This fusion of ideas is evident in the instruments' design, which incorporates principles of geometry, trigonometry, and celestial mechanics. His innovative approach resulted in unique instruments that could measure time, track celestial bodies, predict eclipses, and calculate astronomical phenomena with unparalleled precision.

The following are the structures that are part of Jaipur's Jantar Mantar:

Samrat Yantra (The Supreme Sundial)

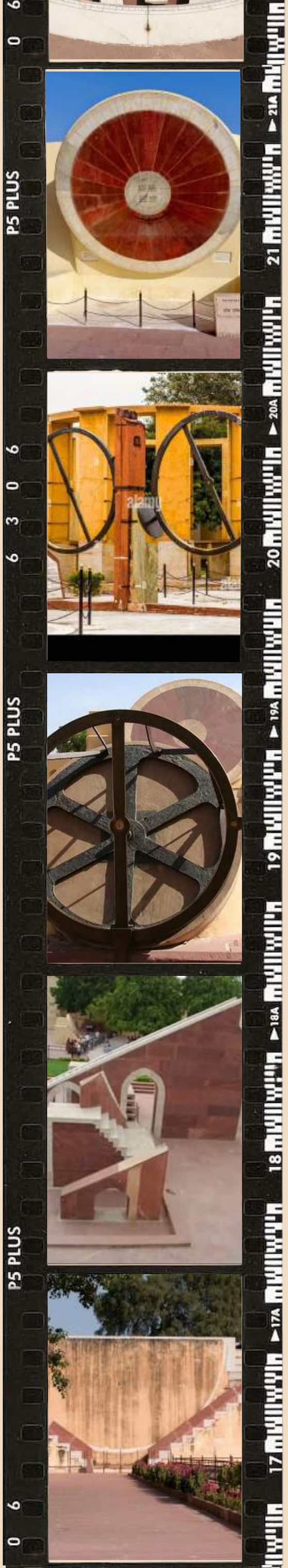
The Samrat Yantra, meaning "supreme instrument," is the most prominent structure in the Jantar Mantar. It is a massive sundial shaped like a triangular ramp with steep sides, standing 27 meters tall. The hypotenuse of the triangle is aligned with the Earth's axis, pointing toward the North Pole. Its shadow moves along two curved scales on either side, which are marked with precise measurements for calculating local time. Additionally, the Samrat Yantra could predict eclipses, measure the decline of celestial objects, and determine their altitudes. Its size reduces observational errors, making it one of the most accurate ancient time-measuring devices.

Jaiprakash Yantra (Celestial Hemisphere)

The Jaiprakash Yantra consists of two complementary hemispherical bowls sunk into the ground, with their interiors marked by a grid of latitude and longitude lines. These lines represent the celestial sphere, allowing observers to study the position of stars, planets, and the sun. A metal crosswire suspended above the bowls casts a shadow onto the engraved coordinates, enabling precise calculations of celestial objects' positions. This instrument was particularly innovative for visualizing the three-dimensional movement of the heavens, providing astronomers with a unique perspective on the cosmos.

Rama Yantra (Altitude and Azimuth Instrument)

The Rama Yantra is a pair of cylindrical structures, each open to the sky, with markings on their inner walls and floors. These markings help measure the altitude (vertical angle) and azimuth (horizontal direction) of celestial objects. Observers stand inside the cylinder and align their sight with the markings to determine the object's position. The Rama Yantra is remarkable for its simplicity and precision, offering an intuitive way to track the movement of celestial bodies across the sky.



Narivalaya Yantra (Equatorial Dial)

The Narivalaya Yantra is a pair of circular instruments designed to measure the time based on the sun's position. One dial faces the northern hemisphere and is used when the sun is in the northern sky, while the other faces the southern hemisphere for use during the southern solstice. The Narivalaya Yantra demonstrates the builders' understanding of the Earth's axial tilt and its effect on the apparent motion of the sun throughout the year.

Chakra Yantra (Declination Measurement)

The Chakra Yantra comprises four semicircular arcs mounted on a frame. These arcs were used to measure the declination of celestial bodies, which is their angular distance north or south of the celestial equator. By carefully observing the position of a celestial object along the arcs, astronomers could determine its movement and position relative to Earth.

Disha Yantra (Direction Finder)

The Disha Yantra is a simple but essential instrument for determining the cardinal directions. It was used to ensure that other instruments in the observatory were accurately aligned with the true north and other directional points. This alignment was critical for maintaining the accuracy of the astronomical observations.

7. Kranti Yantra (Ecliptic Instrument)

The Kranti Yantra is a sophisticated tool designed to measure the ecliptic coordinates of celestial objects. It calculates their latitude, longitude, and declination (angular distance from the celestial equator). This instrument was particularly useful for studying the movement of planets and their positions relative to the Earth's axis.

Dhruva Yantra (Pole Star Locator)

The Dhruva Yantra was specifically designed to locate the Pole Star (Dhruva Tara) and other fixed stars in the night sky. By focusing on these stars, the instrument helped astronomers determine the true north direction and study stellar navigation.

Dakshin Bhitti Yantra (Meridian Wall)

The Dakshin Bhitti Yantra is a vertical wall instrument used to measure the meridian altitude of celestial bodies, which is their highest point in the sky as they cross the local meridian. This data was critical for determining the local time and understanding the object's movement across the celestial sphere.

Unnatasha Yantra (Solar Altitude Instrument)

The UnnatashaYantra is a small, yet significant tool designed to measure the altitude of the sun. It consists of a simple frame with scales and was used to track the sun's movement throughout the day and year, contributing to the calculation of the solar calendar.

The fact that Jantar Mantar remains relevant and produces accurate results to this day is fascinating and is a proof of the craftsmanship of the generation that built it. The sheer thought and precision with which it was designed is truly praiseworthy.

EGYPT

The science behind the monuments of Egypt, such as the pyramids, involves advanced engineering and construction techniques for their time. Let's take the Great Pyramid of Giza as an example:

- Quarrying and Transport: The pyramid's stones were quarried using copper chisels and transported using ramps and pulleys. Recent theories suggest that a long-lost branch of the Nile might have been used to transport materials year-round.
- Ramps and Levers: The ancient Egyptians likely used earthen ramps to move the blocks into place. These ramps were built in a zigzag pattern to allow workers to pull the blocks up using ropes and wooden pulleys.
- Alignment and Leveling: The pyramids were aligned with the cardinal directions, requiring knowledge of astronomy. Water-filled trenches were used to level the perimeter.
- Engineering Feat: The Great Pyramid is about 481 feet tall and was built from over 2.3 million stone blocks, each weighing an average of 2.5 tons.
- Technological Innovation: The pyramid's construction demonstrates a sophisticated understanding of mathematics and physics, as it was built with precise geometric proportions and aligned with celestial bodies.

These techniques highlight the advanced scientific and technological capabilities of ancient Egyptian civilization. The discovery of the lost Nile branch, known as the Ahramat Branch, has significantly enhanced our understanding of pyramid construction by revealing a crucial transportation route for materials and workers. This ancient waterway, now buried under modern landscapes, likely played a pivotal role in facilitating the construction of the pyramids by providing a means to transport massive stone blocks using boats during the annual floods. The presence of this branch explains why many pyramids were built along its course, as it offered logistical advantages for construction. This finding underscores the ingenuity and strategic planning of ancient Egyptian engineers in utilizing natural resources to achieve monumental feats.

FUN FACT:

The Pyramids of Giza are the oldest of the seven wonders of the world.

The pyramids were built more than 1,200 years before the rule of Tutankhamun—the young pharaoh known around the world as King Tut—and the Great Pyramid of Giza is the oldest and last remaining of the Seven Wonders of the Ancient World.

Amidst the shifting sands and ancient secrets,

The Lost Expedition Log of the Great Pyramid Odyssey:

The Experiment of Psammethicus

GIZA

He isolated 2 infant babies. The were looked after a mute shepherd and a goat' — Hence recreating the environment at the begining of time — when we had no language to learn from. Having been given only bread to eat their entire life their first word was 'BEKOS' which was the phrygian word for bread. This brings us to the assumptive conclusion that phrygian was probably

BABAΓΕΙ ΤΕΓΑΙΣΓΡΟΥΤΑΓΟΣΚΟΙΓΑΙΥΑΓΕΙΟΣΒΕΚΕΓΑΙ

an orginal inscript of phrygian

Psammethicus or Psamtik I

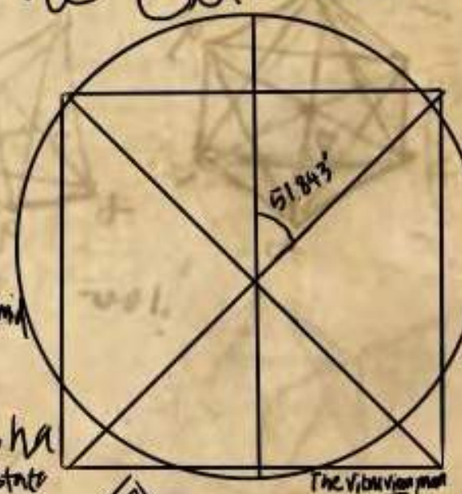
This experiment was reported by the Lycee historian Herodotus

phrygians have now been extinct since 5BCE

The Science Behind Pyramids

The ancients believed that if you could square a circle, it would be the most powerful and indestructable architecture

Scientists have discovered that The Vitruvian man shows same proportions as an egyptian pyramid



Theories:

- Pi was used to set base height
- This proportion was determined using THE GOLDEN RATIO

The avg length of side of square base = $\bar{x}$ = 230.363m

The std deviation of side of base = S_x = 0.0387m

The error in construction (deviation from perfect square) can be estimated from coefficient of variation

$$CV = \frac{S_x}{\bar{x}} \times 100 = 0.01657\%$$

The tomb has a floor for state seperate from the sarcophagus

Due to tomb robbers, there are lot of mechanisms and guards in The Medjay

Is Curing Alzheimer’s impossible? Promising Frontiers in Alzheimer’s Disease Research

By Meenakshy Sreekanth Ranjeela

Alzheimer’s disease (AD) is one of the greatest challenges in modern medicine, characterized as a progressive neurodegenerative disorder, it affects millions of people worldwide causing cognitive decline, memory loss, and ultimately, losing oneself. Despite decades of research, the search for a definite cure remains elusive thus raising the question: Is curing Alzheimer's impossible?

No treatment can yet stop or reverse the disease but, the recent advancements in neuroscience, molecular biology, and artificial intelligence are shedding light on potential breakthroughs.

Alzheimer’s disease is primarily associated with the accumulation of amyloid-beta (Aβ) plaques and tau protein tangles in the brain, leading to the formation of neurofibrillary tangles and eventually neuronal apoptosis. The exact cause of the formation of these hallmarks is still unknown but, genetic factors such as mutations in APP (Amyloid Precursor Protein) PSEN1 (Presenilin-1) and PSEN2 genes have a role in early onset AD along with environmental factors.

The disease progression can be classified in 3 stages:

1. Preclinical Stage: Early stage with no noticeable symptoms, but pathological changes already occurring in the brain.
2. Mild Cognitive Impairment (MCI): Subtle memory problems begin to emerge such as loss of memory, no sense of direction, etc.
3. Alzheimer’s Dementia: Memory loss worsens, severely affecting daily activities thus, progressing to severe cognitive decline.

One of the biggest obstacles in curing Alzheimer’s is its complexity. The brain is a highly intricate organ, and neurodegenerative diseases involve multiple pathways, genetic predispositions, and environmental influences. Additionally, Alzheimer’s pathology begins decades before symptoms appear, making early intervention challenging. Historically, treatments have focused on reducing amyloid-beta plaques, but many of these strategies have failed in clinical trials.

Other difficulties include:

- The blood-brain barrier prevents effective drug delivery.
- Late-stage diagnosis reducing treatment efficacy.
- Individual variability in response to therapies.

Promising Frontiers in Alzheimer's Disease Research:

1. Targeting Amyloid and Tau Proteins: Recent drug developments have revisited the amyloid hypothesis with a precise approach. The FDA had approved Aducanumab and Lecanemab which are monoclonal antibodies that clear amyloid plaques. Their mechanism is clear although their effectiveness in slowing cognitive impairment remains unclear. The tau proteins also correlate closely with the disease progression in AD. Tau-targeting drugs such as Semorinemab are currently in clinical trials.
2. Neuroinflammation and Immune System Modulation: Chronic neuroinflammation has an important role in the Alzheimer's disease progression. The ways to decipher and regulate the immune responses in the brain, particularly by targeting microglia and astrocytes, the brain’s immune cells. Drugs like Pexelizumab, an anti-inflammatory compound are being tested to reduce inflammation that contributes to neuronal damage.
3. Genetic and Epigenetic Approaches: Advancements in CRISPR gene editing have increased the possibility of identifying and correcting genetic risk factors such as APOE4, a gene variant strongly linked to AD. Epigenetic drugs such as HDAC Inhibitors (Histone Deacetylase) modify the gene expression without altering DNA sequences are also being researched.
4. Artificial Intelligence in Early Diagnosis: AI and Machine Learning are improving the means for early Alzheimer's detection. Deep Learning Models analyze brain scans, blood biomarkers, and other relevant data to identify at-risk individuals before symptoms appear.

Early diagnosis of Alzheimer’s is crucial for effective intervention and treatment. While a definite cure is not yet available, the studies are rapidly evolving. Currently, the treatment protocols are targeted mostly at amyloid and tau while a possible shift to a multi-modal strategy involving neuroinflammation, genetics, regenerative medicine, and artificial intelligence is promising. There is a chance that Alzheimer’s will be managed like chronic disorders like cancer, diabetes, etc. but with the possibility of achieving a certain quality of life. The emergence of precision medicine, where treatments are tailored to an individual’s biological profile holds great promise for the future. As scientific knowledge expands, so too does our ability to fight Alzheimer’s — one discovery at a time.

#Go purple for AD

FUN FACT:

The National Institute on Aging (NIA) reports that education can lower the risk of getting Alzheimer’s Disease. This is accomplished by keeping the brain active in old age. Help to lower the odds with various activities including learning new languages, taking classes, playing musical instruments and participating in group activities.

Molecule Check!

01 DOPAMINE

By **Dr. Devika Das**

Also known as the “feel-good molecule,” drives rewards, motivation, and movement. It not only provides pleasure, its imbalance can lead to Parkinson’s or schizophrenia. In trace amounts but powerful since C8H11NO2 shapes how we feel and act.

LITHIUM 02

By **Dr. Dhamodaran Santhanagopalan**

The lightest metal, lithium, stabilizes moods in bipolar disorder. It is found naturally in water, and has a calming history dating back to ancient times - simple element with profound effects on the mind.

Molecules That Pass The Vibe Check!

03 OCTENIDINE

By **Dr. Vivek Vinod**

Octenidine is a potent antimicrobial that disrupts germ membranes. A rising star in wound care, it’s a clever alternative to alcohol-based sanitizers, proving chemistry saves lives.

H2O 04

By **Dr. G Siddaramana Gowd**

Water is undoubtedly a molecular dynamo. Its unusual density anomaly causes ice to float, isolating aquatic organisms. With its great heat capacity, it moderates temperatures, while cohesion and adhesion propel capillary action. Its polarity creates hydrogen bonds, molding everything from DNA to ocean currents. Neutrally balanced at pH 7, water powers all biochemical reactions and maintains life on Earth.

Navigating Academic and Career Transitions: Insights from Preetham Permude and Dr.Gaganashree

In the world of academia and research, transitions can be both challenging and transformative. Two inspiring figures, Dr. Gaganashree and Preetham Permude share their journeys from Amrita School of Nanosciences and Molecular Medicine to international institutions, offering valuable lessons in resilience, adaptability, and innovation.

Dr. Gaganashree and Preetham Permude both began their academic journeys at Amrita, where they were exposed to cutting-edge research facilities and mentorship from renowned professors like Dr. Shantikumar V Nair. Amrita's emphasis on interdisciplinary learning and hands-on research experience laid the foundation for their future success. Dr. Gaganashree recalls the initial challenges of adjusting to a new environment but credits the supportive faculty and peers for making her master's experience rewarding. After completing their master's degrees, both researchers embarked on different paths. Preetham Permude joined IIT Bombay as a research fellow before pursuing a PhD in Australia, while Dr. Gaganashree pursued her PhD in New Zealand and later transitioned into research compliance officer in Australia.

Dr. Gaganashree's shift from academia to administration was driven by a changing career vision and an openness to new opportunities. She emphasizes the importance of recognizing that career changes are not failures but natural steps in personal and professional development.

Both researchers highlight key skills essential for aspiring scientists. Preetham Permude stresses clear communication and constant updating of knowledge, which he refined during his time in Australia. Dr. Gaganashree underscores the value of networking and flexibility, noting that informational interviews and online resources were instrumental in her career transition. Dr. Gaganashree's research path involved studying hyperglycemic retinal explants and EGFR variant III expression. She emphasizes that resilience and mental toughness are crucial in overcoming challenges like unsuccessful experiments and long lab hours.

Persistence is a universal virtue in research, allowing scientists to navigate setbacks and continue striving for breakthroughs.

For students aiming to work abroad, Preetham Permude advises persistence and proactive networking. He recounts sending over 1600 emails to secure a PhD scholarship, illustrating the importance of extensive effort in achieving international opportunities. Dr. Gaganashree encourages students to take the plunge and be prepared for unforeseen challenges, emphasizing that studying abroad builds resilience and adaptability.

Preetham Permude's work on Liquid Organic Hydrogen Carriers (LOHC) is a significant contribution to clean energy. LOHC technology addresses the hydrogen storage problem by using organic molecules to bind and transport hydrogen, offering a promising solution for future energy needs.

Permude believes that with continued investment, LOHC will become a major player in the clean energy sector.

Preetham Permude reflects on his involvement with academic magazines, highlighting the development of leadership skills and creativity. He notes that taking initiative in small projects is crucial for building leadership abilities, and creative pursuits can enhance problem-solving skills.

Both Preetham Permude and Dr. Gaganashree's journeys serve as inspirations for students navigating academic and career transitions. Their experiences demonstrate that with the right attitude, flexibility, and proactive mindset, individuals can overcome challenges and achieve their aspirations. The key takeaway is to recognize one's strengths, pursue opportunities with persistence, and embrace new possibilities without fear of change.

Risdiplam for Prenatal Therapy of Spinal Muscular Atrophy

By Gayathri S Pillai

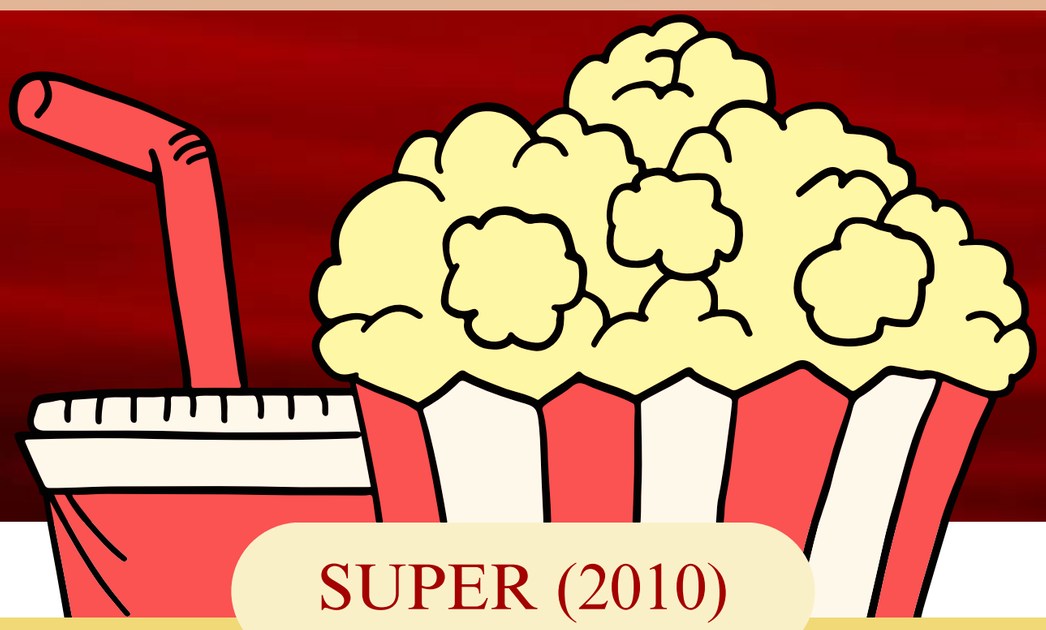
Spinal muscular atrophy (SMA) is a rare autosomal recessive neuromuscular disorder characterized by the progressive loss of motor neurons, leading to muscle atrophy, weakness, and impairments in both motor and respiratory functions. A homozygous deletion or loss-of-function mutation in the survival of the motor neuron 1 (SMN1) gene, which produces the SMN protein and is found at locus 5q13 on chromosome 5, causes the most common type, 5q-SMA. The SMN2 gene, a paralog of SMN1 due to alternative splicing of exon 7 produces a shortened transcript and a limited quantity of functional SMN protein. Higher copies of SMN2 are typically associated with milder SMA phenotypes, although this correlation is not always absolute.

The successful prenatal therapy of spinal muscular atrophy (SMA), as reported in a case study in the New England Journal of Medicine, offers promise for early intervention in this difficult genetic condition. A pregnant lady whose foetus was diagnosed with severe type 1 SMA was given risdiplam, an oral drug created by Roche, by researchers at St. Jude Children's Research Hospital under the direction of Richard Finkel. The foetus was at risk for a severe form of the condition that usually results in death before the age of three because she lacked both copies of the SMN1 gene and only had two copies of SMN2. The maintenance of motor neurons in the brainstem and spinal cord, particularly in late pregnancy and early infancy, depends on the SMN protein. The drug was given to the mother from 32 weeks, 5 days' gestation until delivery. The infant continued the drug postnatally. Michelle Farrar, a paediatric neurologist at the University of New South, said that the child is now 30 months old and does not exhibit any clinical indications of SMA, which is an exceptional result.

FUN FACTS:

- Octopuses have three hearts - two that pump blood to the gills, and one that pumps it to the rest of the body.
- Water might not be wet. This is because most scientists define wetness as a liquid’s ability to maintain contact with a solid surface, meaning that water itself is not wet, but can make other objects wet.

MOVIE REVIEW



SUPER (2010)

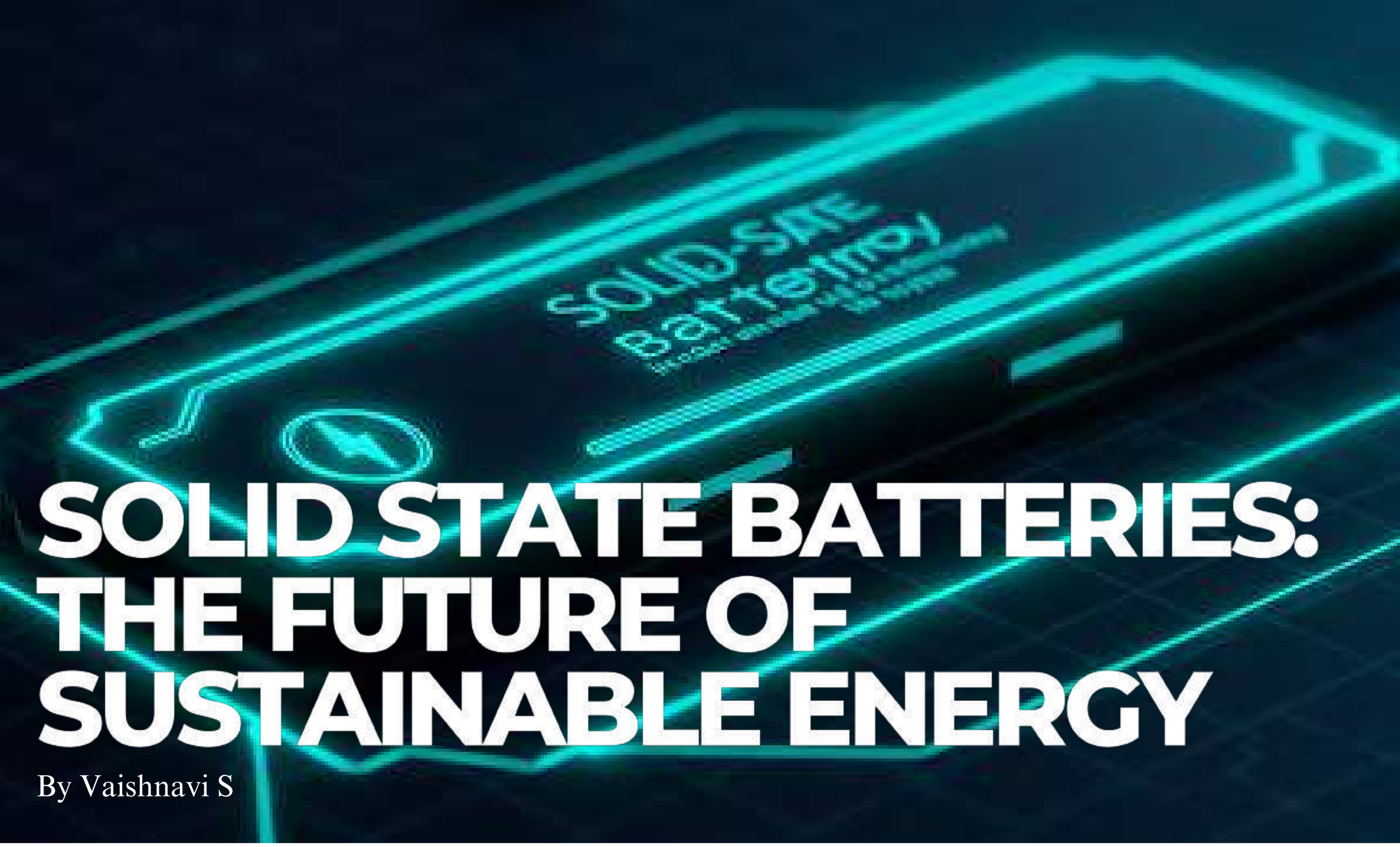
If you want to know how good this movie is just look at the talent it has, Elliot Page, Liv Taylor, Rainn Wilson, Kevin Bacon, Michael Rooker, Nathan Fillion. I don't even know how people missed this one, it was second the directorial venture from James Gunn right after Slither(2006). The life of a commoner with sufficient psychological issues acquired from traumatic experiences from his childhood, amidst which he finds someone he loves and loves back for the person he is, but even that is taken away and he reacts in the most brutal, gritty, skull cracking, pedophile hitting manner possible. The interesting thing about the character played by Rainn Wilson is that his reaction to everything is apt, by that I mean realistic, relatable, and something you would if given a chance but still wouldn't because of "life". The movie at the core is about what the human spirit will do to help itself, it's about self-reliance, the phoenix-like nature of our spirit, birthing inspiration, encouragement, intellect, and resourcefulness from our plights, situations, and dire plots. Pulling himself out of a pit with imaginary tentacles, Jesus gives him the tools to save his wife from the grips of a drug dealer with an adolescent girl as his sidekick. Every punch, every injury lasts, it's painful, and it leaves a mark, like the story does to us. It's pure, it's simple and it's thoughtful. It's a movie where the idea of taking a stand for himself is considered fictional for the main character, so much so that he has to invent a mythical being to allow him to do what he must.

ANAGRAMS:

- Diluent eco - nucleotide
- Crispin to rant - transcription
- Tiny sore - tyrosine
- Neatly come - melanocyte
- Run one - neuron

FUN FACTS:

- Sloths have such a slow metabolism that it can take up to a month to digest a single meal.
- Electric eels can generate shocks of up to 600 volts to stun prey or defend themselves.
- Capsaicin, the compound in chili peppers, activates the same pain receptors that sense heat.



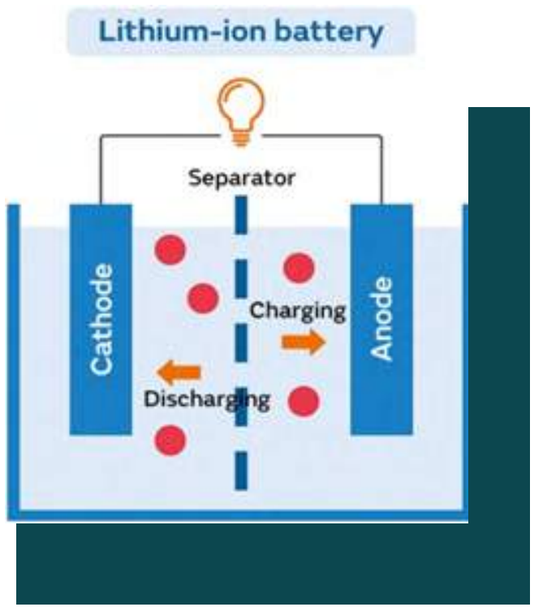
SOLID STATE BATTERIES: THE FUTURE OF SUSTAINABLE ENERGY

By Vaishnavi S

I recently read about an engineering breakthrough that could revolutionize how we store and use energy. The solid-state battery (SSB) is a novel technology that has a higher specific energy density than conventional batteries. Imagine a world where electric vehicles (EVs) charge in minutes, last for thousands of miles, and are completely safe from fire hazards. This could soon be our reality!

Unlike the traditional Lithium-ion batteries, which use a liquid electrolyte to transport lithium ions between the anode and cathode, solid-state batteries replace the liquid electrolyte with a solid material, often made of ceramics, polymers, or sulphides.

Traditional Lithium-ion batteries are prone to issues like leakage, flammability, and capacity degradation over time. Also, they have limited energy density (how much energy they can store in a given size). While these powerhouses promise significant advancements. Their improved conductivity and structure allow for rapid charging without overheating. Additionally, lithium metal for the anode increases energy density meaning long-lasting batteries in small sizes. A car powered by a solid-state battery could have a range 2–3 times longer than one using a lithium-ion battery of the same size. The solid electrolyte is non-flammable, unlike liquid electrolytes, reducing the risk of fires or explosions. What's even more thrilling is their potential impact on sustainability. These batteries degrade much slower, meaning they can last through many more charge cycles. Their improved conductivity and structure allow for rapid charging without overheating.

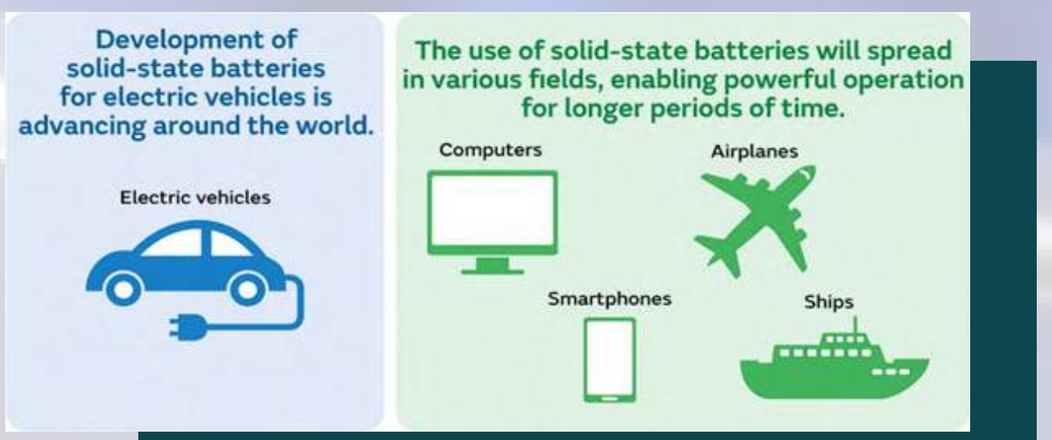


However, challenges remain, the materials and processes required to make SSBs are currently expensive. Scaling up for mass production is a major hurdle. Also, finding the right combination of solid electrolyte and electrode for high performance is still an active area of research.

These findings are then used to study the expected impact of SSBs over the dominant battery types currently used in EVs.

Startups and tech giants alike are racing to develop commercially viable versions. Toyota, for instance, promises commercial solid-state batteries by 2028. They claim their batteries could recharge fully in about 10 minutes. QuantumScape is a leading startup working on scalable solid-state battery technology.

Their recent prototypes show promising results. It’s fascinating to think how solid-state batteries could reshape industries and make renewable energy more accessible. As solid-state batteries inch closer to mainstream use, one question remains: will we embrace their potential to transform our world sustainably? What do you think?



FUN FACTS:

- The Universe's average colour is called 'Cosmic latte'. In a 2002 study, astronomers found that the light coming from galaxies averaged into a beige colour that’s close to white.
- Our solar system has a wall. The heliopause – the region of space in which solar wind isn’t hot enough to push back the wind of particles coming from distant stars – is often considered the “boundary wall” of the Solar System and interstellar space.

Curiosity corner

Question: Why has the Ashoka pillar of Delhi been resistant to rust, despite being exposed to the elements for 1,600 year.

Answer for previous Issue:

When a woodpecker pecks, 99.7% of the impact energy is converted into strain energy in the rest of the woodpecker's body, and only 0.3% is converted in the head. The small amount of strain that remains is quickly dissipated from the head in the form of heat.

1. Their smaller brain size is one of the reasons, a smaller brain size allows them to withstand high deceleration.
2. Hyoid bone: The woodpecker has a specialized bone called the hyoid, which wraps around the back of the skull and acts as a shock absorber.

This helps woodpeckers peck into the wood without any damage.

Think Fast, Heal Faster: How Your Brain Puts Out Immune Fires

By Lakshmi Preethi

Researchers have uncovered an interesting relationship between the brain and the immune system, explaining how they interact to regulate inflammatory responses. At the heart of this interaction are the vagus nerve and the caudal nucleus of the solitary tract (cNST), an area found in the brainstem that assists in maintaining immune system equilibrium.

This is how it gets done: When immune cells see an infection or danger, they emit cytokines—molecules that drive the inflammation. Not only do cytokines act on the immune system, but they also activate and stimulate neurons in the vagus nerve, which send signals to the brain. As a kind of control center, the brain can then modulate the immune response, either turning up or turning down inflammation as necessary.

For a better understanding of this process, scientists carried out experiments on mice. When they inactivated cNST neurons, the mice developed excessive and uncontrolled inflammation, which highlights the brain's important role in immune regulation. But when they activated this pathway, inflammation subsided, triggering anti-inflammatory responses.

This finding has big implications for making new therapies against autoimmune diseases and illnesses such as cytokine storms, in which the immune response goes into hyperdrive. Scientists could potentially exploit the brain's inherent capacity for modulating inflammation to develop medicines that calibrate immune responses, preventing them from being too boisterous or too timid—a kind of thermostat for the body.

ORGANISM OF THE MONTH

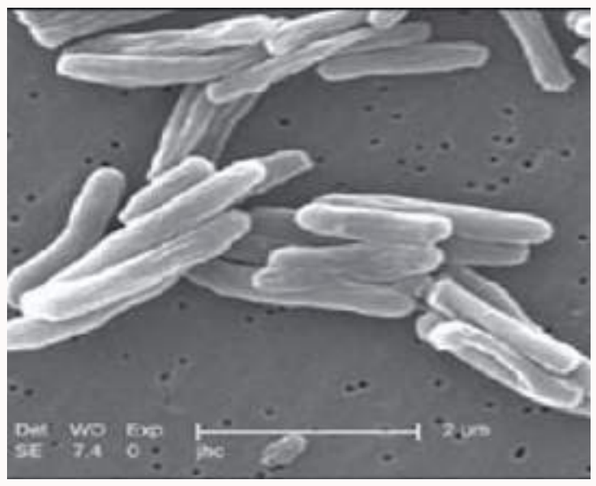


Figure 1. a) electron microscopy image of Mycobacterium tuberculosis.

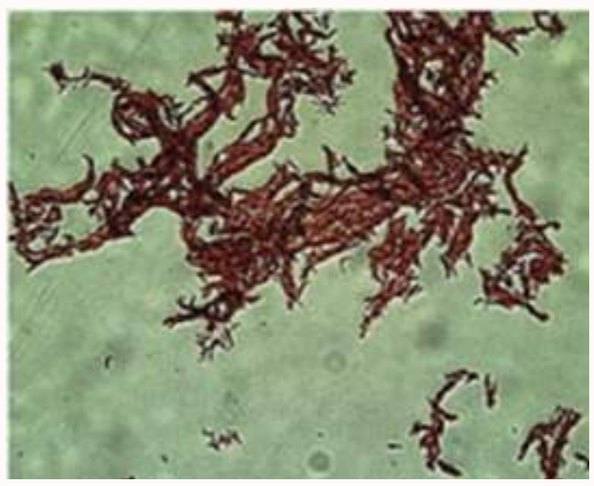


Figure 1. b)

Mycobacterium tuberculosis also known as Koch's bacillus is a slow growing chemoorganotrophic, non-motile, non-sporeforming, aerobic bacteria that causes the disease tuberculosis in humans. M.tuberculosis causes over 1.8 million deaths per year making it the leading infectious cause of death worldwide. Mycobacterium tuberculosis can cause metabolic remodeling of host cells during chronic infections. It has the ability to exist in a metabolically inactive, slow replicating dormant stage for long periods of time, causing latent infections and making the disease progression in tuberculosis a complex process.

Koch's bacillus displays structural features of both Gram positive and Gram negative bacteria. It has asecond outer membrane composed of mycolic acids-long-chain, branched fatty acids that impart several important characteristics to the bacteria including impermeability to stains, intrinsic drug resistance and antibiotic tolerance. Additionally, the cell wall is rich in immunomodulatory molecules such as lipoarabinomannan and sulpholipids However the cell wall of the bacillus remains it's Achilles heels as it's synthesis mechanism is the target of several frontline antibiotics for tuberculosis.

Image credits

1. Figure 1.a) Reprinted from the U.S. Department of Health and Human Services, Centers for Disease Control and Prevention's Public Health Image Library (PHIL), (PHIL image identification number 8438, permission PD-USGeVHHS-CDC, public-domain U.S. government image.)
2. Figure 1.b)Vilchèze C, Kremer L. Acid-fast positive and acid-fast negative Mycobacterium tuberculosis: The Koch paradox. Microbiology spectrum. 2017 Apr 30;5(2):10-128.

FUN FACT:

Bacteria on your skin cause your itches. Specifically, bacteria known as Staphylococcus aureus can release a chemical that activates a protein in our nerves. This sends a signal from our skin to our brains, which our brain perceives as an itch.

Sharp Ideas, Not Needles: The Rise of Needle-Free Injections

By Diya Rajesh Krishnan

Thinking of getting flu shots, Botox, or tattoos? FlowBeams has got you covered.

This time five years ago, the virus causing COVID-19 spread around the globe unchecked, and people haunted by trypanophobia were being made to face their worst fears, injections. Trypanophobia denotes an intense fear of needles that may be triggered by a spectrum of causes including past traumatic experiences, hyperalgesia, and familial history amongst others. Not only does this debilitating condition interfere with your life by compelling you to miss necessary doctor's appointments or not follow treatments but it also endangers the people around you during predicaments like the pandemic. Driven by the challenge of eliminating needle-based discomfort, a team of researchers from the University of Twente set out to understand the basis of needle-free injections. Led by Professor David Fernandez Rivas, the BuBble-Gun team—comprising several postdoctoral researchers, PhD candidates, and students—conducts multidisciplinary research on cavitation, jetting, and impact.

Following 10 years of academic research FlowBeams was founded in 2021 with a vision to alter the face of healthcare through needle-free technology.

FlowBeams leverage a low-power laser to locally heat a microfluidic chip filled with fluid or medicament, creating a micro-bubble that expands rapidly. This propels a thin micro-fluidic jet, thinner than human hair, at high speed through the superficial layers of the skin enabling rapid absorption into the body. The dosage is split into multiple small repeated injections for precision and control over the total volume. The tuneable jet velocity (250km/h) ensures delivery in the desired skin layer with minimum power and a small jet radius of 25µm minimizes pain. The method was developed by Prof. David Fernandez Rivas in collaboration with the Massachusetts Institute of Technology. He reflected that the process is quicker than a mosquito bite and "should not cause pain" because nerve endings in the skin are not touched.

Every year an estimated 16 billion injections are administered worldwide and 1000kg of sharps waste, like used syringes and needles, is generated by a typical large hospital. However, not all the needles and syringes are properly disposed of afterward. This takes a significant toll on both the environment and climate. Accompanying this hurdle is the prospect of needle stick injuries with over 1 million cases reported worldwide and spanning 8% of all in-hospital injuries. FlowBeams address these drawbacks by replacing millions of hazardous used needles with reusable alternatives in healthcare facilities, tattoo parlors, and other industries while eliminating needle anxiety and reducing the risk of cross-contamination from needle stick injuries.

This real-life manifestation of hyposprays is a testament to the belief that the right question often leads to groundbreaking scientific inception and may just incentivize you to schedule your next appointment with your doctor.

Get! Set! Certifications!

1.**IISER Bhopal Summer Internship Program 2025:** IISER Bhopal invites applications from bright and motivated students interested in basic sciences, engineering sciences and economic sciences, Humanities and Social Sciences for its summer research internship program.

2. **CSIR-Indian Institute of Chemical Biology Summer Internship program 2025:** The program is open to the students pursuing postgraduate courses in all branches of chemical and life sciences at any recognized Indian University/ College/ Research Institute.

3. **ICMR School of Public Health Internship:** The internships will be provided in the following technical areas Public Health & Epidemiology, Health Systems Research, Biostatistics, Public Health, Data Management, Social and Behavioural Sciences, and Library Sciences.

4. **ICMR NCIDR internship:** Post Graduate students in fields of Medicine, public health, epidemiology, statistics, demography, data science, computer or information technology, social sciences, philosophy and ethics from a state or central Government, MCI/AICTE/UGC – recognized University/College/Institute. Undergraduate students may apply if it is part of the course curriculum and application will be reviewed on a case to case basis.

More Institutes Offering Research Internships

Keep an eye on the following institutes for internship opportunities!

- IISER Kolkata
- IISER Bhopal
- Saha Institute of Nuclear Physics
- Bose Institute
- S N Bose National Institute for Basic Science
- ICMR-NIREH
- ICMR-NICED
- CSIR-IIIM
- CSIR-IICB
- ICMR-NIE
- ICMR-NCDIR
- ICMR-NITM
- DBT-NCCS
- DBT-CDFD
- NII
- IIT-HYDERABAD
- IIT-MADRAS
- IISER TVM
- RGCB TVM
- NISER

Check out this website for free GATE coaching from IIT professors!
https://gate.nptel.ac.in/video.php?branchID=13&cid=1

Editor's note

Dear Readers,

As we step into another edition of our newsletter, it constantly reminds us of the limitless possibilities that arise when knowledge, teamwork, and creativity come together. It is more crucial than ever to keep informed and involved with new ideas in an ever-changing world.

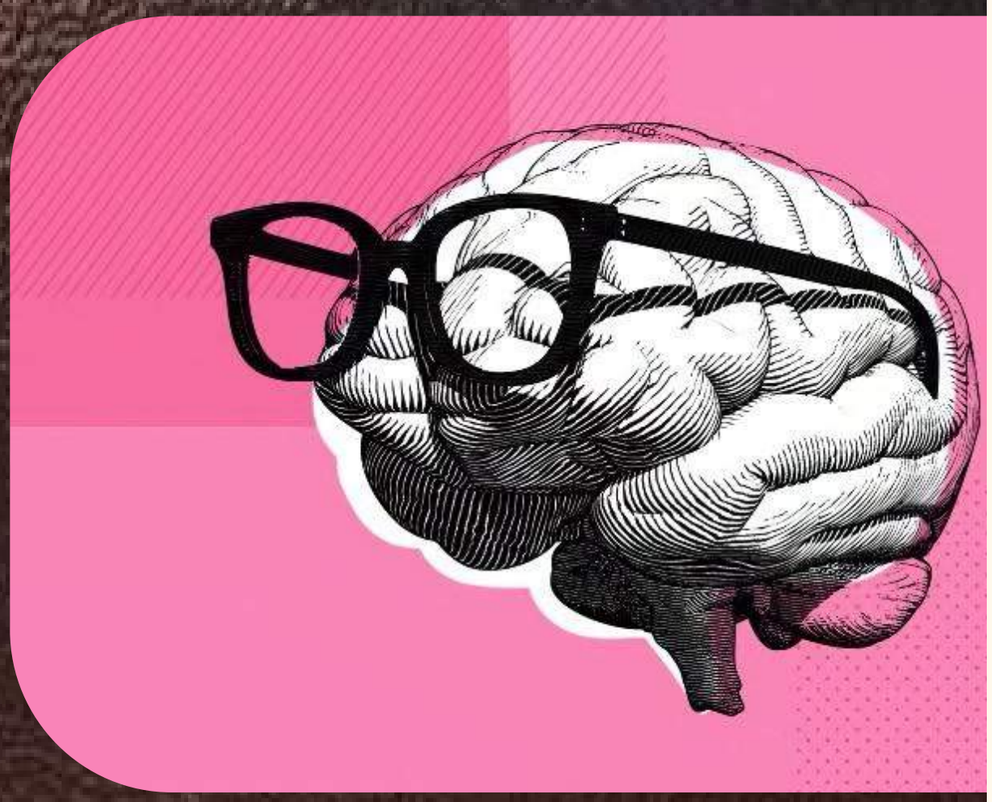
This issue offers you a carefully chosen collection of perceptive articles, innovative research, and motivational tales that challenge our current understanding, it is a monument to our shared quest for knowledge. From provocative analysis to discoveries, our goal is to pique interest and promote deep dialogue. We hope that everyone will find something useful in this edition, whether they are looking to learn about advancements, or just to find inspiration.
We welcome your thoughts, ideas, and feedback—because the best conversations are born from shared curiosity and a passion for learning.

Inquisitively yours,
Lakshmi Preethi and **Diya Rajesh Krishnan**

Think you've found the next frontier!?
Share it with us at
astrafrontiersnewsletter@gmail.com

OUR TEAM - FEB 2025

The architects of Astra's voice



CREATIVE INPUT BY:

Molecules that passed the vibe check:
- *Nakshatra Jayachandran*

Comic strip:

Artist:
- *Malachi Norton*
- *Sredha Pillai*

Script:
- *Malachi Norton*
- *Anupama P*
- *Diya Rajesh Krishnan*

Fun Facts:
- *Nakshatra Jayachandran*
- *Aarathi R Nambiar*

Curiosity corner:
- *Samirdhi Susan Maju*

Movie Review:
- *Anirudh E*

Science Behind Monuments:
- *Shazia Anas*
- *Anupama P*
- *Lakshmi Preethi*

Anagrams:
- *Liya Ann George*
- *Anjitha Harish*

What's in a name?:
- *Bharanika Jethani*

Organism of the Month:
- *Samirdhi Susan Maju*

DESIGN AND LAYOUT:

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- *Anupama P*
- *Lakshmi Preethi*
- *Diya Rajesh Krishnan*
- *Ann Theres*
- *Anirudh E*

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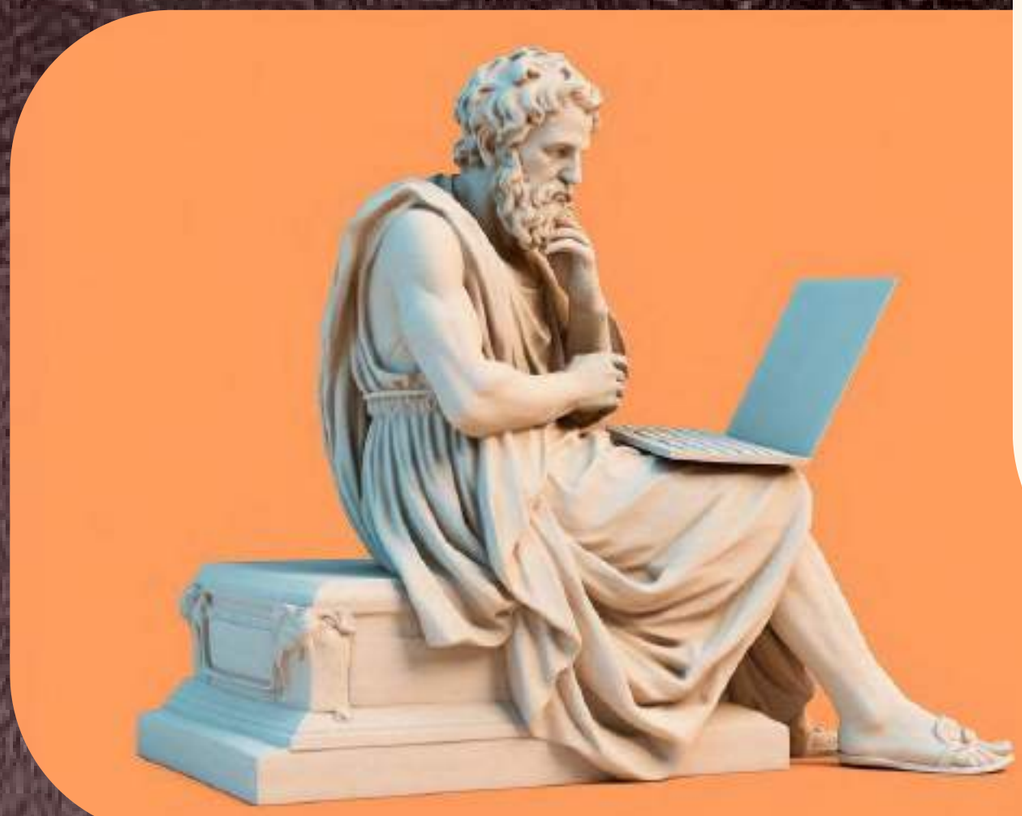
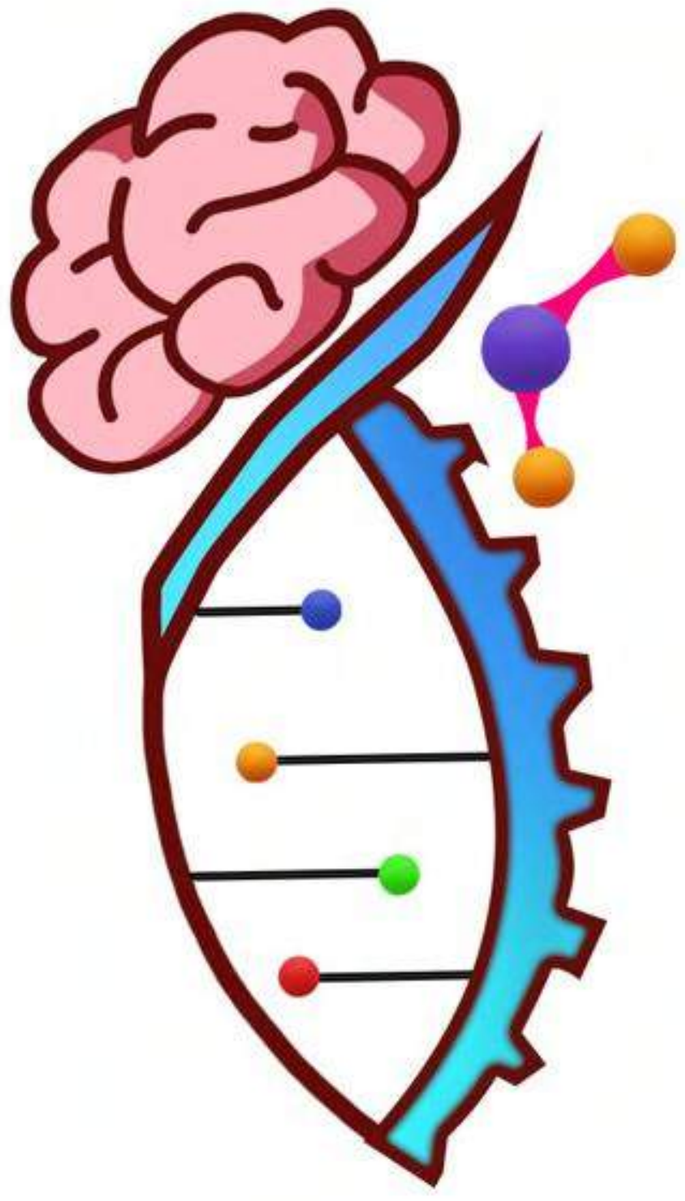
- *Diya Rajesh Krishnan*
- *Richard Jome*





ASTRA