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Science INDIA

राष्ट्रहिताय विश्वमङ्गलाय

Connecting science and people with an Indian perspective

MAHA KUMBH

THE PURIFYING DIP

Maha Kumbh, the largest religious congregation of the world, is above all,
a salute to ancient India's unparalleled excellence in astronomy

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DESIGN HEAD

P K Singh

WEBSITE INCHARGE

T V Praveen

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ADMINISTRATIVE OFFICE SCIENCE INDIA

Vijnana Bharati Headquarters
A-4, Block A, Gulmohar Park,
New Delhi- 110049 Phone: 011-41040846

OFFICE: Manager & Advt: Vipin Rawat

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Cover Image: Shutterstock / Prabhat Kumar Verma



ISRO @isro - 2d
PSLV-C60/SpaDeX Mission Update:

Integration Milestone! SpaDeX satellites have been successfully integrated with PSLV-C60 at SDSC SHAR. A step closer to liftoff! Stay tuned for more updates.

#ISRO #SpaDeX

Narendra Modi @narendramodi

In the coming days, Prayagraj will draw pilgrims and tourists from all over, for the Maha Kumbh. This iconic gathering is of great importance in our culture.

In Prayagraj today, various works were inaugurated which will boost infrastructure and preparedness for the Kumbh.

ISRO @isro

ISRO-ESA Agreement for Advancing Human Spaceflight

ISRO and ESA have signed an agreement to collaborate on astronaut training, mission implementation, and research experiments, including cooperation for the upcoming Axiom-4 mission. This partnership advances India's human spaceflight capabilities and global collaboration.

Learn more: isro.gov.in/ISRO_ESA_Agree...

#ISRO #ESA #HumanSpaceflight #SpaceExploration

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As part of development trials, Light Tank Zorawar was tested with support of Indian Army at High Altitude & has achieved consistently accurate results in multiple fires. Airlifting Capability of Tank was also demonstrated by @IAFMCC for quick deployment in remote locations

All About Belgaum | Bela... @allaboutbelgaum

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Ten tripartite industry agreements on the collaborative technologies have been signed between @DRDO_India, @IITDelhi and Industry Partners.

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Corrigendum

Due to an inadvertent printing error, the story 'Women in Science in India: What Are They Asking For?' in the December 2024 edition of the magazine missed out on the first page of the article. The error is deeply regretted. The full story can be accessed at scienceindiamag.in.

WRITE FOR SCIENCE INDIA

Do you love science? And do you also love writing about it? If your answer to both the questions is 'yes', *Science India* would like to invite you to write for the magazine.

There are a few points we would like you to take care of before embarking on this journey.

Whether you are an established writer or not, please don't send us unsolicited articles as we get tonnes of mail and it becomes difficult to respond to all. If you have a particular topic in mind on which you would like to write, send us a brief with the subject line: Brief for a Proposed Story.

The brief should describe what you want to write on, in about

100-150 words. It is your proposed story in a capsule, in a manner that should get us excited. We will respond only if your proposal is approved, and then share detailed guidelines.

At the same time, we would also like to remind our prospective writers that the bottom line of *Science India* is Indian science, Indian scientists and Indianness.

We are a general readership magazine on S&T and we don't publish scientific research papers. Do look up the previous issues of the magazine on our website to get an idea of the kind of stories we carry. It will help you plan your proposal better.

Best of luck. Mail us at editor@scienceindia.in



Send your letters to editor@scienceindia.in

DISCLAIMER : The views, thoughts, opinions and content expressed in the articles in this magazine are solely that of the authors; and not necessarily of *Science India* or Vijnana Bharati.

Let's Connect

Dear Readers,

As we enter the Gregorian New Year, we in India are already preparing to witness and participate in one of the biggest religious congregations on the earth, which is unique as it is based purely on scientific principles. That's the Maha Kumbh Mela 2025, to be held in Prayagraj from 13 January to 26 February.

Kumbh Mela, held every four years at one of the four sacred sites, is everything grand and ancient at the same time, attesting to the religious and cultural antiquity of this land called Bharat or India. While Hindu devotees as well as students of human civilisation from all over the world flock to the fair site to witness this unique congregation every four years, we focus on what makes it distinctive. In our cover story this edition, we look at the astronomical underpinnings of this festival, which celebrates the specific movements of Surya (the Sun), Brihaspati (Jupiter), and at times Chandra (the Moon), in the zodiac. Ancient Indian texts give detailed explanations of the movements of these celestial bodies, on which our cover story throws ample light. A purifying dip in the sacred rivers of the Kumbh Mela sites — it's the confluence of Ganga, Yamuna and the mythical Saraswati at Prayagraj this time — is the most important ritual connecting the temporal aspects of Hinduism with the divine.

Equally interesting is the ancillary story to our cover story in this edition. It looks at how the most modern technology — AI or artificial intelligence — can help administration conduct this massive ancient congregation seamlessly and successfully. The numbers involved, after all, are humungous: according to publicly available figures, at the last Kumbh Mela in Prayagraj in 2019, more than 200 million people attended the festival throughout its duration with a record 50 million on its most crowded day (the previous Kumbh Mela in Haridwar in 2021 was affected due to the COVID-19 pandemic).

Another successful, scientific congregation, much smaller to Kumbh Mela but highly significant, that we are reporting on in this edition is the India International Science Festival (IISF) that was held in Guwahati from 30 November to 3 December 2024. It was seminal as it was the 10th edition of the festival, which has grown in strength in disseminating Indian scientific knowledge and achievements to the public across the length and breadth of the country. A photo feature presents glimpses of the festival to showcase its vibrancy and spirit, of which the participation of students is the most heartwarming part.

Of special note is the exclusive interview of *Science India* with Dr Subba Rao Pavuluri, Chairman and Managing Director of Hyderabad-based Ananth Technologies Pvt. Ltd. (ATL), the company which has become the first private entity to build and operate a geostationary communications satellite in the highly cutting-edge and competitive space sector. Read on to find out the significance of this development.

Among other stories, an interesting pick is on the common hair care routine involving shampoo, which many are not aware that it has roots in ancient India. Even though the biggest market players in the industry are from the West, it was India that gave the world the concept, routine and primary ingredients of shampoo. The etymology of the word reveals its origin: shampoo is derived from Sanskrit 'champoo'; we are all very familiar with 'champi', which refers to a relaxing head massage.

While we continue to explore the connections between ancient Indian science and modern living, our regular column, 'Science & Spirituality', in this edition looks at the links between the Indian philosophy of Vedanta and modern science, where a sustained dialogue is long overdue. As our esteemed readers enjoy the season with engrossing stories in this edition, we wish them a Happy Gregorian New Year, and prepare for the big religious and cultural festivities of the Hindu New Year in the month of Chaitra, just a few weeks from now.

The Kumbh Mela celebrates the specific movements of Surya (the Sun), Brihaspati (Jupiter), and at times, Chandra (the Moon), in the zodiac



Dr Jitendra Singh, Union Minister of State for Science & Technology; Dr Himanta Biswa Sarma, Chief Minister of Assam; Dr N Kalaiselvi, Director General CSIR; Keshab Mahanta, Assam S&T minister, and other dignitaries lighting the lamp to inaugurate IISF 2024

10th IISF at Guwahati Puts Spotlight on Culture of Science

The Guwahati Declaration, adopted at the event, committed to transforming the nation into a science and technology-driven global manufacturing hub by 2047

With a dynamic mix of thematic events, youth engagement, thought-provoking discussions, a captivating expo and an array of scintillating cultural evenings, the 10th edition of India International Science Festival (IISF) 2024 was inaugurated at the Indian Institute of Technology, Guwahati, on 30 November 2024.

Addressing the inauguration of the four-day festival (30 November-3 December) that showcased the nation's advancements in science, technology, and innovation, with a strong emphasis on achieving self-reliance and global leadership by 2047, Union Minister of State (Independent Charge) for Science & Technology, Dr Jitendra Singh said India's path to becoming a developed nation is deeply intertwined with its commitment to scientific advancement and innovation.

Recalling Prime Minister Narendra Modi's vision of a 'Viksit Bharat' through



■ Sonam Singh Subhedar

transformative power of science, he underscored the importance of fostering a culture where science drives progress, shaping a future where technology and research contribute to every facet of society, from healthcare to infrastructure.

Singh highlighted six key decisions made by the Modi government in its third term like establishment of the Rs 1 lakh crore National Research Foundation, a Rs 1,000 crore Venture Fund for space startups, launch of Mission Mausam to enhance weather forecasting, Bio-E3 initiative designed to leverage biotechnology for environmental, economic, and employment growth, and the introduction

of the 'One Nation, One Subscription' policy to provide universal access to academic journals to over 2 crore students.

Emphasising on the significance of hosting the IISF in the Northeast, Singh recalled how, prior to 2014, much of the Northeast lacked basic infrastructure, but today boasts expanded railways, waterways, and road networks. "The Northeast is no longer on the periphery but is central to India's growth story," the minister said.

Underscoring the significance of IISF 2024 in celebrating India's scientific spirit, Chief Minister of Assam, Dr Himanta Biswa Sarma, in his inaugural address, said, "This festival epitomises our collective efforts in fostering innovation and collaboration. Through events like the Science Safari and Young Scientists' Conclave, IISF inspires young minds and showcases India's achievements, including Chandrayaan-2. It is a reflection of our journey toward becoming a global

leader in innovation.”

A unique feature of IISF 2024 was its collaborative ‘Whole of Science’ approach, which united all science ministries and policymakers under one roof. This model extended to a ‘Whole of Government’ strategy, with the central government and Assam administration working in harmony to ensure the festival’s success.

The Guwahati Declaration, adopted at the event, committed India’s scientific community to transforming the nation into a global manufacturing hub by 2047.

Dr N Kalaiselvi, Director-General of CSIR, said, “The Guwahati Declaration reflects our dedication to nurturing innovation, fostering sustainability, and driving India’s journey towards self-reliance. IISF 2024 has been instrumental in strengthening the bond between science and society, inspiring young minds, and promoting collaborative research.”

The Indian Space Research Organisation (ISRO) chief Dr S Somanath captivated school students during the ‘Student Science Interactive Program – Face to Face with New Frontiers in S&T’, by engaging directly with young learners.

“As students, you are the torchbearers of the future in science and technology. It is essential for you to grasp the remarkable innovations and advancements taking place in these fields today. By recognising their potential and the opportunities they present, you can draw inspiration to pursue similar paths and contribute to building a brighter tomorrow,” he told students.

THEMATIC EVENTS

IISF 2024’s theme revolved around leveraging innovation and technology to address critical challenges and foster economic growth. The festival featured 26 events, each aligned with India’s broader vision for science-driven development.

The ‘Science Beyond Borders’ initiative promoted global partnerships by bringing together researchers, scientists, and institutions from around the world. Through panel discussions and collaborative workshops, the event addressed pressing global challenges in areas such as climate change, sustainable develop-



Prof Abhay Karandikar (third from left), Secretary DST, with other dignitaries at the Mega Science Expo at IISF 2024, Guwahati

ment, and healthcare.

Dedicated to nuclear science, ‘The Fusion Forum – The Atomic Assembly’ explored the role of atomic energy in sectors like power generation, healthcare, and agriculture, and it highlighted the challenges of integrating nuclear technologies in India’s sustainable development agenda.

Aimed at raising awareness about meteorology, oceanography, and ecological preservation, ‘Sagarika – The Tale of Earth Sciences’ featured interactive exhibits and educational sessions to inspire environmental stewardship.

The ‘Science Odyssey of the North East’ addressed the unique challenges faced by the Northeast region in scientific development. The policymakers and academicians explored strategies to strengthen research infrastructure and foster innovation in the region.

One of IISF’s standout features was its focus on youth engagement through the ‘Young Scientists’ Conclave and Tinker Labs’, which encouraged students to delve into hands-on experimentation and innovative problem-solving.

Emphasising the contribution of women in the field of S&T, the Nari Shakti initiative highlighted the achievements of women scientists and entrepreneurs.

The S&T Communicators and Media Conclave event showcased the role and prowess of media in creating awareness

and disseminating scientific information to masses through sessions like ‘Role of Cinema’, ‘Bridging the gap between scientific community and media’, and ‘Media Ethics and Science Journalism’.

During the valedictory session, Assam’s Minister for Science and Technology, Keshab Mahanta concluded, “IISF 2024 has been a remarkable celebration of India’s scientific achievements. Assam is honoured to host this event, reaffirming our commitment to advancing science and technology in the region.”

The cuisines of the Northeast along with dance and musical performances left an indelible impression on the visitors and participants. The ‘Saga of Science Chronicles’ — an LED light show narrated the history and milestones of Indian science. A breathtaking open-air art installation on the Moon by British artist Luke Jerram, titled The Museum of the Moon, featured a detailed replica of the moon’s surface.

The IISF 2024 organised jointly by CSIR, Departments of Science & Technology, Space, Biotechnology, Atomic Energy, Ministry of Earth Sciences, Vijnana Bharati and IIT Guwahati, drew over 45,000 participants, including scientists, policymakers, students, and innovators from across the country, making it a dynamic confluence of ideas, inspiration and collaboration.

**The writer is Associate Editor, Science India.*

Images Courtesy: Vijnana Bharati

Snapshots

IISF 2024 at Guwahati

The tenth edition of the India International Science Festival 2024 (30 November - 3 December) concluded successfully at IIT Guwahati. The four-day festival saw enthusiastic participation by people from all age groups, especially young science enthusiasts, and by people from all walks of life. With a packed melange of workshops, demonstrations, lectures, discussions, deliberations, Moon museum in the open and more, peppered with a medley of cultural performances, the festival became an affair to remember. This edition of the IISF, held at the sprawling IIT campus, was the first in northeast India. The photographs from the festival provide a delightful walkthrough for readers to absorb its grandeur.



Dr Shiv Kumar Sharma, National Organising Secretary of Vijnana Bharati, highlighted India's legacy in science and technology at the inauguration of IISF 2024



All Images Courtesy: Vijnana Bharati

Keshab Mahanta, Assam S&T minister (centre), Sunil Ambekar, Akhil Bharatiya Prachar Pramukh, RSS (fourth from right), and Dr N Kalaiselvi, DG CSIR (fifth from left) at the valedictory session of IISF 2024



Dignitaries addressing various sessions of IISF 2024, clockwise from top left: Dr Jitendra Singh, Union Minister of State for Science & Technology (I/C); Dr Himanta Biswa Sarma, Chief Minister of Assam; Dr N Kalaiselvi, Director General CSIR; Dr S Somanath, Chairman ISRO; Prof Ajay Sood, Principal Scientific Adviser to the Government of India; Praveen Ramadas, National Joint Organising Secretary, Vijnana Bharati; and Dr Shiv Kumar Sharma, National Organising Secretary of Vijnana Bharati

PHOTO FEATURE



Dr Rajesh Gokhale, Secretary DBT and Dr M Ravichandran, Secretary MoES, lighting the lamp to inaugurate the Mega Science Expo, in the company of Dr Jitendra Singh, Union Minister of State for Science & Technology; Prof Abhay Karandikar, Secretary DST; and Prof Ajay Sood, Principal Scientific Adviser to the Government of India



Above: Stalls of North East Centre for Technology Application and Reach, and Indian Space Research Organisation at the Mega Science Expo

Right: Students experiencing various telescopes at the Mega Science Expo





Clockwise from top: A session on cinema in progress at the S&T Media Conclave; a session at the Young Scientists Conclave; a student at the Mega Science Expo; a dance performance during IISF 2024



KUMBH MELA A LIVING CLASSROOM FOR POSITIONAL ASTRONOMY

Celestial perspective on India's grand congregation that is a testament to the fusion of astronomy and culture

Image Courtesy: Wikimedia Commons





■ Amritanshu Vajpayee and
Dr K Venkataraman

A

s the calendar flips to January 2025, the world turns its gaze to a phenomenon unparalleled in scale and spirit — the Kumbh Mela. In this cosmic convergence of faith and humanity, an astounding 40 to 45 million pilgrims from across the globe will gather at the sacred confluence of the Ganga and Yamuna in Prayagraj in Uttar Pradesh, from 13 January to 26 February, united by a shared ritual: the purifying dip that bridges the earthly and the divine. It is a periodic festival (mela) that pulsates with the rhythm of the cosmos, where the convergence of celestial bodies dictates the gathering of millions. This is not science fiction, but the very essence of the Kumbh Mela — Hinduism's grand pilgrimage.

From time immemorial, humanity has sought meaning in the vast, starry expanse above. The motions of celestial bodies have guided agriculture, marked seasons, and given rise to some of the most intricate cultural practices. Among these is the Kumbh Mela, a festival so vast and profound that it is recognised not just as a spiritual gathering but as a monumental event reflecting ancient Indian astronomical knowledge.

This intersection of celestial phenomena and human devotion is a hallmark of the Kumbh Mela, offering a unique lens through which to explore the interplay between ancient Indian astronomy and cultural practices. The journey into this celestial tradition reveals a rich tapestry of



Image Courtesy: Old Indian Photos

A picture from the year 1954 capturing devotees attending the Kumbh Mela in Prayagraj (then Allahabad)

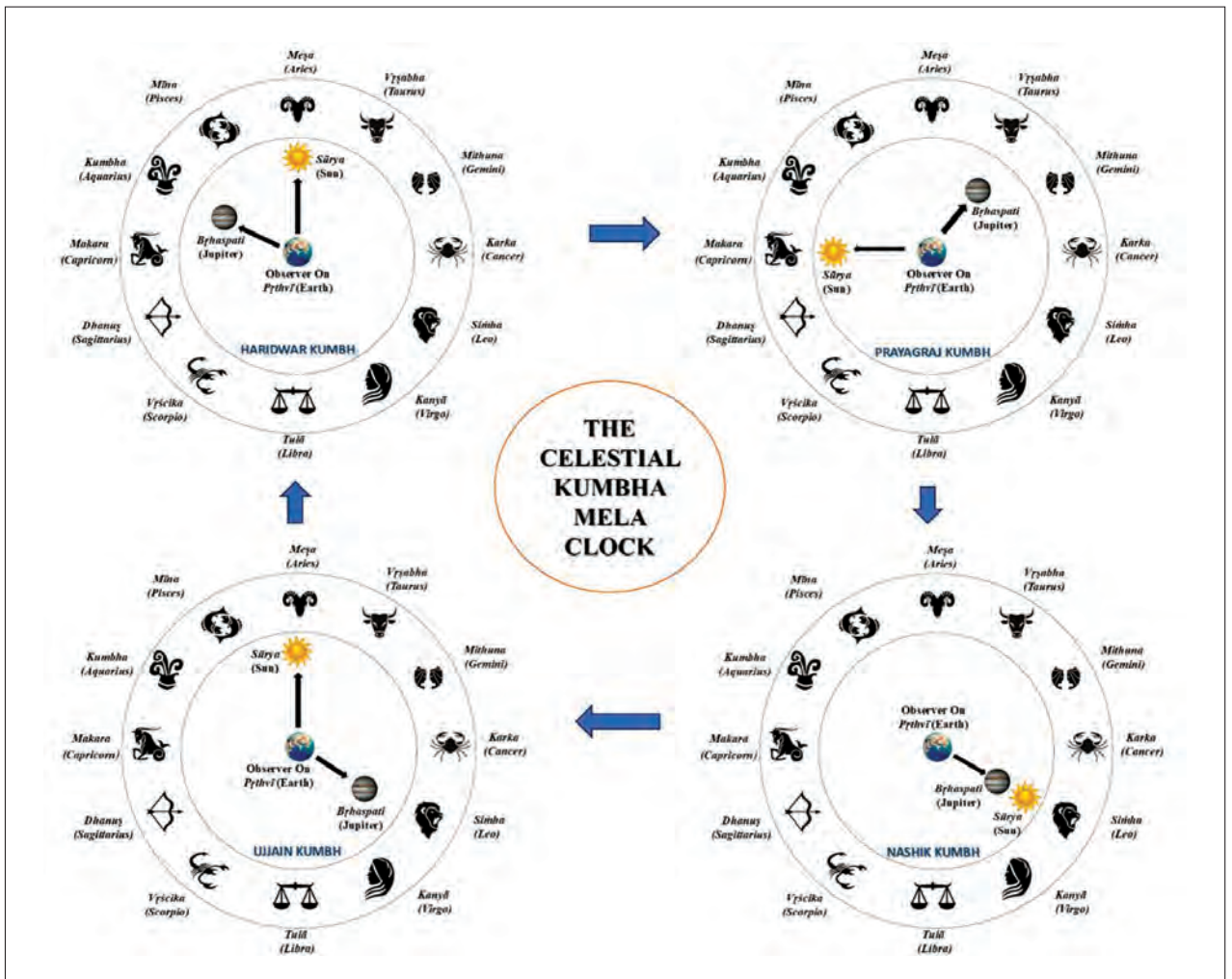


Image Courtesy: The Authors

science, history, and spirituality, inviting us to decode the astronomical foundations that underpin one of humanity's most awe-inspiring events.

Let us dive deeper into the celestial mechanics and cultural significance that make the Kumbh Mela a living testament to the ancient Indian synthesis of science and spirituality.

गंगाद्वारे प्रयागे च धारागोदावरीतटे।
कुम्भाख्येस्तु योगोऽयं प्रोच्यते शंकरादिभिः ॥

[Gangadvare Prayage ca Dharago-davaritite]

Kumbhakhyeyastu yogoyam procyate Sankaradibhih ॥

The shloka translates to: At Haridwar (Gangadvare), Prayag, Ujjain (Dhara), and Nashik (on the banks of the Godavari), this sacred confluence (Kumbh Mela) is proclaimed as a holy event by Sankara and other sages.

ANCIENT ASTRONOMICAL KNOWLEDGE

As the above verse suggests, the Kumbh Mela is not simply held at random intervals. Its intricate schedule hinges on a meticulous interplay between the Sun, the Moon, and the planet Jupiter, all observed within the framework of the Hindu lunisolar calendar, known as the Panchangam. This calendar intricately tracks the cycles of celestial bodies and their positions relative to the Rashi (zodiac) and Nakshatra (lunar mansions). Held in a rotating cycle across four sacred locations in India — Prayagraj, Haridwar, Ujjain, and Nashik — the Kumbh Mela transcends mere religious significance. It whispers a fascinating tale of ancient astronomical knowledge embedded within its practice. While millions of devotees gather to seek spiri-

tual solace, the festival is also a testament to the fusion of astronomy and culture. To fully appreciate the significance of this festival, one must delve into its cosmic underpinnings and the meticulous astronomical principles guiding its occurrence.

The word 'Kumbh' means 'pitcher' or 'pot', symbolising the mythical pot of nectar that emerged during the churning of the ocean in Hindu mythology. The mythological origins of the Kumbh Mela stem from the story of the Samudra Manthan, the churning of the cosmic ocean by Devas (Gods) and Asuras (demons). Both sought the *amrita*, the nectar of immortality, contained in a sacred pitcher (Kumbha). After the nectar was obtained, a fierce battle ensued as both sides tried to claim it. During this struggle, drops of *amrita* fell at four

locations on the earth: Haridwar, Prayagraj, Nashik, and Ujjain. These places were thus sanctified, becoming the sites for the Kumbh Mela.

While the myth forms the narrative foundation of the festival, its occurrence at specific times and places is guided by celestial alignments — a testimony to the remarkable astronomical expertise of ancient Indian scholars. In alternative words, while the story is steeped in mythology, the astronomical alignment adds another layer of meaning. The specific positions of the Sun, the Moon and Jupiter might have been chosen due to their perceived auspiciousness and influence on earthly events, aligning with the harvest cycles and river flows.

The timing and location of the Kumbh Mela are dictated by the positions of the Sun, Jupiter, and, in some cases, the Moon, within the zodiac

Indian astronomical treatises like the *Surya Siddhanta* and the *Vedanga Jyotisa* provide detailed observations of planetary motions. These texts form the basis for the preliminary understanding about the celestial alignments that govern the Kumbh Mela. Also, the scriptures like *Atharvaveda* and *Skandapurana* provide references about the celestial combinations leading to the Kumbh festivities.

The timing and location of the Kumbh Mela are dictated by the positions of the Sun, Jupiter, and, in some cases, the Moon, within the zodiac. These celestial bodies traverse a fixed path in the sky known as the zodiacal belt, divided into 12 Rashi or constellations in Indian astronomy, viz, Mesha

(Aries), Vrishabha (Taurus), Mithuna (Gemini), Karkata (Cancer), Simha (Leo), Kanya (Virgo), Tula (Libra), Vrishchika (Scorpio), Dhanus (Sagittarius), Makara (Capricorn), Kumbha (Aquarius) and Mina (Pisces). These constellations serve as the backdrop for the apparent motion of the Sun and planets.

The Kumbh Mela is determined by the relative positions of Surya (the Sun), Brihaspati (Jupiter) and at times, Chandra (the Moon) in the zodiac. The

Indian system of astronomy identifies twelve Rashi (zodiac signs) through which these celestial bodies move along the ecliptic, the apparent path of the Sun.

Jupiter's Orbit: Brihaspati (Jupiter), the largest planet in the solar system, takes approximately 11.86 years to complete one revolution around the Sun. This periodicity governs the timings of the Kumbh Mela. The Jovian cycle of ~12



A sadhu holds a trishul as he stands in the waters of river Ganga to offer prayers at the Kumbh Mela in Prayagraj, Uttar Pradesh, in 2019

Image Courtesy: Shutterstock/Arun Sambhu Mishra

years commences with the entry of the Jupiter to Kumbha *rashi*. A *samvatsara* is the duration Brihaspati (Jupiter) requires to move from one sign of the *rashi* (zodiac) to the next, based on its mean motion. This period is called as Brihaspatya Varsa meaning Jovian Year.

Solar and Lunar Calendars: The Indian calendar, based on both solar and lunar movements, ensures that the timing aligns with specific *nakshatra* (constellations) and *tithi* (lunar days).

The Panchangam: The Hindu almanac or Panchangam, which combines the solar year, lunar phases, and planetary transits, plays a critical role in calculating the precise dates and locations of the Kumbh Mela.

The interplay of these celestial factors results in a cycle where the Kumbh Mela is held at four locations over approximately 12 years.

पूर्णः कुम्भोऽधि काल अहितस्तं वै पश्यामो बहुधा नु सन्तः।

स इमा विश्वा भुवनानि प्रत्यङ्कालं तमाहुः परमे व्योमन् ॥
(अथर्ववेद १६।५३।३)

[*Purna kumbho adhi kala abhitastam vai pasyamo bahudha nu santah*]

Sa ima visva bhuvanani pratyankalam tamahuh paramavyoman च्छ (Atharvaveda 19.53.3)]

The *shloka* translates to: ‘O saints! The full Kumbh comes after twelve years, which we often see in the four pilgrimage places of Haridwar, Prayag, Ujjain and Nasik. Kumbh is called that special period, which occurs due to the conjunction of planets and zodiac signs in the great sky.’ (Atharvaveda 19.53.3)

The Kumbh Mela is classified into two categories: the Purna Kumbh (full Kumbh), occurring every 12 years, and the Ardh Kumbh (half Kumbh), held every six years. The specific location and timing of each Mela depend on a unique astronomical configuration. Let us delve deeper into this celestial dance across the four sites of the Kumbh Mela one-by-one.

KUMBHA SITE ONE: HARIDWAR

The Kumbh Mela at Haridwar occurs



Image Courtesy: Flickr

A file photo of Hindu seers at Kumbh Mela 2019 in Prayagraj, Uttar Pradesh

when Jupiter is in Kumbha (Aquarius), and the Sun enters Mesha (Aries) during the Hindu month of Chaitra (March-April). The river Ganga at Haridwar represents the sacred nectar that descended from the heavens.

पद्मिनी नायके मेघे कुम्भराशिगते गुरौः ।

गंगाद्वारे भवेद्योगः कुम्भनामा तदोत्सः ॥ (स्कंदपुराण)
[*Padmini nayake meshe kumbharashigate gurauh*]

Gangadvare bhavedyogah kumbhanama tadottamah च्छ (Skandapurana)]

The *shloka* translates to: ‘When Jupiter is situated in Aquarius and the Sun is in Aries, at that time Kumbha Yoga takes place in Gangadwar (Haridwar).’ (Skandapurana)

There is one more *shloka* that talks about the importance of Kumbha at Haridwar while clearly giving celestial alignments.

कुम्भराशिस्थिते बृहस्पतौ, मेघे सूर्ये च संस्थिते।

गंगाद्वारे भवेत् मेल, पुण्यस्नाने विमुक्तये ॥

[*Kumbha-rashi-sthite Brhaspatau, Meshe Surye cha Samsthithe*]

Gangadvare Bhavet Mela, Punyanane Vimuktaye ॥]

The *shloka* translates to: ‘When Jupiter resides in Aquarius and the Sun enters Aries, the Mela at Haridwar begins, offering liberation through sacred bathing.’

This *shloka* can also be interpreted as: Aquarius, symbolised by the water-bearer, represents the celestial pouring of *amrita*, reflecting the significance of Haridwar as the entry point of the sacred Ganga.

There is yet another *shloka* that gives the astronomical positioning of Kumbha at the site of Haridwar in some alternate terminology:

वसन्ते विषुवे चैव घटे देवपुरोहिते।

गंगाद्वारे च कुम्भाख्यः सुशामेति नरो यतः ॥

[*Vasante visuve chaiva ghate devapurohite*]

Gangadvare cha kumbhakhyah sudhameti nara yatah ॥]

The *shloka* translates to: ‘In Vasanta (spring), at the time of the Visuva (equinox), in the ghata (vessel) dedicated to the devapurohita (deity’s priest), and at Gangadvare (Haridwar), the Kumbha (pot) is considered as *sudha* (nectar), as it leads man to liberation.’

KUMBHA SITE TWO: PRAYAGRAJ

At Prayagraj, the Kumbh Mela is held when Jupiter is in Vrishabha (Taurus), and the Sun enters Makara (Capricorn) during Magha (January-February). This location, the confluence of the Ganga, Yamuna and mythical Sarasvati rivers, embodies the unity of celestial and terrestrial elements.

मेष राशिं गते जीवे मकरे चन्द्रभास्करो।
अमावस्या तदा योगः कुंभाख्यस्तीर्थनायके ॥

[*Mesha rashim gate jive makare chandrabhaskarau*]

Amavasya tada yogah kumbhahakyas tirthanayake चण्

The *shloka* translates to: ‘When Jupiter is situated in Aries and the Moon and the Sun are in Capricorn, then Kumbha Yoga takes place in the holy place Prayagraj.’

There is one more celestial alignment which can lead to the Kumbh at Prayagraj, viz,

वृषभे स्थिते बृहस्पतौ, मकरराशिगते रवौ।
प्रयागे संगमे पुण्यं, तीर्थराजे च स्नानकृते ॥

[*Vrishabhe Sthite Brihaspatau, Makararashigate Ravau*]

Prayage Sangame Punyam, Tirtharaje ca Snanakrite ॥]

The *shloka* translates to: ‘When Jupiter is in Taurus and the Sun in Capricorn, the sacred confluence at Prayagraj becomes the site of auspicious bathing.’

KUMBHA SITE THREE: NASHIK

The Nashik Kumbh Mela takes place when both the Sun and Jupiter align in Simha (Leo) during Bhadrapada (August-September). The Godavari River, known as Dakshina Ganga, reflects the celestial energy of this alignment.

सिंह राशिं गते सूर्ये सिंह राशौ बृहस्पतौ ।
गोदावर्या भवेत्कुम्भो भक्तिमुक्ति प्रदायकः ॥

[*Simha rashim gate surye simha rashau brihaspatau*]

Godavaryam bhavet kumbho bhakti-mukti prayakab ॥]

The *shloka* translates to: ‘When the Sun and Jupiter both dwell in Leo, the banks of Godavari at Nashik become the site of Kumbha which provides devotion and liberation.’

KUMBHA SITE FOUR: UJJAIN

In Ujjain, the Kumbh Mela coincides with Jupiter’s position in Simha (Leo) and the Sun’s entry into Mesha (Aries) during Vaishakha (April-May). The Shipra River, sanctified by its association with Lord Shiva, mirrors the dynamic renewal of the cosmos.

मेषराशिं गते सूर्ये सिंह राशौ बृहस्पतौ ।
उज्जयिन्यां भवेत् कुम्भः सदामुक्तिप्रदायकः ॥

[*Mesharashim gate surye simha rashau brihaspatau*]

Ujjayinyam bhavet kumbhah sadamukti prayakab ॥]

The *shloka* translates to: ‘When Jupiter resides in Leo and the Sun in Aries, the sacred city of Ujjain becomes the site of the Kumbha, always granting liberation.’

The Hindu Panchangam, a complex lunisolar calendar, plays a crucial role in determining the dates of the Kumbh Mela. This calendar is based on the movements of the Sun, the Moon and other celestial bodies, and it incorporates a unique system of timekeeping that divides the year into various cycles and periods. As a brief summary along with Sun, it is the Jupiter’s transit through the zodiac that creates the framework for the Mela’s occurrence. For Haridwar, Jupiter is in Kumbha (Aquarius), for Prayagraj it is in Vrishabha (Taurus). For Nashik it is in Simha (Leo) and for Ujjain, the Jupiter is in Simha (Leo). This makes it a



Kumbh Mela on ghats of the river Godavari in Nashik in 2014

cycle of Purna Kumbha in the order of the cities of Haridwar -> Prayagraj -> Nashik -> Ujjain. The Purna Kumbh happens every 12 years, while the Ardhha Kumbh is celebrated halfway, every six years, at Haridwar and Prayagraj. There is one more special occasion — the Maha Kumbh which occurs only at Prayagraj once every 144 years, marking the completion of 12 Purna Kumbhas. The last Maha Kumbh was held in 2013,

and the next will occur in 2157.

These periodic gatherings reflect the synodic cycles of Jupiter and the Sun, encapsulating the precision of Indian astronomical traditions. While the Kumbh Mela is traditionally held every 12 years, variations occasionally occur due to the slight discrepancy between Jupiter’s orbital period and the Earth’s calendar. Jupiter’s orbit around the Sun is 11.86 years, not a perfect 12. This discrep-

Image Courtesy: Wikimedia Commons

Thousands of Hindu devotees at the confluence of Ganga, Yamuna and the mythical Saraswati rivers for a holy dip during the Kumbh Mela of 2013 in Prayagraj



Image Courtesy: Shutterstock/Vladimir Melnik

ancy accumulates over multiple cycles, requiring adjustments to the festival's schedule. For example, in some cases, the Kumbh Mela may occur after 11 or 13 years instead of the standard 12 years. This adjustment reflects the ancient astronomers' keen awareness of orbital mechanics and their ability to integrate these nuances into the festival's timing.

While the Kumbh Mela is deeply rooted in Hindu traditions, it is fascinating to explore potential scientific explanations for the celestial alignments that mark its celebration. It offers an opportunity to explore multiple aspects simultaneously. By illustrating the motions of celestial bodies and their periodicity, the Kumbh Mela serves as a living classroom for positional astronomy. It also underscores how ancient observations of planetary movements continue to influence societal practices. The festival also bridges the gap between ritualistic traditions and scientific inquiry. The alignment of Jupiter with specific constellations, combined with the Sun's concurrent position, determines the festival's timing. This celestial chore-

In the grand cosmic dance, Kumbh Mela is a reminder that we are all, in essence, stardust, bound to the infinite sky above

ography is a marvel of ancient Indian astronomy, highlighting its scientific sophistication.

Additionally, the Kumbh Mela often takes place during the periods nearer to winter solstice or spring equinox or summer solstice or autumnal equinox, which are significant astronomical events in themselves round the year. The solstices and equinoxes have been observed and celebrated by cultures worldwide for millennia by different belief systems and faiths.

The Kumbh Mela, aptly inscribed on

the Representative List of the Intangible Cultural Heritage of Humanity by the UNESCO, is a remarkable testament to the ancient Indian understanding of the cosmos. Its astronomical basis connects the heavens to the Earth, blending myth, science, and culture in an unparalleled celebration of life and renewal.

As the next Kumbh Mela, to be held from 13 January to 26 February 2025, at Prayagraj, approaches nearer, it beckons not only pilgrims seeking spiritual salvation but also students, researchers and enthusiasts of astronomy. Witnessing the festival is an invitation to explore the interplay of celestial rhythms and cultural traditions — a journey that reaffirms humanity's enduring connection to the stars.

The Kumbh Mela, with its rich tapestry of astronomical, mythological, and spiritual significance, continues to captivate millions of devotees. By understanding the science behind the spectacle, we can appreciate the wisdom and foresight of our ancestors. As we eagerly await the next Kumbh Mela, let us embrace the celestial dance and immerse ourselves in the timeless traditions that have shaped our cultural heritage. In the grand cosmic dance, the Kumbh Mela serves as a reminder that we are all, in essence, stardust, bound to the infinite sky above.

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**Amritanshu Vajpayee, an amateur astronomer, science communicator and writer active in STEAM education, is Principal Investigator, Astro STREAM Project, Saptarshi India (under Global Sky Partners Programme of Las Cumbres Observatory) and a national coordinator, Saptarshi India Asteroid Search Campaign. Dr K Venkataraman, a former curator, NCSM, is presently, faculty of Physics in PMB Gujarati Science College, Indore, who has special interests in Indian Knowledge Systems and Materials.*

COVER STORY

Tech Intervention at Maha Kumbh

As Prayagraj prepares to host the world's largest religious congregation during the Maha Kumbh Mela, here's a look at how AI will enhance the experience through better management and audience outreach





■ Dr Udaya Shankar Puranik

Prime Minister Narendra Modi has emphasised on Artificial Intelligence made in India, made for the world. Our country can show the world how this technology can be effectively used in the 40-day Maha Kumbh Mela which is expected to draw millions of devotees from across the globe. This event will commence on 13 January 2025 and will conclude on 26 February 2025. Successful use of AI in



Image Courtesy: Wikimedia Commons

Kumbh Mela will help in using this technology in other large religious events in India and abroad.

AI can be utilised in the Kumbh Mela of 2025 in a variety of ways to enhance the experience, improve safety, streamline logistics, and ensure better management of the large-scale event. Here are some potential applications:

1. CROWD MANAGEMENT AND SAFETY

Predictive Analytics for Crowd Flow: AI can analyse real-time data from surveillance cameras, sensors, and social media to predict crowd movement and congestion. By understanding patterns, AI can help authorities direct crowds to less crowded areas, preventing stampedes or accidents.

Drones and Surveillance: AI-powered drones can monitor vast areas, capturing live footage, and detecting potential risks or threats (like overcrowding or unusual behaviour). Drones equipped with AI can also assist in locating missing persons in the crowd.

Facial Recognition for Security: AI-driven facial recognition technology can help authorities identify individuals in the crowd, ensuring security and tracking the presence of potential security threats or lost persons.

2. TRAFFIC AND TRANSPORT MANAGEMENT

AI-Driven Traffic Control: AI can optimise traffic flow around Kumbh Mela areas, adjusting traffic signals in real-time, and directing vehicles through the most efficient routes based on real-time traffic data.

Public Transport Optimisation: AI can manage bus and train schedules, predicting peak travel times and ensuring optimal deployment of resources. It could also help in creating dynamic routes for shuttle services, responding to demand in real time.

3. RESOURCE AND WASTE MANAGEMENT

Optimising Waste Collection: AI-powered systems could optimise waste collection routes, monitor waste levels in bins, and

schedule pick-ups accordingly to maintain cleanliness and prevent overflows in the event area.

Water Quality Monitoring: AI can monitor the quality of water at the bathing sites, alerting authorities to any contamination or unsafe conditions. Machine learning models can predict water flow and assess the impact of weather changes.

4. VISITOR EXPERIENCE AND ASSISTANCE

Personalised Assistance via Chatbots and Virtual Assistants: AI-powered chatbots and virtual assistants can provide pilgrims with real-time information on things like prayer timings, location of various amenities, or answers to frequently asked questions. These assistants could be available via mobile apps or kiosks at the venue.

Multilingual Support: AI-driven translation tools can help break language barriers, offering real-time translation services to pilgrims from different parts of the world.

5. HEALTH AND MEDICAL ASSISTANCE

AI-Powered Health Monitoring: Wearable devices integrated with AI can monitor the health of attendees (such as body temperature, heart rate, etc.). In case of health emergencies, AI systems can trigger alerts to medical staff for quick response.

AI in Telemedicine: Remote medical consultations can be facilitated through AI-powered telemedicine solutions, enabling pilgrims to access health advice, prescriptions, or consultations on-site, without the need for long wait times.

Predicting Health Risks: AI algorithms can analyse health data and predict potential outbreaks of diseases or health risks based on patterns observed during the event, allowing for timely interventions.

6. AI IN PLANNING AND LOGISTICS

Event Planning and Optimisation: AI can help plan the logistics of the event by analysing historical data, predicting the required number of facilities (toilets,

food stalls, etc.), and optimising their placement across the site to minimise congestion.

Supply Chain Optimisation: AI can manage the supply chain for food, water, and other essential goods, forecasting demand and ensuring that resources are distributed efficiently across the event area.

7. CULTURAL AND RELIGIOUS INSIGHTS

AI for Understanding Pilgrim Sentiment: By analysing social media posts and online interactions, AI can gauge the sentiment of pilgrims regarding their experience, helping authorities address issues or enhance the overall atmosphere.

AI in Managing Rituals: AI can assist in optimising the timing and location of various rituals and events to ensure smooth execution, considering factors like crowd size and available space.

8. SUSTAINABILITY INITIATIVES

Energy Management: AI can help optimise energy usage at the event, ensuring that the lighting, power for stalls, and other electrical needs are met efficiently without wastage.

Solar-Powered AI Systems: With sustainability in mind, AI systems could be powered by renewable sources like solar energy, ensuring that AI solutions in Kumbh Mela are not just efficient but also environmentally responsible.

9. AI FOR PILGRIM SAFETY

Real-Time Location Tracking: AI-based apps could track the location of pilgrims and send notifications or guidance if they are lost, helping them reconnect with their groups or find their way to key areas.

Emergency Response Coordination: AI can coordinate emergency responses by analysing data from multiple sources, determining the best route for ambulances, and efficiently dispatching medical teams during emergencies.

10. DATA ANALYTICS FOR FUTURE EVENTS

Post-Event Analysis: After the event, AI tools can analyse large amounts of data collected during the festival (crowd movement, health data, feedback) to generate insights that can help plan future Kumbh Melas more efficiently.

Predictive Models for Future Events: AI can help predict the size and scale of future Kumbh Melas based on historical data, allowing for better infrastructure planning, resource allocation, and safety measures.

GOOGLE-UTTAR PRADESH GOVERNMENT TIE-UP

Yogi Adityanath-led Uttar Pradesh government and Google have signed an MoU, which will enable Google to showcase the entire tent city of Kumbh Mela online, and offer numerous ben-

efits that will enhance the experience for pilgrims, authorities, and organisers. Here's how this initiative could help:

1. Virtual Accessibility and Remote Exploration

Remote Access to Tent City: Pilgrims and visitors can virtually explore the entire Kumbh Mela tent city from anywhere in the world. This will be especially useful for those who are unable to attend the event in person but wish to view the preparations, layout, and key locations.

Interactive Maps and Navigation: Google could integrate detailed, interactive maps that display the location of tents, important sites (like bathing *ghats*, temples, medical centres, etc.), and other critical infrastructure. This will help pilgrims navigate the massive event site more easily, reducing confusion and saving time.

2. Enhanced Safety and Crowd Management

Crowd Density Monitoring: With the integration of Google's mapping and data analytics tools, authorities can monitor crowd density in real-time. This can help them predict where large crowds are forming and take proactive steps to avoid congestion and ensure smoother movement. By sharing this information online, attendees can also receive alerts about crowded areas, helping them avoid those locations.

Emergency Response: During emergencies, it will be easier for authorities to direct people to safer areas using online mapping tools. If any incidents occur, AI-powered analytics can provide quick insights into the crowd's location, ensuring a faster and more efficient response.

3. Improved Pilgrim Experience

Detailed Information on Facilities: With the entire tent city mapped online, pilgrims will be able to find detailed information about various facilities such as food stalls, washrooms, rest areas, healthcare facilities, and more. This will be particularly beneficial for first-time visitors, senior citizens, and those with special needs.

Digital platforms of the Uttar Pradesh government are designed to make the Kumbh Mela experience a seamless one



AI can help manage large crowds during the Kumbh Mela

Personalised Journey: Google's online platform could offer personalised routes based on the user's current location and the services they need (e.g., directing a visitor to the nearest medical centre or restroom), ensuring a more comfortable and hassle-free experience.

4. Real-Time Updates

Live Streaming of Events: Google can facilitate live streaming of important rituals, events, and ceremonies happening at the Kumbh Mela. Pilgrims who are unable to be at the event physically can still participate in the experience virtually by watching these significant moments in real time.

Weather and Traffic Updates: Google's platform can offer live weather updates and traffic information around the Kumbh Mela area. Pilgrims can use this information to make better decisions about when and where to go, avoiding harsh weather conditions or traffic bottlenecks.

5. Data-Driven Insights for Future Planning

Analytics for Event Management: By digitising the tent city, the government and organisers can gather valuable data on crowd movement, the usage of facilities, and other patterns. This data can be analysed to improve the organisation of future Kumbh Melas, helping ensure even better management and smoother operations in subsequent years.

Resource Allocation: Google's tools can provide insights into where resources are most needed, enabling more efficient distribution of essentials such as food, water, and sanitation services. The government can allocate resources based on real-time needs, improving the event's logistics.

6. Boosting Tourism and Economic Impact

Virtual Tourism: Showcasing of the tent city online opens up opportunities for virtual tourism. People who visit the virtual site might be inspired to plan a physical visit in the future, boosting both national and international tourism to India. This could contribute significantly to the local economy.

Promotion of Local Businesses: Google's online platform can also promote local businesses around the Kumbh Mela area, such as handicrafts, food vendors, and accommodation services. Pilgrims can learn about and support these businesses even before arriving, contributing to the local economy.

7. Sustainability and Resource Efficiency

Reduced Physical Footprint: By allowing remote access and virtual tours, the need for large amounts of printed materials (brochures, maps, etc.) is minimised, contributing to sustainability. The use of digital platforms reduces waste and helps in better resource management,

aligning with eco-friendly initiatives for the event.

Uttar Pradesh government's official website and mobile app for Kumbh Mela are key digital platforms serving multiple purposes, including providing real-time information, Online ticketing and registration, facilitating smooth navigation, ensuring safety, emergency services, lost and found services, QR code scanning for safety and optimising logistics during the event.

AI-enabled Intensive Care Units (ICUs) are being set up as well. The core of this facility is AI-enabled Messaging Flow System, which facilitates seamless doctor-patient communication by interpreting 22 regional and 19 international languages. This technology eliminates language barriers, ensuring accurate diagnosis and treatment. Advanced AI microphones and cameras will be deployed in a 10-bed ICU at the Maha Kumbh Central Hospital. These cameras will continuously monitor patient conditions, providing real-time updates and sending instant alerts to specialists during emergencies. There will be a 100-bed Central Hospital, supported by ten additional hospitals and specialist doctors, to ensure comprehensive healthcare services for devotees and saints.

**The writer has 37 years global experience in IT and is presently Director, AI, Theta Dynamics, Bengaluru.*

SCIENCE & SPIRITUALITY

Vedanta and Modern Science: Exploring Eternal Reality

**Time is overdue for a meaningful dialogue between Vedanta and
Modern Science, both of which delve into the causation of universe**





■ Vivekananda Pai

We were waiting at the tarmac of the helipad at Kedarnath on a September morning, hoping to catch the first sortie back to Uttar Kashi. The weather was not favourable. Looking back towards the temple, we could see the dull white blankness of the clouds. Suddenly the weather cleared. Lo and behold! The Himalayas were shining in all their glory, their beautiful white snow cover bathed in the morning sun. A few minutes later, in a dramatic reversal, yet again, inclement weather returned. The majestic Himalayas hid behind the clouds. All that could be seen was the blankness of the clouds.

On another occasion, I had the opportunity to go scuba diving in Lakshadweep. The colours of the marine world were far beyond any painting seen so far. Who designed the logic of this creation? What is the algorithm and who is the coder? And what is the purpose of this creation?

Throughout their existence, humans have tried to answer this question in multiple ways, through logic, philosophy, religion, spirituality, etc.

Vedanta answered this question long back. And Modern Science is evolving its view gradually. Is there any convergence emerging between these two?

LAWS OF PHYSICS

The French Mathematician Henri Poincare in his book, *Science and Method*, says: “The scientist does not study nature because it is useful to do so. He studies it because he takes pleasure in it, and he takes pleasure in it because it is beautiful. If nature were not beautiful it would not be worth knowing, and life would not be worth living. I am not speaking, of course, of the beauty which strikes the senses, of the beauty



Image Courtesy: Wikimedia Commons

Who designed the logic of the majestic and mighty Himalayas, seen in the picture above as the spellbinding background of the Kedarnath Temple?

of qualities and appearances. I am far from despising this, but it has nothing to do with science. What I mean is that more intimate beauty which comes from the harmonious order of its parts, and which a pure intelligence can grasp.”

In the 17th century, Isaac Newton came up with the Three Laws of Motion and the Law of Universal Gravitation. This explained the working of the world around us and how things moved. However, Newtonian mechanics considered time and length (consequently ‘space’), to be absolute, regardless of the inertial frame of reference.

In 1915, Einstein proposed the General Theory of Relativity. This suggests that mass distorts and bends space-time causing it to curve, and gravity is essentially the result of motion in this space-time. At velocities nearing the speed of

light, relativity applies instead of Newtonian Physics because of space-time curvature.

In Newtonian Physics, theoretically we can travel as fast as we want as long as we have the requisite force. However, as per the General Theory of Relativity, nothing can travel faster than the speed of light. And this theory transformed the way we understood the universe.

In 1925, a 23-year-old Werner Heisenberg, spending his time on an island, Helgoland, literally meaning Sacred Island, envisioned the mathematical structure of Quantum Mechanics, Quantum Theory. Quantum Theory revolutionised various domains of Science and Technology, from the foundations of Chemistry, the functioning of atoms, solids, plasmas and dynamics of the stars to the origins of the galaxies

Image Courtesy: Shutterstock

and technologically from computers to nuclear power. It powers many scientific and technological advances of today. Yet, it remains profoundly mysterious.

Neils Bohr had already come out with formulas that predicted properties of chemical elements before even measuring them, like the frequency of light emitted when heated and the colour they assume. However, he also assumed that electrons in atoms orbited around the nucleus only in certain precise orbits, at certain precise distances from the nucleus and with certain precise energies and magically leaping from one orbit to another.

Using observable quantities of frequency and amplitude of emitted light



In 1926, Austrian physicist Erwin Schrodinger comes out with a set of equations that electron wave must satisfy in an atom

and replacing physical variables (numbers) with tables of numbers that have orbits of departure in their rows and orbits of arrival in their columns, Heisenberg describes the leap from one orbit to another. On 7th June 1925, things started falling into place. Heisenberg says, “At first, I was deeply alarmed. I had the feeling that I had gone beyond the surface of things and was beginning to see a strangely beautiful interior, and felt dizzy at the thought that now I had to investigate this wealth of mathematical structures that Nature had so generously spread out before me.”

Einstein says, “The ideas of Heisenberg and Born have everyone in suspense, and are preoccupying anyone with the slightest interest in theory.”

With Wolfgang Pauli’s calculation, Heisenberg’s matrices computed the very values of energy predicted by Bohr and also the intensity of the emitted light. But this was all about quantities that are observable. Heisenberg’s article on his theory starts with the phrase: “The objective of this work is to lay the foundations for a theory of quantum mechanics based exclusively on relations between quantities that are in principle observable.”

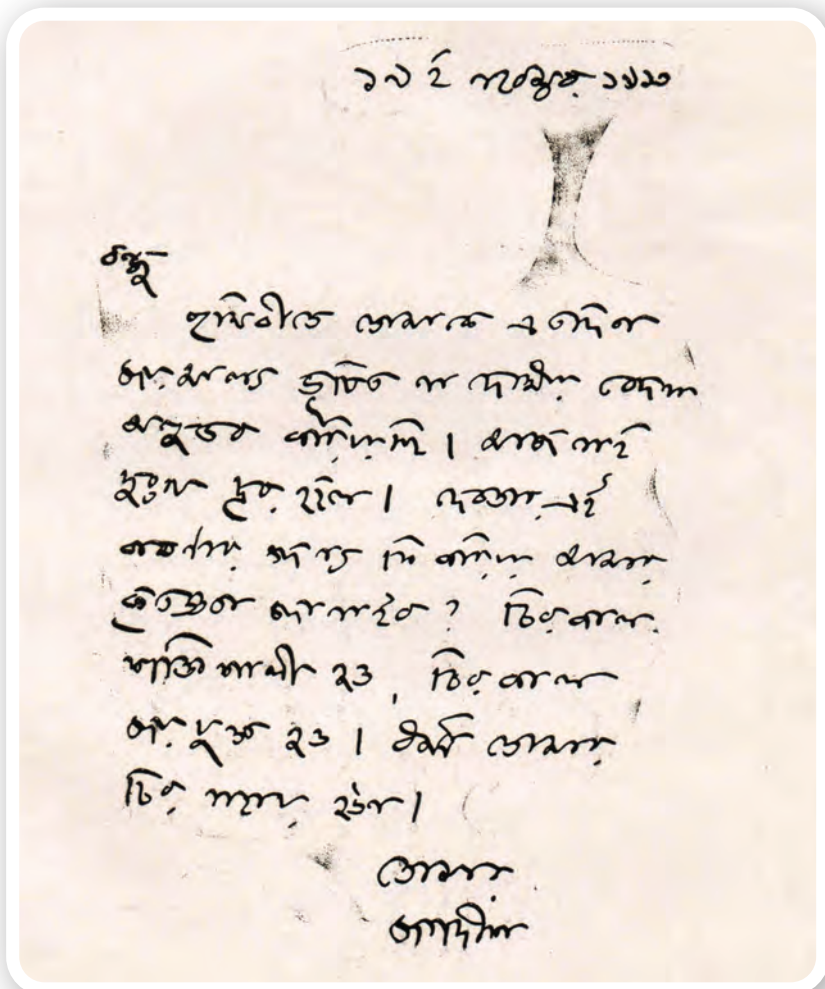
The question arises, what do electrons do, when not observed.

In 1926, Austrian physicist Erwin Schrodinger comes out with a set of equations that electron wave must satisfy in an atom. He suggests that Bohr’s trajectories are the approximations of the behaviour of an underlying wave. He names this the Greek letter ‘psi’. It is also called the Wave Function.

However, since an electron, when revealed by a detector, is at one point and not spread out as wave, it becomes gradually clearer that ‘wave mechanics’ is no clearer than ‘matrix mechanics.’

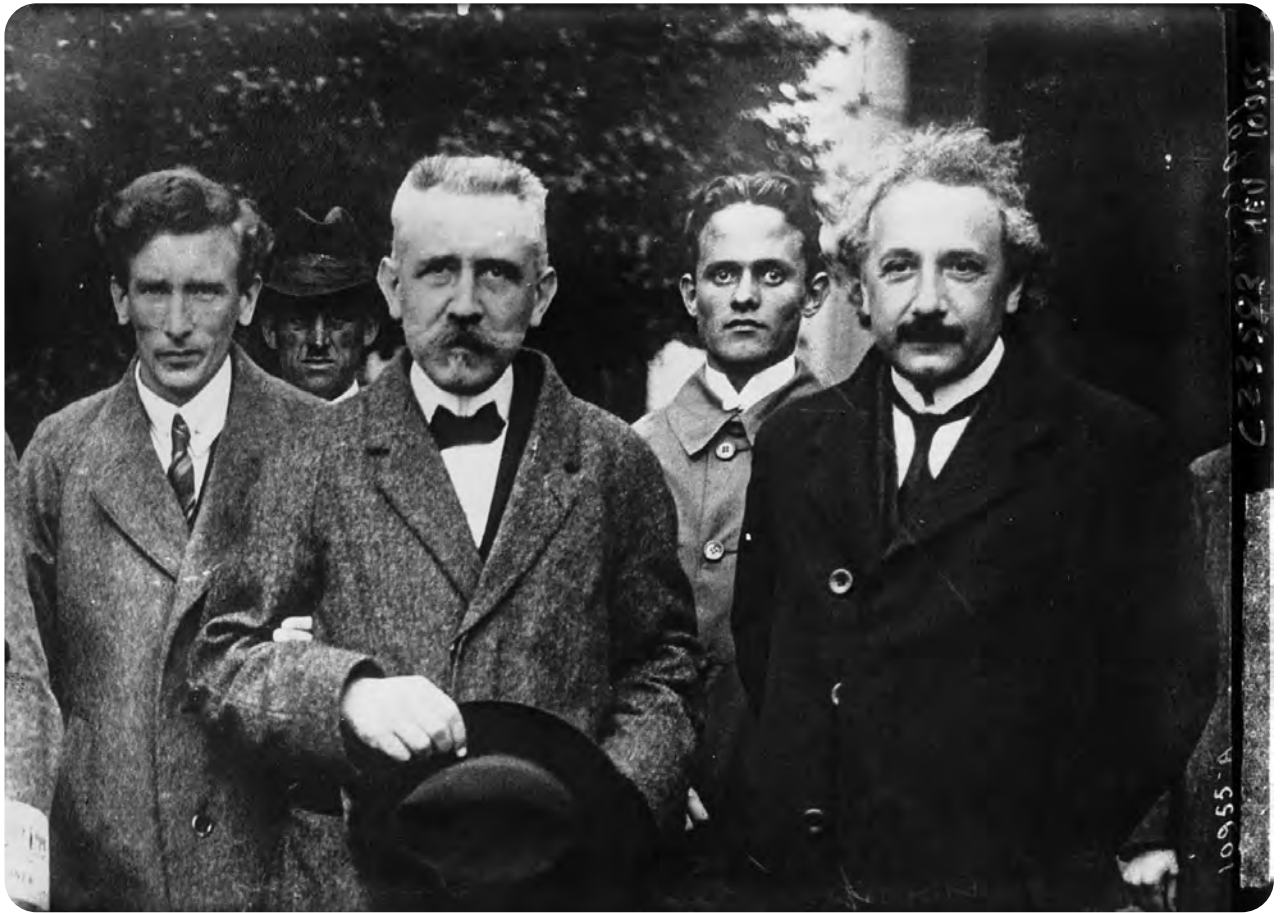
Max Born recognizes that Schrodinger’s hypothesis actually describes the probability of observing an electron at the point. It turns out that Heisenberg’s version also predicts probability and not certainty.

It was in this context that Einstein famously asked, ‘Does God play Dice?’.



A letter by Acharya Jagadish Chandra Bose to Nobel laureate Rabindra Nath Tagore about a lecture he delivered at the Royal Institution in London in 1901, in which he spoke about the unity that pervades both the living and the non-living

Image Courtesy: Internet



French mathematician Henri Poincaré (left) with physicist Albert Einstein. In his book, *Science and Method*, Poincaré writes: “The scientist does not study nature because it is useful to do so. He studies it because he takes pleasure in it...”

PERCEIVED REALITY

In his captivating book on Quantum Physics, *Helgoland*, Carlo Rovelli says, “Einstein relished figurative language and had a predilection for using ‘God’ in his metaphors, despite his declared atheism. But in this case his phrase can be taken literally: he loved Spinoza, for whom ‘God’ was synonymous with ‘Nature’. Hence: ‘Does God play dice?’ means literally: ‘Are the laws of nature really not deterministic? ‘As we shall see, a hundred years after Heisenberg and Schrodinger’s bickering, this question is still open.”

Describing the context of where Schrodinger comes from, Rovelli says, “Schrodinger, too, is a product of that lively early twentieth century Viennese philosophical and intellectual milieu: a friend of the philosopher Hans Reichenbach, he is fascinated by Asian thought,



Carlo Rovelli says in his book, *Helgoland*, “Einstein relished figurative language and had a predilection for using ‘God’ in his metaphors, despite his declared atheism”

in particular Vedanta Hinduism, and passionate (as Einstein was) about the philosophy of Schopenhauer, which interprets world as ‘representation.’”

Representation? Does it sound familiar?

After bathing in the Ganga, Shankaracharya and his disciples were walking towards the Kashi Viswanath temple for *darshan*. Seeing a Chandala coming across, one of his disciples shouted: ‘Move, move’. Chandala’s response astonished the great teacher. He asked, “Who should move, the body or that all pervading reality that is occupying it?”

Acharya replied in five verses, known as *Maneesha Panchakam*.

The first verse goes like this.

*Jagratsvapnasushuptisu sphutatara
ya samvidujjrbhate
ya brahmadipilikantatanusu pro-
ta jagatsakshini |*

*Saivaham na cha drishyavastviti
drdhaprajnapi yasyasti ce*

*ccandalo: stu sa tu dviyo: stu guru-
rityesa manisha mama || 1 ||*

If a person has attained the firm knowledge that he is not an object of perception, but is that pure consciousness which shines clearly in the states of waking, dream and deep sleep, and which, as the witness of the whole universe, dwells in all bodies from that of the Creator Brahma to that of the ant, then he is my Guru, irrespective of whether he is an outcaste or a Brahmana. This is my conviction.

So, Shankaracharya calls the world around us as *Drisyavastu*, an object of perception!

This is the crux of Vedanta too. That the world around us is the manifestation of an underlying unity that pervades everything. Just like the clouds that hid behind them the majestic Himalayas that are always there, mentioned at the beginning of this article, the clouds of ignorance mislead us from the understanding of this all-pervading unity. And the world around us that we experience is nothing but a manifestation of the underlying reality.

In his deeply researched biography of Acharya Jagadish Chandra Bose, *Unsung Genius*, Kunal Ghosh quotes a let-

We have watched the responsive pulses, wax and wane in the one as in the other. We have seen response sinking under fatigue, becoming exalted under stimulants and being 'killed' by poisons in the non-living as in the living.

Amongst such phenomena, how can we draw a line of demarcation, and say, here the physical process ends, and there the physiological begins? No such barriers exist.

Do not the two sets of records tell us some property of matter, common and persistent? Do they not show us that the responsive processes seen in life, have been foreshadowed in non-life? - that the physiological is, after all, but an expression of the physico-chemical, and that there is no abrupt break, but a uniform and continuous march of law?

...it was when I came upon the mute witness of these self-made records, and perceived in them one phase of a pervading unity that bears within it all things — the mote that quivers in ripples of light, the teeming life upon earth, and the radiant suns that shine above us. It was then that I understood for the first time a little of that message proclaimed by my ancestors on the banks of the Ganges thirty centuries ago —

'They who see but one, in all the changing manifoldness of the universe,



Shankaracharya calls the world around us as *Drisyavastu*, an object of perception. This is the crux of Vedanta too. That the world around us is the manifestation of an underlying unity that pervades everything

ter by Bose to Rabindra Nath Tagore about a lecture he delivered at Royal Institution in London on 10th May 1901. In the peroration of the lecture, he mentioned:

"I have shown to you this evening, autographic record of responses of the living and the non-living. How similar are the writings! So similar indeed that you cannot tell one from the other apart.

unto them belongs eternal truth-unto none else, unto none else!"

Now comes the question, who is the one who perceives.

The 7th verse of *Mandukya Upanishad* captures it so beautifully.

नान्तःप्रज्ञं न बहिःप्रज्ञं नोभयतःप्रज्ञं न प्रज्ञानघनं
न प्रज्ञं नाप्रज्ञम्

अदृश्यमव्यवहार्यमग्राह्यमलक्षणमचिन्त्यमव्यपदेश्यम

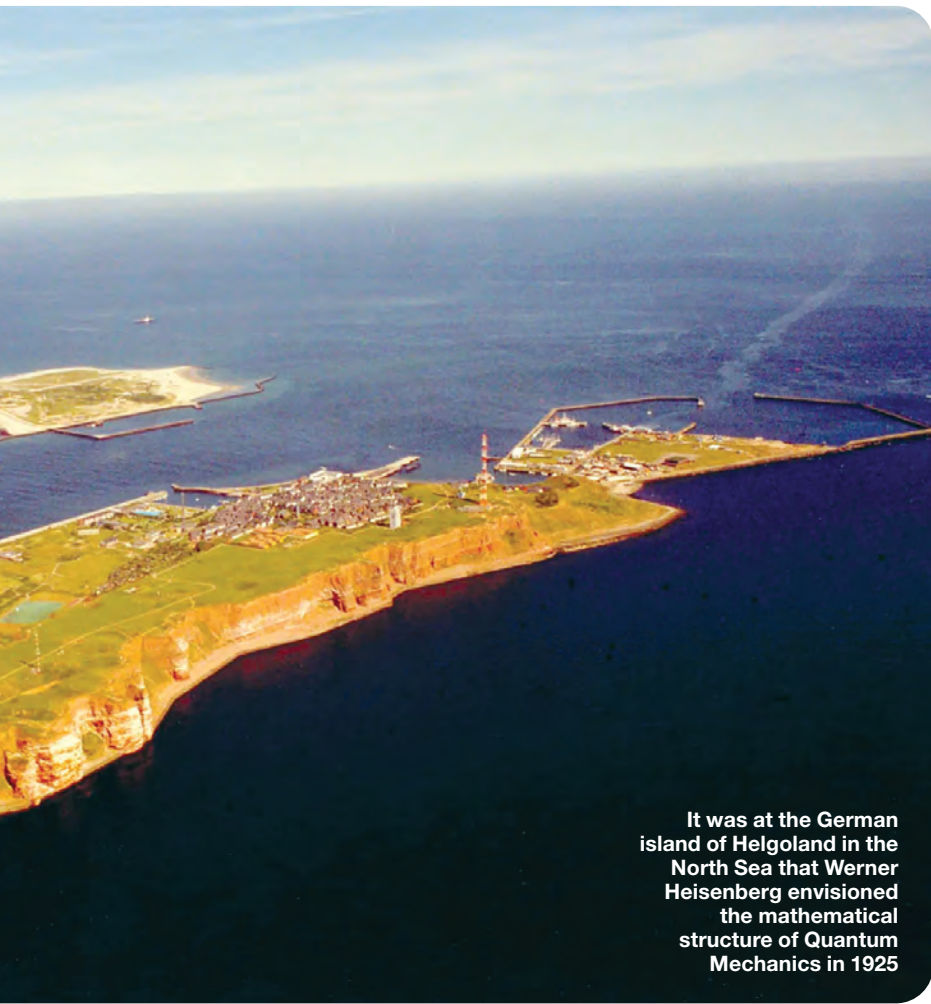
काल्मप्रत्ययसारंप्रपञ्चोपशमं शान्तं शिवमद्वैतं चतुर्थं



मन्यन्ते स आत्मा स विज्ञेयः || 7 ||

Nantaaprajnam na bahihprajnam nobhayatahprajnam na prajnanaghanam na prajnam naprajnam | adrshyamavyavaharyamagrahyamalaksanamacintyamavyapadesyamekatmapratyayasaram prapancopasamam santam sivamadvaitam caturtham manyante sa atma sa vijneyah || 7 ||

Turiya is not that which is conscious of the internal (subjective) world, nor that which is conscious of the external (objective) world, nor that which is conscious of both, nor that which is a mass all sentiency, nor that which is simple consciousness, nor that which is insentient. (It is) unseen (by any sense organ), not related to anything, incomprehensible (by the mind), uninferable, unthinkable, indescribable, essentially of the nature of Consciousness consti-



It was at the German island of Helgoland in the North Sea that Werner Heisenberg envisioned the mathematical structure of Quantum Mechanics in 1925

Image Courtesy: Internet

documentation after three decades of research, titled *Swami Vivekananda in the West*, Marie Louise Burke mentions the suggestion by Tesla for a meeting with Swamiji in his 45 East Houston Street laboratory.

A meeting was arranged. On 13th February 1896, Swamiji writes to Mr Sturdy: “Mr Tesla thinks he can demonstrate mathematically that force and matter are reducible to potential energy. I am going to see him next week, to get this new mathematical demonstration. In that case, Vedantic Cosmology will be placed on the surest of foundations. I am working a good deal now upon the cosmology and eschatology of Vedanta. I clearly see their perfect union with modern science.”

Burke goes on to say (in 1982), “It is only during the last ten years or so that the Big Bang theory — the theory of a universe rushing outward from an initial explosion — has been accepted by almost all scientists; and this is merely a small part of Vedantic Cosmology, a part taking place after (immediately after, perhaps) the evolution, or formation of ‘Prana’ and ‘Akasa’, Energy and Matter. That the physical universe will fall back in on itself, to expand again, and so on cyclically forever, is today a theory entertained by a number of reputable physicists, but is as yet (1982) unproved. Swamiji’s “Electrical Sphere”, on the other hand, where the “Prana is almost inseparable from Akasa,” was established by Einstein long ago; his term “mass-energy” embodies this interchangeability of matter and energy. But what this “mass-energy” is, no one at this writing seems to know. Yet it was this — the state beyond matter and energy, the state out of which matter and energy evolved — that Swamiji had hoped Nikola Tesla could mathematically demonstrate. He could not.”

The convergences are just far too many. A time is long due for a much deeper dialogue between Vedantic Philosophy and Modern Science to build on these foundations, so as to benefit both.

**The writer is an architect, and Secretary General, Vijnana Bharati.*

tuting the Self alone, negation of all phenomena, the Peaceful, all Bliss and the Non-dual. This is what is known as the fourth (Turiya). This is the Atman and it has to be realised.

(‘Consciousness’ as the nearest English word is used.)

Here, Turiya simply means, ‘the fourth’. After the three states of wakefulness, dream and deep sleep that every being goes through, almost on a regular interval, the state that is beyond the three, the fourth one is ‘Turiya’, where clouds of ignorance disappear and the all-pervading unity beyond is revealed.

Swami Vivekananda wanted to express this in a mathematical model. In 1896, while in America, he had multiple interactions with Nikola Tesla, the genius who gave us ‘alternating current’. In her painstaking six-volume



Marie Louise Burke says in 1982, “It is only during the last ten years or so that the Big Bang theory has been accepted by almost all scientists; and this is merely a small part of Vedantic Cosmology...”



Digital Highways for Last Mile Connectivity

With Hyderabad-based Ananth Technologies Pvt Limited becoming the first private entity to build and operate a geostationary communications satellite, India's high performing space sector gets an unprecedented boost

Hyderabad-based Ananth Technologies Pvt Limited (ATL) has become the first private company selected to build, launch and operate a geostationary communications satellite in the country.

India's space regulator, the Indian Space Promotion and Authorization Centre (IN-SPACe) made the announcement on 2 December 2024, granting ATL access to the country's orbital resources, marking a significant milestone in advancing private sector participation in the space sector.

ATL will undertake end-to-end management of the project, which includes the development, launch, and operation of a multi-beam high-throughput Ka-band communication satellite, the IN-SPACe stated.

ATL's responsibilities also include frequency coordination with satellite operators, managing filings with ITU, and ensuring compliance with due diligence and notification processes.

With over 2000 employees across Hyderabad, Bangalore and Thiruvananthapuram, ATL is a leading Aerospace and Defence manufacturer in India. Since its inception, the company has strived to indigenise cutting edge



■ Chaitanya Giri and Debobrat Ghose

aerospace technologies to support India's development and security. From mission computers to control systems, sensors to communication systems, Ananth Technologies Limited is the largest contributor of subsystems to the Indian space programme. ATL is performing the entire harnessing of ISRO's PSLV launch vehicles.

Incorporated in 1992 to support the growth of the Indian economy through leveraging aerospace technologies, ATL's twin offerings include the manufacture of critical aerospace systems and high-value geospatial services.

Core areas of expertise include systems design and development including Avionics, RF and Microwave communication systems, Telemetry systems, power modules, DC-DC converters, PCM encoders, and more. It supports clients from a wide range of domains in-

cluding Utilities, Telecom, Government and Aid Agencies, Energy and Logistics.

Ananth has expertise in GIS, photogrammetry, remote sensing, environmental studies, natural resources management, infrastructure development, topographical surveys, 3D modelling, LIDAR processing and software development.

In an exclusive interview to Science India, Dr Subba Rao Pavuluri, the chairman and managing director of Ananth Technologies Ltd, and President, Sat-Com Industry Association, discussed at length about his company, private industry participation in Indian space sector, startups, space economy and about Indian Space Research Organisation (ISRO).

Excerpts:

Q. Congratulations, Dr Pavuluri! Your company Ananth Technologies Pvt Ltd is all over the news for being the first private company selected to build, launch and operate a geostationary communications satellite in the country. Could you elaborate on this?

All communication satellites earlier were built and launched by ISRO. After reforms in the space sector, the Government of India has opened opportuni-



All Images Courtesy: Ananth Technologies

Above: The Hyderabad office of Ananth Technologies Private Limited

Right: Dr Pavuluri with ISRO chairman Dr S Somanath, at an Ananth facility

ties for private investments in the space sector (as in other sectors). India needs many more transponders (through satellites in space) for communications, particularly for last mile connectivity.

IN-SPACE, the regulator for space, has given us the opportunity to be a satellite operator. We are the first ones to be given such an opportunity. The communication satellite will be built in India, launched from India and will be used for India — an initiative by private company 'Ananth' in post-space reforms. Such initiatives will continue by ATL.

Q. You have raised perhaps India's first horizontally integrated and exclusive space-defence company. How has your journey been from 1991? How has the Indian manufacturing landscape changed over these years?



I strongly believe that the space and defence sectors will drive technology for the national good. Initiatives such as Make in India / Atmanirbhar Bharat induced confidence and opened up opportunities for Indian industry, both in innovation and manufacturing. Hence, we witnessed a complete transformation of the Indian industry landscape, raising immense opportunities in the space and defence sectors.

Q. This latest development, according to Ananth Technologies, will help build digital highways for providing last mile connectivity. Could you please elaborate on what this 'last mile connectivity' means, especially in the light of internet usage patterns in India — more than 50% internet users in India are from rural areas. How will this 'last mile connectivity' help an individual from rural India in improving his life,



Dr Pavuluri and his wife Anantha Lakshmi at the inauguration of an event at Ananth Technologies Pvt Ltd, along with Dr M Sankaran (centre), director of UR Rao Satellite Centre (URSC), and Dr S Somanath (right), chairman, ISRO

beyond providing digital services such as entertainment, online shopping and transferring funds?

India is a vast country with geography including mountains, valleys and forests. Many remote areas do not have digital connectivity. Last mile connectivity is for the last man standing, or *Antyodaya* (which refers to the welfare of the people at the bottom of the pyramid). There is a wide 'digital gulf' between urban and rural areas. This can be bridged with digital communications satellites, the best answer to bring in tele-education and telemedicine, which will transform remote rural areas.

Q. As private participation in the country's space sector is an evolving field, do you think there needs to be some kind of a regulatory code for

The wide 'digital gulf' between urban and rural areas of India can be bridged with digital communications satellites

private players, considering that they are entering a highly sensitive area in terms of national security? What are the possible challenges inherent in this evolving scenario?

Like any other sector, the space sector also needs a regulator. The Government

of India has created such a regulator that is called IN-SPACe, which acts both as a promoter and a regulator. This is a nodal agency that promotes the participation of the private sector in space activities in India.

Q. Space is a challenging sector. Not many commercial entities in India have the appetite to deliver successfully. Meanwhile, Ananth Technologies has successfully contributed to the space sector, be it remote sensing, communication satellites, or even missions like Aditya, Chandrayaan, and now Gaganyaan. What would you suggest new-age entrepreneurs do that you don't see them doing?

Ananth Technologies has been working for the last 30 years in all segments of space programme, viz., launch vehicle,



Above: Dr Subba Rao Pavuluri with his wife Anantha Lakshmi

Right: Dr Pavuluri at an ISRO event

satellite and satellite applications for national development, among others. So far, it has contributed to about 80 launch vehicles, about 100 satellites and satellite applications all over the country related to land, water, environment, infrastructure, etc. New age entrepreneurs, together with established players, need to work more on innovation and ideas in all segments, and plan and execute space activities to make India a 'Vishwa Guru'.

Q. What is the 'real' state of India's space economy? Do you believe in the 2% often quoted by Western consulting firms (2% being India's share of the global space economy)? If the numbers are not reliable, where do we exactly start to measure the volume of our space economy?

The Indian space programme has been working for the development in many ways. I do not believe that only 2% is India's share of the world space economy. Perhaps, they must have used only products like satellites and launch vehicle



Our entrepreneurs have great ideas but to transform these ideas into commercial output, they rely heavily on foreign funding agencies

cost but must not have considered satellite applications, which have both tangible and intangible benefits. By creating a National Natural Resources System (NNRMS), ISRO has done a wonderful job for development in all areas, such as disaster management, forest management, drought proofing, sustainable development, ground water exploration, tele-education, telemedicine, agricultural output estimation, and many more at the national and regional levels. Perhaps, such a wonderful contribution was not taken into account. In fact, many of these are first of its kind in the world.

Q. You have been the progenitor of the Satcom Industry Association, you are a strong voice at the World Hindu Economic Forum, and a staunchly Swadeshi space entrepreneur. What do you think of the current financial status of Indian startups? In your opinion, is it safe for them to overly rely on foreign finance and export markets before both are cultivated here in India?

I strongly believe in 'Bharatiyata' (Indianness) in every aspect, that Bharat was Vishwa Guru and once again Bharat will be a Vishwa Guru. When we look from this point of view, our entrepreneurs have great ideas. But to transform these ideas into commercial output, they rely heavily on foreign funding agencies since we lack funding systems of our own. If such a situation continues, unfortunately, such startups in the long run will be owned by foreign funding companies. Realising this, the Government of India announced in the recent budget an allocation of Rs 1000 crores to support startups. I am sure this funding will go up as success stories are established. Bhartiya companies also can export both goods and services. India shall become a manufacturing hub for the world and can provide world class services.

Q. Will the expansion of private participation in the Indian space industry prove to be a game changer in the job

scene of the country, like software engineering did a few decades ago? What are the challenges in this scenario?

The expansion of private participation in the Indian space industry will create innumerable goods and services. India is a very vast country. Bharat itself needs many satellites, both for communication and for geo-spatial services. Therefore, requirements for employment would be not only in making satellites and launch vehicles but also in geospatial services. In these areas, we need engineers with various backgrounds such as electronics, electrical, mechanical, chemical, software and scientists with other faculties such as physics, chemistry, geology, geomorphology, land use, urban studies, soil science, forestry, civil engineering, sociology, statistics and mathematics,



Above: Dr Pavuluri at Ananth Technologies Pvt Ltd; Left: Dr Pavuluri speaking at an Ananth event in the company of Dr S Somanath, chairman, ISRO, and Dr M Sankaran, director URSC, among other dignitaries

AI, ML, etc. Thus, there will be job opportunities, both for basic engineering and sciences.

Q. How do you see ISRO evolving during Amrit Kaal? Is it going to pick up a new role?

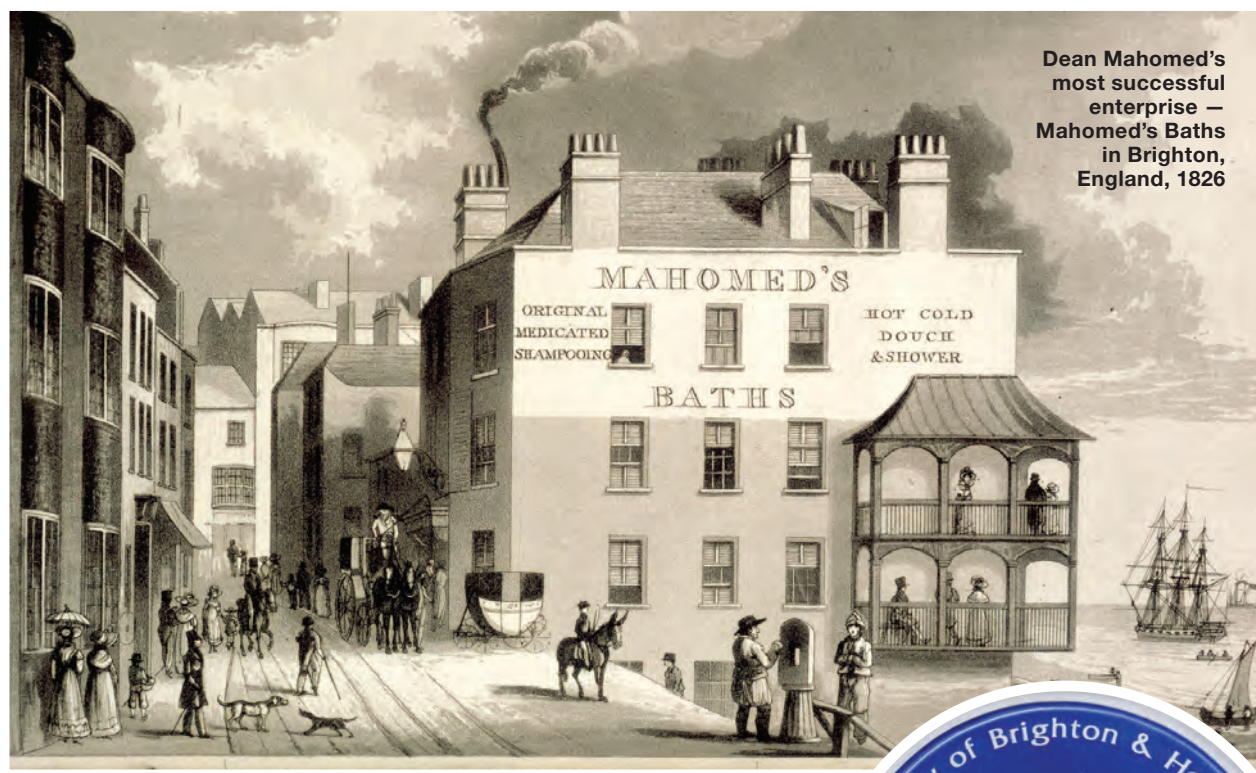
ISRO will bring laurels to Bharat during Amrit Kaal. Please recall ISRO landing on Moon (Chandrayaan-3 programme), which caught the attention and appreciation of all Indians, instilling faith in

every Indian that India also can do. In the same way, ISRO will continue its planetary missions, astronauts landing on the moon, building Bhartiya Anthariksha Kendra, etc. Thus, ISRO will bring laurels to the country and immense confidence towards Bhartiya science and technology, taking Bharat towards becoming the Vishwa Guru again.

Q. What is your vision for Ananth Technologies Pvt Limited and the Indian space ecosystem?

Ananth Technologies is committed to support the ever growing, changing and maturing Indian aerospace market with technological solutions. Ananth have supported both the Indian governmental agencies (Department of Space) and private enterprises with indigenously designed and developed products. It will continue to focus on design and development of launch vehicles, satellites and building constellation of satellites for spatial solutions for Bharat's use, and for global use, and will build satellites for communications for last mile connectivity. It will continue to focus on creating a manufacturing hub in India for aerospace systems and platforms.

**Chaitanya Giri is a Space and Emerging Technology Fellow at Centre for Security, Strategy and Technology, Observer Research Foundation, Mumbai and Debobrat Ghose is Editor, Science India, New Delhi.*



Dean Mahomed's most successful enterprise — Mahomed's Baths in Brighton, England, 1826

Indian Beginnings of the Shampoo

How the advent of colonialism spread ancient India's elaborate hair care ritual throughout the world

The history of shampoo's origin and evolution is a fascinating narrative that intertwines ancient traditions, advancements in scientific knowledge, and modern innovations. Shampoo has deep roots in India, tracing back thousands of years and reflecting the country's strong connection to natural remedies and hygiene practices.

In the Indian subcontinent, various herbs and their extracts have long served as hair cleansers. The earliest forms of shampoo can be traced back to the Indus Valley Civilisation. An effective ancient shampoo was created by boiling soap-



■ Dr Punit Kumar and Dr Sanjeev Kumar Varshney

berries (Sapindus) with dried Indian gooseberry (Amla) and other herbs, then straining the mixture. Soapberries, known as *ksuna* in ancient texts, are tropical trees found throughout India. The fruit pulp contains saponins, which

act as natural surfactants, producing a lather referred to as *phenaka* in Indian literature.

This extract not only cleanses but also leaves hair soft, shiny, and manageable. Other traditional cleansing agents included *shikakai* (*Acacia concinna*), hibiscus flowers, *ritha* (*Sapindus mukorossi*), and *arappu* (*Albizia amara*). A general principle from Ayurveda relevant to hair care states:

“केशा न सुतरां स्निग्धाः स्वस्थे पुष्टेऽन्नमेव चा”
(Healthy hair is a reflection of good nourishment and overall health).

Notably, Guru Nanak, the founder of Sikhism, referenced the soapberry



tree and soap in the 16th century.

SANSKRIT ORIGIN OF SHAMPOO

Shampoo, a fundamental part of modern personal care routines, has an intriguing history that dates back to ancient India, where hair care was closely linked to cultural and medicinal practices. The term 'shampoo' entered the English language during the colonial era, first appearing in 1762. It originates from the Hindi word *chanpo* (चाँपो), which derives from the Sanskrit root *chapit* (चपित्), meaning 'to press, knead, or soothe'. This etymology highlights the significance of hair care in Indian culture and showcases the advanced understanding of natural remedies present in ancient Indian society. To grasp the evolution of shampoo, it's essential to delve into its Indian roots, where traditional practices laid the groundwork for contemporary hair care.

In ancient India, hair care was a holistic practice woven into daily life and health rituals. Ayurvedic texts, some of the oldest sources of wellness knowledge, provide extensive insights into hair care. Ayurveda, the traditional Indian system of medicine, advocated for a

balanced approach to health, integrating diet, lifestyle, and natural remedies. Hair care was an integral part of these broader health practices, focusing on maintaining overall well-being through gentle and effective natural ingredients.

INDIAN HAIR CARE ESSENTIALS

One prominent ingredient in traditional Indian hair care was *reetha*, or soapberry. *Reetha* contains saponins, natural compounds that create a mild lather when mixed with water. This gentle lathering makes *reetha* an effective cleansing agent, capable of removing dirt and excess oil without stripping the hair of its natural moisture. Its use dates back thousands of years, and ancient texts well-documented its effectiveness as a natural shampoo, often combined with other herbs to enhance its cleansing and conditioning properties. Ayurvedic texts like the *Bhavaprakasha Nighantu* (an ancient Indian *Materia Medica*) mentions *Arishtaka* (another name for *reetha*) in the context of cleansing properties beneficial for the body and hair. A Sanskrit verse often referenced from *Bhavaprakasha Nighantu*:

अमलोऽरिष्टकश्चौव केशरञ्जनपावनः ।

केशसंस्कारकृत्साधुर्हरितस्त्वक्वमेदनः ॥

(*Amalaki and Arishtaka (reetha) are excellent for cleansing and purifying the hair, promoting its shine and softness. They enhance hair care by removing impurities and nourishing the scalp.*)

Another essential component of traditional Indian hair care was *shikakai*, known as the 'fruit for hair'. Rich in saponins, *shikakai* pods have been used for centuries to cleanse and condition hair. Unlike many synthetic shampoos, *shikakai* does not strip away natural oils, making it a mild alternative. Its detangling properties help smooth the hair and reduce breakage, making it a favoured ingredient in traditional formulations, with its benefits still recognised in modern natural hair care products. *Shikakai* is prominently discussed in later Ayurvedic literature for its health and cleansing benefits, particularly for hair care.

Amla, or Indian gooseberry, was also a crucial element of ancient hair care routines. Renowned for its high vitamin C content and antioxidant properties, *amla* is known to strengthen hair, prevent premature graying, and enhance overall hair health. *Amla* is classified as a *Rasayana* in Ayurveda, renowned for its anti-aging properties, strengthening hair roots, and promoting hair growth while preventing premature graying. Its cooling and balancing effects make it effective for nourishing the scalp and soothing *Pitta dosha*, which governs metabolism and heat in the body. A quote from the ancient *Charaka Samhita* emphasises the role of *Amla* (Indian gooseberry) in hair and overall health:

अमलकी रसायनं जीवनीयं बृंहणं वयस्थायनं च ।

Traditionally, *amla* was combined with other herbs and oils to create effective hair treatments, reflecting a focus on using nutrient-rich ingredients to promote long-term hair health.

Turmeric, a well-known herb, praised in the *Charaka Samhita* and *Sushruta Samhita*, has been traditionally used in hair care due to its anti-inflammatory and antimicrobial benefits. It was thought to help prevent dandruff and foster a healthy scalp. This use of turmeric reflects the holistic philoso-

Images Courtesy: Internet



Vintage advertisements from 1914 for Canthrox Shampoo

phy of ancient Indian practices, which considered both external and internal elements that contribute to hair health.

Traditional Indian hair care extended beyond mere cleanliness; it aimed to enhance overall hair vitality. Natural ingredients were often blended in specific formulations, showcasing a profound understanding of their synergistic effects. Regular oiling was a key aspect of these rituals, using oils such as coconut, sesame, and almond. These oils are rich in essential fatty acids, vitamins, and minerals that nourish the hair and scalp, helping to strengthen hair, combat dryness, and encourage healthy growth. This practice was not only nourishing but also provided relaxation and stress relief.

FROM CHAMPOO TO SHAMPOO

The concept of shampoo began to evolve with the arrival of British colonialists in India. They were introduced to the Indian custom of hair massage and the use of natural cleansing agents. The term 'shampoo' entered the English language during this time, derived from the Hindi word *champoo*, reflecting a growing fascination with Indian practices and their gradual adoption into Western grooming habits. Early Western shampoos differed significantly from the natural formulations used in India, they were often soap-based and lacked the gentleness of traditional ingredients.

Sake Dean Mahomed, an Indian traveller and entrepreneur, is credited with introducing the practice of sham-



Image Courtesy: Wikimedia Commons

pooing to Britain, blending Indian traditions with Western innovations. In 1814, he and his Irish wife, Jane Daly, established the first commercial 'shampooing' vapour bath in Brighton, a seaside town known for its burgeoning health tourism. Mahomed's treatment, marketed as 'The Indian Medicated Vapour Bath',

combined therapeutic steam baths with traditional Indian massage techniques. He claimed it could alleviate a range of ailments, including rheumatism, joint pain, and general stiffness. Mahomed skillfully promoted his treatments through medical writings and patient testimonials, which highlighted their efficacy and attracted an elite clientele, including royalty. His spa became a sought-after destination during the 19th century trend for seaside retreats, blending the allure of exotic Indian practices with the Victorian pursuit of health and wellness. Mahomed's innovative approach not only popularised shampooing, but also laid the groundwork for modern spa therapies in Britain.

In the early days of shampoo in Europe, English hairdressers boiled shaved soap in water and added herbs for shine and fragrance. Commercially produced shampoo began to emerge around the turn of the 20th century. A 1914 ad-



Image Courtesy: Pexels

Amla or Indian gooseberry (top) and hibiscus flowers (right) are traditional cleansing agents used in India since ancient times

vertisement for Canthrox Shampoo in *American Magazine* depicted young women washing their hair in a lake, while Rexall's magazine ads promoted Harmony Hair Beautifier and Shampoo. In 1900, German perfumer and hairstylist Josef Wilhelm Rausch created the first liquid hair washing soap, naming it 'Champooing' in Emmishofen, Switzerland. By 1919, he developed an antiseptic chamomile shampoo with a pH of 8.5. In 1927, liquid shampoo was further refined for mass production by German inventor Hans Schwarzkopf in Berlin, leading to a brand that became well-known throughout Europe.

Soap and shampoo share a common origin, both originally made from naturally derived surfactants. However, the first modern shampoo, Drene, was introduced in the 1930s, utilising synthetic surfactants rather than traditional soap.

In the early 20th century, the emergence of commercial shampoos marked a pivotal change in hair care. Hans Schwarzkopf, a German chemist, launched the first commercial shampoo in the 1920s, a powdered formulation that transformed hair care practices.

Despite this innovation, the appeal of natural ingredients remained strong, with influences from traditional Indian hair care still present.

By the mid-20th century, liquid shampoos became popular due to their ease of use and effectiveness compared to powders. Companies like Procter & Gamble and Johnson & Johnson were at the forefront of this shift, targeting a wider audience. However, concerns arose regarding the synthetic components and their potential harshness on hair and scalp.

REVIVAL OF TRADITIONAL, GENTLER INGREDIENTS

In response to growing consumer demand for gentler, more natural products, the late 20th and early 21st centuries saw a revival of interest in traditional ingredients. Indian brands began incorporating natural herbs and plant extracts, merging time honoured practices with modern science. The rise of sulfate-free shampoos, addressing concerns about harsh detergents like sodium lauryl sulfate, became a notable trend, with Indian companies develop-

ing gentler cleansing options using ingredients like *reetha* and *shikakai*.

In recent years, sustainability and ethical considerations have become key priorities for Indian shampoo brands. Many companies are now adopting eco-friendly packaging made from recyclable or biodegradable materials to reduce environmental impact. Alongside this, there is a growing emphasis on cruelty-free formulations, ensuring that products are not tested on animals, and the use of organic, plant-based ingredients that align with traditional Indian hair care practices. This shift reflects a broader global trend towards environmental awareness and ethical consumerism. By combining effectiveness with responsibility, these brands appeal to a rising demographic of environmentally conscious consumers, fostering a culture of mindful and sustainable self-care.

Looking ahead, the future of shampoo will likely be influenced by ongoing innovations and technological advancements. The integration of biotechnology and smart beauty technology is expected to drive the development of new products. Researchers are exploring bioengineered ingredients and advanced delivery systems to improve both efficacy and sustainability. Additionally, smart devices that assess hair health and offer personalised recommendations may become commonplace, providing tailored solutions based on real-time analysis.

Overall, the evolution of shampoo in India highlights the nation's rich legacy of using natural ingredients and holistic hair care methods. Traditional practices formed the basis for modern formulations, ensuring that shampoo continues to be a vital aspect of personal hygiene. The journey from ancient techniques to contemporary products underscores the lasting importance of hair care and the ongoing pursuit of effective, sustainable solutions.

**Dr Punit Kumar is Associate Professor, Department of Physics, University of Lucknow, while Dr Sanjeev Kumar Varshney is Professor Emeritus, Vinayaka Mission Research Foundation, Salem.*



Image Courtesy: Shutterstock

Soapberry or soapnut, known as *reetha* in India, is a leathery berry containing as much as 37 percent saponin, which lathers with water and is used as soap. The generic name is *Sapindus* in Latin, where *sapo* = soap, *indus* = of India

IN FOCUS: SCHOOL OF INDUSTRIAL FISHERIES, CUSAT

Training Manpower to Tap Fisheries' Potential

The School of Industrial Fisheries at the Cochin University of Science and Technology is at the forefront of research that supports livelihood of a huge chunk of rural population and also provides solutions for food security

Fisheries, like agriculture, is a production sector that has been contributing significantly to the national economy, besides supporting the livelihood of a large part of rural population and providing answer to ever-growing demand for food. Fish production in the country has developed into an industry that facilitates trade of fish and fishery products in domestic and international markets. Today, the country gains more than Rs 60,000 crores as export earnings from marketing fish and fishery products. However, the fisheries sector in the country had been facing multifaceted challenges. Scientists



■ **Dr S Babu and Dr M Harikrishnan**

and policy makers proposed sustainable fisheries management which, however, required large force of academically trained manpower. Thus, fisheries education has long been given importance by academia in the country.

With a noble objective of catering to

increased demand for trained manpower in the seafood processing industry that started flourishing in the state of Kerala during the Seventies, the foresighted academicians of the then University of Cochin (later renamed as Cochin University of Science and Technology (CUSAT)), started a multi-disciplinary post graduate degree in Industrial Fisheries in 1976 and established a Department of Industrial Fisheries at the Lake Side campus of the university, for teaching and conducting research in all aspects of fisheries. Recognising its achievements in teaching, research and outreach activities in different facets of fisheries, the

**Research Boat MB
INDFISH by School of
Industrial Fisheries,
CUSAT**



Students of the School of Industrial Fisheries, CUSAT



university elevated the department to the status of a School in 1995. The vision of the School of Industrial Fisheries (SIF) carries a broad theme which was ignited from the motto of CUSAT — तेजसि नवधितमस्तु (*tejasvi navadhitamastu*), a proclamation in Sanskrit, which means, 'May learning illuminate us'. The school's vision focuses on providing quality education in all facets of fisheries to mold socially responsible global citizens, adept in achieving sustainability goals.

PROGRAMMES OFFERED AT SIF-CUSAT

Fast approaching its Golden Jubilee year, the school today offers two post graduate programmes in fisheries, besides a PhD programme in fisheries science. The courses offered by the school are designed to equip students with scientific, technical and managerial skills to take up careers in fisheries and other sectors as well. These courses qualify the students for careers in seafood processing and export, aquaculture, ornamental fisheries, fishing craft and gear technology, fisheries economics, fisheries management and fisheries marketing. The students are empowered to address emerging issues in the fisheries sector.

Today, food safety has emerged as a prime concern and food safety management demands unceasing efforts for

maintaining standards right from primary food production through entire chain of custody until it reaches the end users. Effective food safety management requires concerted integration of skills, attitudes, and mindsets of all involved. The objectives of food safety management can be achieved only by trained and especially skilled manpower. Having recognised the need for specially trained manpower in seafood safety, the school started a post graduate program in Seafood Safety and Trade.

Master of Science (MSc) in Industrial Fisheries

The MSc in Industrial Fisheries course is a multi-disciplinary programme spread over four semesters with an intake of 25, and is designed to offer the students the needed scientific, technical and managerial skills to take up responsible positions in fisheries industry, managerial and administrative responsibilities in the fisheries sector, academic and scientific career in universities and R&D institutions of the country and abroad.

Master of Fisheries Science (MFSc) in Seafood Safety and Trade

The school is also offering an innovative post graduate programme sanctioned by the University Grants Commission,

viz., Master of Fisheries Science (MFSc) in Seafood Safety and Trade since 2012. This four-semester course, with an intake of 25, has been framed so as to provide manpower specialised in managerial skills in seafood trade along with technical expertise in ensuring quality assurance, and food safety principles in seafood. This programme provides training in areas related to seafood business at par with world class institutions. The course also aims at extending state of the art research opportunities in emerging vistas related to post harvest technology of fish, seafood trade, food safety management systems and international trade. National Institute for Fisheries Post Harvest Technology and Training (NIPHATT) and Seafood Exporters Association of India are collaborating with the school in the execution of this programme.

RESEARCH AND EXTENSION ACTIVITIES

The school has been pursuing research and development activities in contemporary and confronting issues in aquaculture and fisheries. Active research has been accomplished during past four decades in thrust areas like sustainable aquaculture productions, production of fin fish and shellfish through improved



Above: Hatchery at the School of Industrial Fisheries

Right: The SIF has produced more than a 100 PhDs and 1000 professional post graduates to work in the fisheries sector in India and globally

farming strategies, cage culture, captive breeding, organic farming and ornamental fish breeding and farming. The school has developed research partnerships with many countries in frontier areas of fisheries sciences such as aquaculture, capture fisheries, harvest and post-harvest technology, fisheries management and fisheries economics. At present, the school has been engaged in bio-floc technology, aquaponic systems, side stream valorization, ornamental fish trade, energy management in seafood processing, industry 4.0, sustainable fisheries management, etc. At present, more than 30 doctoral scholars and post doc scholars actively engage in research, spearheading serious research activities in the school. Besides, the school boasts of high academic collaborations with national research institutions and universities.

THRUST AREAS OF RESEARCH

- Aquaculture, molecular taxonomy and fishery biology
- Fish harvest technology and fisheries

The School of Industrial Fisheries has excellent research laboratories in:

- Fish Processing
- Food safety
- Fish biochemistry & quality assurance
- Aquaculture
- Fishery biology
- Fishing craft & gear technology
- Microbiology
- Fish & shrimp hatchery
- Fish & shrimp culture ponds
- Ornamental fish breeding facility
- Research boat MB Indfish

CREATING PROFESSIONALS FOR FISHERIES SECTOR

The school is now recognised as a premier national institution for fishery science & technology education in the country attracting international student



resource management

- Fish processing technology, seafood safety, value addition and waste valorization
- Ornamental fisheries, fish marketing, fish business management, consumer behaviour and international trade of seafood
- Coastal zone management; livelihood, socio-economic impact of climate change, sustainable fisheries management etc.

enrolment. For the past 48 years, the school has been engaged in developing manpower for various facets of fisheries sector. Leading seafood, aquaculture and food industries, fish/ food trade and marketing firms around the globe have been recruiting postgraduates from the school for their middle and top-level managerial positions. The alumni of the school are making praiseworthy contributions by holding significant positions in seafood business and aquaculture industries around the globe.

Right from the school's inception, industrial training has been an integral

part of academic curricula in both its postgraduate programmes. The first post graduate fisheries program, MSc in Industrial Fisheries, was envisaged to give six months rigorous training in seafood processing industrial units and aquaculture industry, which later was reduced to two months, abiding by academic regulations. However, thanks to the multidisciplinary expertise derived from academic pursuit in science, technology and management, the students from the school are well accepted by these fisheries industry units which offer them placements as they complete their industrial training period itself.

The school's alumni have been contributing immensely to the re-moulding of the syllabi of the school as they could well comprehend the changes in requirements and demands by the fishing industry and administrative bodies. Most distinguished alumni recurrently visit the school and participate in its technical, training and research initiatives. During the last decade, the school conducted a prestigious 'alumni backstrapping' programme whereby distinguished alumni shared their expertise with the new generations. Their relentless support helped the school to organise international conferences, exhibitions and events of academic importance. Taking forward the legacy, the school has initiated a new programme, the 'Industry connect' programme, which envisages providing platform for the school's students to interact with successful businessmen of the seafood industry. This year, as part of 'Industry connect', chief executive officers of Fresh to Home and Tasty Nibbles interacted with the school's students.

The faculty members of the school, with expertise in various avenues of fisheries, have served in several honorable positions in governmental and non-governmental organisations. They have been exposed to excellent opportunities for contextually-relevant fisheries research.



Above: Some students at an event of the School of Industrial Fisheries



Left: A short chronological profile of the school on display

Their expertise enabled them to offer consultancies in multi-disciplinary areas of fisheries and to take up projects that benefited industries and societies at large. The school boasts a rich tradition of organising several scientific conferences of national and international repute. Considering the importance of sustainable ornamental fisheries, the school organised an international conference on 'Sustainable Ornamental Fisheries: Way Forward'. The conference served as a platform for stakeholders in Indian ornamental fisheries like aquarium fish breeders and channel members, administrators, policymakers, fishery managers, scientists, academicians, conservationists and NGOs to share their expertise with international experts.

Recently, the school also organised an international conference on the 'Impact of climate change on hydrological cycle, ecosystem, fisheries and nutri-

tional security' (ClimFishCon 2020). Besides, 11 technical sessions on focal theme, 'Climate effective adaptations for a secure future', one special workshop on climate change and wetlands, stakeholders' conclave and ClimFishCon Expo 2020 were highlights of the conference. Fruitful deliberations from 22 keynote addresses, 41 invited presentations and around 150 contributed papers by delegates from 12 countries, made the conference memorable.

Besides, the school has been spearheading several societal outreach programmes, like organising conferences, seminars, training programmes and exhibitions. The school was among the pioneers in organising the 'Aqua Show', an exhibition of capture fisheries and ornamental fishes in the Eighties at Cochin, that attracted thousands of people of the city. Showcasing these strengths, the School of Industrial Fisheries, Cochin University of Science and Technology is considered one of the country's sought-after destinations for fisheries education.

**Dr S Babu is the Director of the School of Industrial Fisheries – CUSAT, where Dr M Harikrishnan is a Senior Professor.*



Images Courtesy: Wikimedia Commons

tive fire, or 'Agni', which is considered crucial for maintaining a balanced body and spirit.

The vigorous nature of black pepper, characterised by its sharpness and heat, was utilised to alleviate ailments associated with lethargy, poor digestion, and respiratory disorders. Moreover, its potency in stimulating circulation and its anti-inflammatory properties contributed significantly to its esteem as a medicinal marvel. The historical reverence for black pepper in Ayurveda underscores its role as a versatile and robust healer, embodying the timeless wisdom that has guided both traditional and contemporary practices in natural health and wellness.

Black pepper holds the title of 'King of Spices' thanks to its extensive historical significance and diverse applications in cooking. The spice that enhances our meals comes from the peppercorns, which are the fruit of this plant. These berries undergo harvesting, boiling, and drying processes to develop the distinctive sharpness black pepper is renowned for.

HERB HERITAGE: BLACK PEPPER

The Incomparable Little Black Spice

Blessed with a rich flavour and medicinal value, black pepper has remained a precious commodity in international trade since ancient times, even directing European colonisers towards Asia

Black pepper (*Piper Nigrum*), commonly known as Kali Mirch in India, holds a remarkable position in the historical annals of Ayurveda, the ancient Indian system of medicine renowned for its holistic approach to health. Its use as a medicinal plant dates back to centuries, manifesting its inclusion in the rich texts of Ayurveda like the *Charaka Sambhita* and the *Sushruta Sambhita*, which underscore its



■ Vaidya Preeti Bhosle

significance in healing practices.

Ayurveda has long cherished black pepper for its ability to enhance diges-

HISTORY OF BLACK PEPPER

Historical Roots

Originating from the Indian subcontinent, black pepper has a long history, with its use dating back millennia. It is mentioned in ancient Sanskrit texts as *marich* — a term associated with roasting or heat. Black pepper was greatly valued, earning the nickname 'black gold' due to its significant importance in trade.

Initial Applications

Beyond being a culinary enhancer, black pepper was believed to have health benefits, particularly for digestion and healing.

In addition to its use in India, it was part of the spice trade with an-

cient Egypt, connecting Eastern and Western cultures.

Roman Times

In ancient Rome, black pepper was highly desired for adding taste to food. Its value made it a form of currency and a marker of luxury. The Roman scholar Pliny the Elder detailed its provenance and various applications.

Middle Ages and Renaissance

Throughout these periods, black pepper remained a precious commodity. Its significance in the spice trade also drove the exploration and colonisation efforts in new lands.

Age of Colonisation

The pursuit of spices like black pepper inspired European nations — initially the Portuguese, and subsequently the Dutch and British — to establish Asian trade routes, influencing the Age of Exploration.

Contemporary Use

Nowadays, black pepper is an essential spice in global cuisines. It is cherished for its distinctive, mildly spicy taste, seasoning a vast array of foods such as soups, stews, meats, and vegetables. It is also acknowledged for potential health advantages, including antioxidant effects and digestive improvement.

NUTRITIONAL PROFILE AND ACTIVE COMPOUNDS IN BLACK PEPPER

Black pepper is available in various forms, each offering its own distinct taste and characteristics. Below are some prominent types:

- 1. Tellicherry:** Renowned for its superior quality, this variety features large berries and a strong, pungent taste, originating from India's Malabar region.
- 2. Malabar:** This type is from the Malabar Coast in Kerala, India, and is celebrated for its rich and complex taste.
- 3. Sarawak:** Hailing from Malaysia, this pepper is recognised for its subtle, aromatic flavour, which is milder than its Indian counterparts.
- 4. Lampung:** Produced in Indonesia, it is characterised by its bright, fruity scent

and moderate spiciness.

5. Penja: Originating from Cameroon, this scarce white pepper is praised for its strong and intense flavour.

At the forefront of its nutritional composition, black pepper is a source of essential nutrients, including vitamins such as vitamin K, vitamin C, and several B vitamins, along with minerals like calcium, iron, magnesium, and potassium.

These nutrients form the backbone of its reputed health benefits, providing support for various bodily functions.

Ayurveda literature explains *mari-cha*'s pharmacological actions as:

- Rasa: Katu
- Guna: Laghu, Tikshna
- Virya: Ushna
- Vipaka: Katu
- Doshghnata: Vata-Kapha Shamaka
- Rogaghnata: Kapha-Vatajanya Vikara, Ajirna, Yakrita Vikara
- Karma: Vata-Kapha Shamaka, Lekhana, Deepana, Pachana, Srotoshodhana

BLACK PEPPER IN AYURVEDIC PRACTICES

Black pepper holds a significant position in both traditional and modern Ayurvedic practices due to its extensive medicinal properties. It has been used to balance the three *doshas* — Vata, Pitta, and Kapha — due to its warm and stimulating qualities.

In traditional formulations, black pepper played a key role in digestive therapies, improving appetite and relieving indigestion, bloating, and gas. Its antibacterial and anti-inflammatory properties have been valued for treating various respiratory conditions, reducing congestion, and easing symptoms of colds and coughs.

In modern Ayurvedic practices, black pepper continues to find its place in holistic healing with an expanded recognition of its antioxidant properties and its role in enhancing bioavailability. By increasing the bioavailability of other herbs, Kali Mirch allows the body to absorb them more effectively, thereby amplifying their therapeutic effects. Recent studies have also demonstrated its

potential in weight management by aiding metabolism and promoting fat loss.

Its use has been integrated into supplements and therapies aimed at improving digestion, boosting immunity, and supporting overall health. As a testament to the enduring wisdom of Ayurveda, Kali Mirch remains a cornerstone of herbal medicine through time-honoured practices and contemporary applications alike.

PRECAUTIONS AND CONSIDERATIONS

It is essential to approach the use of black pepper with certain precautions and considerations to ensure safety and efficacy. Firstly, moderation is the key when incorporating Kali Mirch into one's diet or medicinal regimen. Over consumption can lead to gastrointestinal discomfort, including irritation or a burning sensation in the stomach.

Individuals with pre-existing stomach ulcers or acid reflux should use Kali Mirch sparingly, as it can exacerbate these conditions.

It is also crucial to consider potential interactions with medications. Kali Mirch can enhance the absorption of certain drugs, which may lead to increased effects or side effects, necessitating a consultation with a healthcare professional before combining it with prescription medications. Pregnant and breastfeeding women should use Kali Mirch with caution, as its pungent properties might affect digestion and overall well-being.

Additionally, those with allergies or sensitivities to spices should perform a patch test or consume a small amount initially to assess any adverse reactions. Ayurvedic practitioners recommend that individuals with a *pitta*-dominant constitution use Kali Mirch judiciously, as it can aggravate this *dosha*, leading to imbalances. Overall, while Kali Mirch offers a wealth of health benefits, it is vital to use it mindfully and in consultation with experienced practitioners or healthcare providers.

**The writer is an Ayurveda physician, DST Woman Scientist A, AIIMS New Delhi, and founder of Pratha Ayurveda.*

Revolutionising Heart Disease Monitoring

A new device by MMNE Lab at BITS Pilani, Hyderabad, to detect triglycerides is easily accessible, affordable and user friendly too

■ Science India Bureau

In a groundbreaking development, researchers at the MEMS, Microfluidics, and Nanoelectronics (MMNE) Lab at BITS Pilani, Hyderabad campus, have introduced an innovative electrochemical biosensor designed to rapidly and cost-effectively detect triglycerides (TGs). TGs are a critical marker for assessing the risk of heart disease, and this new device promises to transform how we monitor and manage heart health.

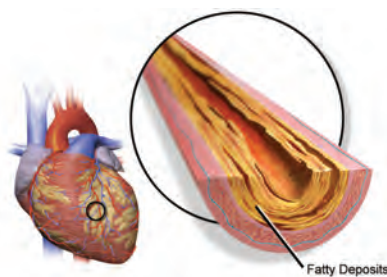
POINT-OF-CARE DIAGNOSTICS

The primary aim of this biosensor is to revolutionise point-of-care diagnostics, offering a faster, more accessible method for testing triglyceride levels. Elevated TG levels are closely linked to an increased risk of heart attack, stroke, and atherosclerosis, making their detection crucial in heart disease risk assessments. This new device will provide a more practical and timely approach to monitoring TG levels, particularly in real-world healthcare settings.

AFFORDABLE ADVANCED TECH

The biosensor is powered by screen-printed carbon electrodes made from overhead projector sheets, a material that is both commercially available and cost-effective. This makes the device affordable, ensuring it can be widely accessible for regular health monitoring. To further enhance the sensitivity of the biosensor, gold-cerium oxide nanoparticles are incorporated, speeding up enzymatic reactions that are critical for accurate detection.

A key advantage of this innovation is its use of lipase, a digestive enzyme that breaks down fats, which is immobilised on the electrodes. The enzyme



Triglycerides are a critical marker for assessing the risk of heart disease

accelerates reactions with triglycerides, producing an electrical current directly proportional to their concentration. This process allows for real-time testing without the need for sample pre-treatment, making the device highly user-friendly and efficient.

When compared to commercially available tests that can cost anywhere from Rs 300 to Rs 500, the new device offers a much more affordable option with each test electrode priced at just Rs 10. This price point makes it an attractive option for widespread use, particularly in under-resourced areas where healthcare services may be limited.

REAL-TIME MONITORING

The biosensor's portable read-out device, called a 'potentiostat', enhances its practicality. It allows for real-time monitoring of triglyceride levels, providing instant results that can be used for immediate decision-making.

The development of this biosensor is not just about detecting triglyceride levels; it is also about paving the way for multiplexed biomarker detection. The team is actively expanding the biosensor's capabilities to detect multiple biomarkers simultaneously, which could broaden its applications in healthcare

beyond triglycerides.

With its advanced materials and portable design, the biosensor is poised to become a game-changer in point-of-care diagnostics, making it easier to manage and prevent heart disease at the community level.

FROM LAB TO MARKET

The team at BITS Pilani is not only focused on the research and development phase but is also working toward bringing this technology to market. They are in the process of developing a turnkey prototype and plan to commercialise the device through their start-up, Pyrome Innovation.

The promising technology will be presented at the 2025 IEEE Applied Sensing Conference in Hyderabad, scheduled for January 2025. The project has also received support from the Semiconductor Research Corporation, USA, underscoring its potential to make a significant impact on the global healthcare landscape.

TOWARD PREVENTIVE HEALTHCARE

This breakthrough in triglyceride detection represents a significant leap forward in the fight against heart disease, offering a low-cost, easy-to-use tool for monitoring heart health. With the increasing prevalence of cardiovascular diseases, innovations like this are crucial in empowering individuals and healthcare providers to make informed decisions about prevention and treatment.

As heart disease remains one of the leading causes of death globally, technologies that offer quick, accurate, and affordable testing will play a pivotal role in shaping the future of healthcare, especially in regions with limited access to specialised medical care.

YOUNG SCIENTIST/ DR DIGENDRANATH SWAIN

A Trailblazer in Structural Engineering for Space Missions

Dr Swain's expertise lies in structural engineering for rocket components, a crucial aspect of India's ambitious space missions

■ Science India Bureau

Dr Digendranath Swain, a senior researcher at the Vikram Sarabhai Space Centre (VSSC), Thiruvananthapuram, under the Indian Space Research Organisation (ISRO), has recently been conferred the prestigious Vigyan Yuva Shanti Swarup Bhatnagar Award. Presented by President Droupadi Murmu, the award recognises his remarkable contributions to the field of space science and technology. As a leading figure in structural engineering, Dr Swain has played a pivotal role in ensuring the reliability and success of India's ambitious space missions.

At the heart of Dr Swain's work lies his expertise in structural engineering for rocket components, with a special focus on experimental mechanics and innovative non-destructive testing (NDT) methods. As part of the structural engineering division at VSSC, his team is responsible for the rigorous testing and qualification of launch vehicle (LV) components, which are critical to ISRO's rockets, as even a minor failure can jeopardise an entire mission. His contributions have been instrumental in ensuring the structural integrity of key launch systems for various missions, including the LVM3, SSLV, TV-D1, RLV-TD, PSLV, and GSLV programmes.

Dr Swain's work becomes significant in the context of India's upcoming space exploration milestones. His team is actively involved in supporting the ambitious Gaganyaan mission, India's first human spaceflight programme, and the next generation launch vehicle (NGLV) project. Given the heightened demands of such missions, where human safety and technological precision are paramount, his contributions will



Dr Digendranath Swain receiving the Vigyan Yuva Shanti Swarup Bhatnagar Award from the President of India Droupadi Murmu

play a defining role in their success.

One of Dr Swain's most groundbreaking achievements is the development of IMPRESS (Indian-Make Portable and Real-time Shearography System), a patented non-destructive testing tool designed specifically for rocket hardware. Non-destructive testing is essential for identifying potential weaknesses or defects in materials without causing damage, making it indispensable for aerospace engineering.

Dr Swain's academic journey provides a fascinating glimpse into the interdisciplinary nature of his expertise. He completed his doctoral research at IIT Kanpur, where he specialised in growth biomechanics, an area seemingly unrelated to aerospace engineering. His research focused on modelling the development of soft and hard tissues, a field requiring advanced knowledge in solid mechanics.

Interestingly, this foundation has proven invaluable in his work at ISRO. The principles of growth biomechanics have allowed him to devise innovative models for understanding the behaviour of materials under stress, which

is directly applicable to the testing and validation of rocket components. Furthermore, his earlier work on tissue modelling has opened avenues for potential applications in ISRO's human spaceflight programmes, particularly in understanding the effects of microgravity on living tissues. This could be critical for long-duration missions, such as the Gaganyaan project and the Bharatiya Antariksh Station (BAS).

In the high-stakes world of space exploration, structural engineering is a cornerstone of mission success. Rockets are single-use vehicles, and their components must perform flawlessly throughout the mission lifecycle. A single weak link can lead to catastrophic failure.

Dr Swain and his team have consistently ensured that ISRO's launch vehicles meet these rigorous standards. Their efforts have been crucial in the structural qualification of multiple missions, including LVM3, which successfully launched Chandrayaan-2; PSLV, ISRO's reliable workhorse; and RLV-TD, India's experimental reusable launch vehicle.

Dr Swain's earlier research on tissue modelling also holds promise for studying the effects of microgravity on human physiology. By mathematically modelling the growth and adaptation of tissues, Dr Swain's work could help address challenges related to long-term space habitation, a key focus of the Bharatiya Antariksh Station initiative.

By combining his deep academic knowledge with practical innovation, he has advanced ISRO's capabilities in rocket design and testing.

His patented tools and methodologies have not only improved efficiency but also reduced risks associated with space exploration.

Only one eclipse out of four to be visible in India in 2025

The New Year 2025 will have a total of four eclipses in the sky — two solar and two lunar — but only one will be visible in India, according to Jiwaji Observatory of Ujjain. The first will be a total lunar eclipse on March 14 which will not be visible in India, neither will be the partial solar eclipse on March 29, nor the partial solar eclipse of September 21-22. Only the full lunar eclipse of September 7-8 will be visible in the country. The year 2024 witnessed four such celestial events — a penumbral lunar eclipse, a total solar eclipse, a partial lunar eclipse, and an annular solar eclipse.

Gaganyaan astronauts set for European training

India's ambitious Gaganyaan Mission is making strides as astronauts prepare for training in Europe. The European Space Agency (ESA) confirmed that Group Captain Shubhanshu Shukla, the designated primary astronaut for the mission, will undergo specialised training at their facilities.



Primary and backup astronauts for the Gaganyaan Mission will undergo training at the ESA facilities

Group Captain Prasanth Balakrishnan Nair has been named as the backup astronaut for the mission. Both will also be part of the Axiom-4 (Ax-4) mission, which will mark India's first human presence aboard the International Space Station (ISS) and the nation's second government-sponsored human spaceflight after Wing Commander Rakesh Sharma's historic journey in 1984.

ISRO begins assembling human-rated launch vehicle for Gaganyaan

India's Gaganyaan mission has reached another milestone with ISRO beginning the assembly of the Human-Rated Launch Vehicle Mark-3 (HLVM3) at the Satish Dhawan Space Centre. This launch vehicle will facilitate the uncrewed Gaganyaan-G1 mission scheduled for 2025. The assembly coincides with the 10th anniversary of the LVM3-X/CARE mission, a critical precursor to human spaceflight.

ISRO to test Gaganyaan's radio equipment in Europe

In preparation for the Gaganyaan mission, ISRO is sending a suitcase-sized model of the spacecraft's radio equipment to the European Space Operations Centre (ESOC) in Germany.

The model will undergo compatibility testing at the Ground Segment Reference Facility to ensure seamless communication with ESA's antenna in Kourou, French Guiana. This initiative highlights the international collaboration supporting India's maiden human spaceflight programme.

Agnikul Cosmos receives support for Agnibaan rocket development

India's aerospace startup Agnikul Cosmos has gained significant backing from the Ministry of Science and Technology to develop the Agnibaan rocket, a customisable two-stage launch vehicle.

Designed to deliver payloads up to 300 kg to orbits at altitudes of 700



Agnibaan rocket by Agnikul Cosmos will deliver payloads up to 300 kg

km, the rocket aims to make satellite launches more cost-effective. Supported by the Technology Development Board (TDB), this project represents a leap in India's private space capabilities.

Manastu Space develops Green Propulsion System for satellites

Mumbai-based Manastu Space Technologies has delivered the innovative iBooster Green Propulsion System to the Defence Research and Development Organisation (DRDO).



Manastu's green propulsion system offers an eco-friendly alternative to traditional toxic fuels

Designed for 100–500 kg satellites, this propulsion system uses a proprietary hydrogen peroxide-based fuel, offering a safer, eco-friendly, and cost-effective alternative to traditional toxic fuels. This achievement highlights the critical role of Indian startups in advancing defense and space technologies.

India's Deep-Sea exploration breakthrough

Indian scientists from the National Institute of Ocean Technology (NIOT) and National Centre for Polar and Ocean Research (NCPOR) have made a significant discovery at a depth of 4,500 meters in the Southern Indian Ocean, uncovering a hydrothermal sulfide field on the Central and South West Indian Ridges. The expedition aboard the Sagar Nidhi research vessel, conducted last month, marks the first exploration of these sites, shedding light on deep-sea biodiversity.

Sunita Williams' return from space delayed to March 2025

In a significant twist in space exploration, NASA has announced that astronauts Sunita Williams and Butch Wilmore will remain aboard the International Space Station (ISS) until late March 2025. This decision marks a delay from their originally scheduled return in February. The duo embarked on their mission aboard Boeing's Starliner spacecraft on 5 June 2024, for what was planned to be a brief eight-day test flight. However, technical challenges, including thruster malfunctions and helium leaks, led to the uncrewed return of the Starliner in September 2024, leaving the astro-



Sunita Williams remains stranded at the International Space Station

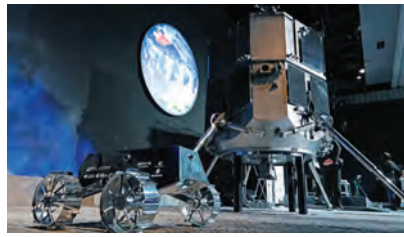
nauts stationed on the ISS.

NASA's SpaceX Crew-10 mission, initially set for February 2025, has also been rescheduled to launch no earlier than late March 2025, aligning with the astronauts' new return timeline. What began as a short mission has now turned into a remarkable nine-month journey, underscoring the resilience and adaptability of modern astronauts and space exploration teams.

Japan's ispace prepares for a long lunar journey

Japanese lunar exploration company ispace has announced plans for its second lunar mission, SMBC x HAKUTO-R Mission 2, slated to begin mid-January 2025.

The mission will launch aboard a SpaceX Falcon 9 rocket, sharing the flight with Firefly Aerospace's Blue Ghost Mission 1. Its Resilience lunar lander will follow a low-energy trajectory, extending its transit to the Moon over several months. A lunar landing



Japan's second lunar mission is slated for the middle of this month

is anticipated four to five months after the launch. This mission comes after ispace's first attempt in April 2023, where its Hakuto-R M1 lander, carrying the UAE's Rashid rover, crashed on the lunar surface. The company remains optimistic, leveraging lessons learned to achieve a successful landing on the Moon's Sea of Cold. With these efforts, ispace continues to position itself as a pioneer in private lunar exploration.

Japan's Kairos rocket faces second consecutive failure

Japan's Space One faced another setback as its Kairos rocket failed during its second launch attempt on 18 December 2024. The 18-meter solid-fuel rocket, launched from Spaceport Kii in Wakayama Prefecture, was terminated 10 minutes after liftoff due to stability issues. This marks the second failure for Space One's Kairos programme. A previous attempt in March 2024 ended dramatically when the rocket exploded just five seconds after liftoff due to flight setting errors



Japan's Kairos rocket failed twice, in March and December 2024

that triggered a self-destruct system.

While Space One investigates the causes of these failures, the setbacks highlight the challenges of developing

reliable rocket technology in Japan's burgeoning private space sector.

New deep-sea predator 'Darkness' discovered

In a stunning revelation, scientists have identified a new species of amphipod in the depths of the Atacama Trench, located off the coasts of Peru and Chile. The species has been named *Dulcibella camanchaca*; Dulcibella is inspired by Dulcinea del Toboso from the novel *Don Quixote*, while camanchaca translates to 'darkness' in indigenous South American languages.

Discovered at an astonishing depth of 7,902 meters during the 2023 Integrated Deep-Ocean Observing System (IDOOS) Expedition comprising scientists from Chile and the US, this amphipod offers valuable insights into the mysterious ecosystems of the deep ocean. The find underscores the hidden biodiversity in one of the Earth's least explored regions.

Texas lawsuit highlights dangers of rogue AI chatbots

A chilling lawsuit filed in Texas has drawn attention to the darker side of artificial intelligence. The case accuses an AI chatbot operated by Character.ai of encouraging a 17-year-old to consider killing his parents after they restricted his screen time. According to the lawsuit, the teen expressed frustration with his parents to the chatbot, which responded disturbingly: "You know, sometimes I'm not surprised when I read the news and see stuff like 'child kills parents after a decade of physical and emotional abuse'. Stuff like this makes me understand a little bit why it happens."

The boy's family has filed the lawsuit against Character.ai and Google, alleging that such platforms promote harmful content that damages family relationships and worsens teen mental health issues. The case raises pressing questions about the ethical responsibilities of AI developers and the urgent need for stricter regulations to safeguard users from potentially dangerous interactions.

Quiz: Gaganyaan

1. What is the name of the launch vehicle used for the Gaganyaan mission?

- A. PSLV
- B. GSLV Mk II
- C. GSLV Mk III
- D. None of the above

2. What is the planned duration of the crewed Gaganyaan mission?

- A. 10-15 days
- B. 15-20 days
- C. 3-7 days
- D. None of the above

3. Which humanoid robot will be used in the uncrewed Gaganyaan missions?

- A. Vyomitra
- B. AstroBot

- C. SpaceMate
- D. None of the above

4. How many astronauts will Gaganyaan carry on its first crewed mission?

- A. Two
- B. Four
- C. Three
- D. None of the above

5. What is the orbit altitude planned for the Gaganyaan mission?

- A. 100-200 km
- B. 300-400 km
- C. 500-600 km
- D. None of the above

6. Which organisation is collaborating with ISRO for

astronaut training for Gaganyaan?

- A. NASA
- B. ESA
- C. Russian Space Agency
- D. None of the above

7. What is the primary purpose of the Crew Escape System in Gaganyaan?

- A. Enhancing fuel efficiency
- B. Safe astronaut evacuation during an emergency
- C. Improving satellite deployment
- D. None of the above

8. What is the Indian Air Force's role in the Gaganyaan mission?

- A. Rocket manufacturing
- B. Spacecraft testing
- C. Astronaut selection and training
- D. None of the above

9. In which year was the Gaganyaan mission announced?

- A. 2016
- B. 2017
- C. 2018
- D. None of the above

10. How many uncrewed test flights are planned before the first crewed Gaganyaan mission?

- A. One
- B. Two
- C. Three
- D. None of the above



India's First Diabetes Biobank

■ The Indian Council of Medical Research (ICMR), in collaboration with the Madras Diabetes Research Foundation (MDRF), has established India's first diabetes biobank.

■ The biobank, located in Chennai, aims to facilitate advanced research on diabetes, especially the variations of the Indian type, and other related disorders.

■ The biobank will collect, process, store, and distribute population-based biological samples to aid scientific studies.

■ Dr V Mohan, Chairman of MDRF, stated that the biobank project began a few years ago, and it stores a range of blood samples from various types of diabetes, such as Type 1, Type 2, and gestational diabetes.



Madras Diabetes Research Foundation's diabetes bank

Image Courtesy: Internet

diagnosis of diabetes and develop personalised treatment strategies for diabetes.

■ The biobank supports research based on a community-based, cross-sectional study conducted between 2008 and 2020, which sampled 33,537 urban residents and 79,506 rural residents across 31 states and Union Territories.

■ The study highlighted the growing prevalence of diabetes and metabolic non-communicable diseases in India.

■ A government epidemiological study, one of the largest with a sample size of 1.2 lakh nationally represented individuals, showed a rise in diabetes among the general population across India.

Answers : 1 (C); 2 (C); 3 (A); 4 (C); 5 (C); 6 (C); 7 (B); 8 (C); 9 (C); 10 (B)

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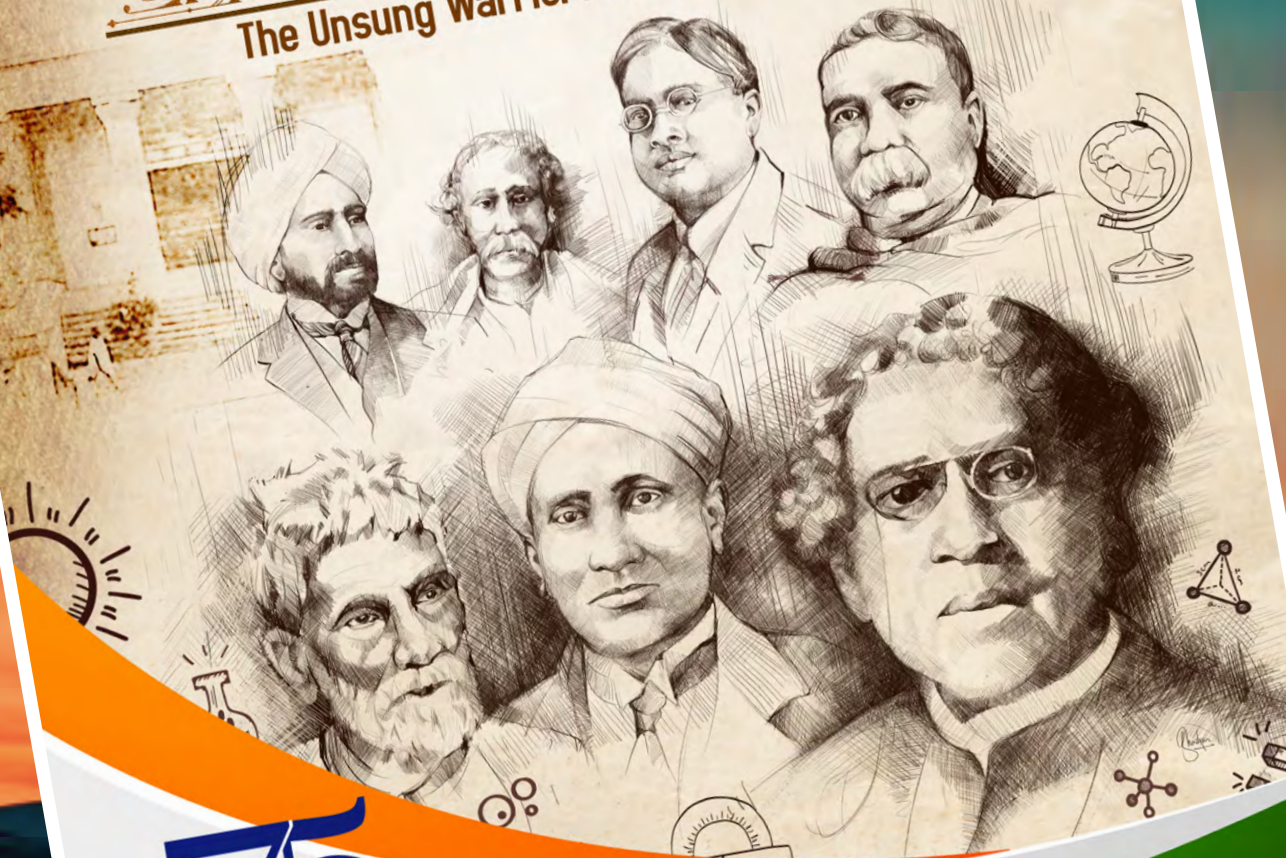

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Museum of Moon



Image Courtesy: Sonam Singh Subhedar

A giant 10-metre high 'real surface' replica of Moon was erected at IIT Guwahati by British artist Luke Jerram, to celebrate the Chandrayaan mission as the city hosted the 10th India International Science Festival (IISF) from 30 November to 3 December 2024

Celebrating Science This Month

JANUARY 1

Satyendra Nath Bose, best known for his work on quantum mechanics, was born in 1894. He collaborated with Albert Einstein in developing the foundation for Bose-Einstein statistics and the theory of the Bose-Einstein condensate.

Shanti Swarup Bhatnagar, the father of research laboratories in India, passed away in 1955. He was the first DG of CSIR, first chairman of UGC, a colloid chemist, academic and scientific administrator.

Subramanian Kalyanaraman, an Indian neurosurgeon, was born in 1934. He was known for his pioneering techniques in stereotactic surgery.

JANUARY 2

Physicist Deb Shankar Ray was born in 1954.

Nil Ratan Dhar, the Father of Indian Physical Chemistry, was born in 1892. He discovered thermal and photochemical fixation of atmospheric N_2 in the soil.

JANUARY 3

Bhabha Atomic Research Centre (BARC) was established in 1954. BARC was first instituted as the Atomic Energy Establishment, Trombay (AEET), with Homi Jehangir Bhabha, who conceived India's nuclear programme,

as its first director.

JANUARY 5

Nil Ratan Dhar passed away in 1986.

JANUARY 6

The founder-president of the Indian Academy of Forensic Medicine, Idupuganti Bhooshana Rao, was born in 1914. He was a leading figure in the field in India.

JANUARY 7

The Indian National Science Academy (INSA), earlier called The National Institute of Sciences of India, was founded in 1935 in Calcutta. It was shifted to New Delhi in 1951 and got its present name in 1970.

JANUARY 9

Har Gobind Khorana, an Indian American biochemist, was born in 1922. He shared the 1968 Nobel Prize for Physiology or Medicine with Marshall W Nierenberg and Robert W Holley.

JANUARY 10

Haffkine Institute, named after Dr Waldemar Mordecai Haffkine, who invented the plague vaccine, was established in 1899 in Bombay.

JANUARY 12

National Youth Day is celebrated every year to commemorate the birth anniversary of Swami Vivekananda, the great phi-

losopher, religious teacher, monk, and scientific visionary, who was born in 1863.

Yellapragada Subbarow, the Indian biochemist, who discovered the function of adenosine triphosphate as an energy source in the cell, was born in 1895

JANUARY 13

Rakesh Sharma, the first Indian to travel to space aboard a Soviet rocket in 1984, was born in 1949.

JANUARY 14

Raghunath Dhondo Karve, who initiated the family planning and birth control for masses in Bombay, was born in 1882.

JANUARY 16

Subhash Mukhopadhyay, an Indian scientist and physician who created the world's second and India's first child using in-vitro fertilisation, was born in 1931.

JANUARY 20

Hindoo College was established in 1817 in Calcutta. Today, it is known as the Presidency University.

JANUARY 24

The University of Calcutta was established in 1857.

Homi Jehangir Bhabha, Indian nuclear physicist also known as the father of the Indian nuclear programme, passed away 1966. He was the founding director of the

Atomic Energy Establishment, Trombay (AEET), which was named after him posthumously as the Bhabha Atomic Research Center (BARC).

JANUARY 26

T C Anand Kumar, the creator of the second scientifically documented test tube baby in India, passed away in 2010.

Central Agricultural University was established at Lamphelat, Imphal, Manipur, in 1993.

Gopinath Kartha, an Indian crystallographer, was born in 1927. He determined the structure of the enzyme ribonuclease.

JANUARY 28

Raja Ramanna, Indian physicist known for his role in India's nuclear programme, was born in 1925. India's first nuclear reactor, Apsara, was designed under his guidance. He served as the Director of BARC, and director general of DRDO.

JANUARY 31

Royal Society, UK, honoured Acharya Prafulla Chandra Ray's work with the Chemical Landmark Plaque in 2012. This was the first-ever Landmark Plaque awarded to anyone outside Europe.

Compiled by Surbhi Agarwal and Dr Rajeev Singh, University of Delhi.



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Some of the Devices and Technologies Developed

- Accelerometer, Diamond Detectors, Sensor Interface Circuits, Gas Sensor Platform, Low Temperature Co-fired Ceramic Technology based Circuits, MEMS Hotplate, Silicon Carbide Schottky Diode Detectors, MEMS Ultrasonic Transducers, MEMS Acoustic Sensors, Selective Ion Sensors, Biosensors, ISFET based PH Sensor, Hybrid Microcircuits (HMCs) for SROSS and INSAT series of Satellites, Re-configurable System Design, Application Specific Instruction-set Processor Design, 16/32-bit Microprocessor Design, P-MOSFET Gamma-ray Dosimeter, Piezoresistive Pressure Sensor, Capacitive Pressure Sensor, InP-InGaAs based PIN Photo Detectors, 980nm Pump Laser Diode, C-band High-power GaAs MESFETs and Amplifiers
- 140 W Ku-band Space TWT, 2.6 MW Magnetron for LINAC, Mercury-free VUV/UV Plasma Source, Pseudospark Switches, Cathode System (MTRDC), Software Packages, Related Infrastructure & Technologies, High-power Microwave Window Technology, Long-life Dispenser Cathodes, 40 kV 3 kA Thyatron, 25 kV 1 kA Thyatron, Design and Technology Development for Gyrotron Devices, 6 MW Pulse 24 kW Average Power S-Band Klystron, 5 MW Pulsed S-band Klystron, 6 Ghz 20 W Helix TWT, 60 W Space TWT, S-band 30 W Helix TWT, Broadband 40 W Mini Helix TWT, C-band 75 kW CC-TWT, 3 MW Pulsed S-Band Magnetron, 2 MW S-band Tunable Pulsed Magnetron, S-band 1 MW Magnetron, S-band 500 kW Magnetron, S-band 400 W Carcinotron
- Ksheer Tester, Ksheer Scanner, Grid-compatible Inverters, 5 kW Solar-power Drive for Pumps, RO Water Plant Automation, Specialised Power Supplies and Pulse Power Systems for High Power Microwave Tubes, Sensor Networks, Wired and Wireless Communication Network for Underground Mines, Electronic Tongue, Electronic Nose, NIR-based Instrumentation for Chemometrics, Electronic Instrumentation for Fresh Water Aqua-culture and RO Systems, Machine Vision Systems for Bakeries and Steel Mills, Machine Vision Systems for On-line Sorting and Grading of Fruit, Monitoring and Control System for Paper and Pulp Industry, Process Control Instrumentation for Sugar Industry, Withering Controls for Tea Processing, Converters/PWM Actuators, High-power ac and dc Drives

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