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Science INDIA

राष्ट्रहिताय विश्वमङ्गलाय

Connecting science and people with an Indian perspective

YOGA SPECIAL

YOGA FOREVER

Yoga is not just a set of fanciful exercises but a way of life, and the surest means to balance mind, body and soul. That is reason enough to celebrate it every day

CSIR-NATIONAL BOTANICAL RESEARCH INSTITUTE, LUCKNOW

Where Plant Based Research Touches Life Through Innovation

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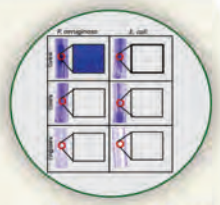

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Science INDIA

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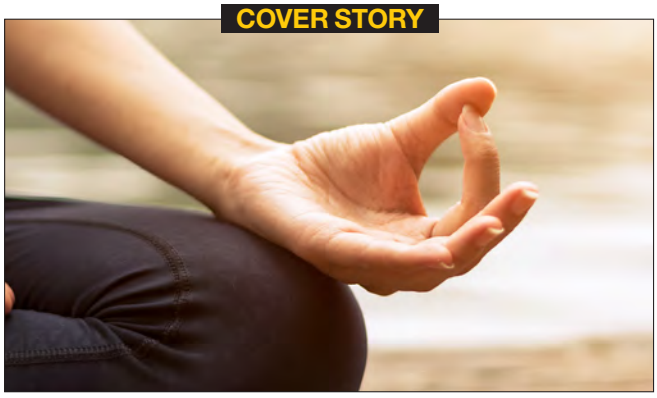

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TRIBUTE TO A QUINTESSENTIAL SCIENCE AFICIONADO

JAYANT SHRIKANT SAHASRABUDHE
National Organising Secretary of Vijnana Bharati and Chief Editorial Advisor, *Science India* magazine.

Born: 17 April 1966, Mumbai
Died: 2 June 2023, Pune

Education & Career: BSc Tech (Mumbai). Joined Bhabha Atomic Research Centre as scientist, but gave up to work as a Pracharak of Rashtriya Swayamsevak Sangh (RSS).

Role as an RSS Pracharak: Worked as a Pracharak across Maharashtra; as Zila Pracharak and Vibhag Pracharak in Konkan province between Mumbai and Goa.

Responsibility of Vijnana Bharati: In 2009, Sangh gave him the responsibility of Vijnana Bharati in the Akhil Bharatiya Pratinidhi Sabha, the highest decision making body of the RSS. He went on to become the National Organising Secretary of Vijnana Bharati.

With the relaunch of *Science India* on 21 October 2020, he helmed the magazine as its fountain head and Chief Editorial Advisor.

Send your letters to editor@scienceindia.in

Let's Connect

Dear Readers,
Every month, we reach out to you with a new edition of *Science India*, delivered with greetings for various happy occasions that fall on the particular month. This month, however, we are coming to you in great pain. It breaks our hearts to share the unfortunate news of the demise of our beloved Jayantji with you.

Jayant Sahasrabudhe, the Chief Editorial Advisor of *Science India*, who was also National Organising Secretary of Vijnana Bharati (Vibha), passed away on 2 June after sliding into comma following a terrible road accident in September last year. No number of designations can ever do justice to the towering influence Jayantji was in the huge Vibha family, and more prominently, in the world of *Science India* magazine, that he re-launched, shaped and nurtured since late 2020.

Everyone who knew him spent the time since his accident on a wing and a prayer, fervently hoping to have him back in our midst as soon as possible. What we have instead are heartfelt remembrances from those who knew him and worked with him closely. The outpouring of grief on his demise has been immense but the scope of the magazine forces our hand in taking only a few sentiments in print. Through these earnest and profound messages, we have hoped to create the immensely rich and multifaceted personality that Jayantji was.

It's a cruel coincidence that Jayantji is no more in the month when the world celebrates the International Yoga Day. There wasn't a bigger believer and promoter of the ancient Indian discipline of yoga in his wide circle. Yoga, today, is a raging phenomenon the world over and it swells every Indian heart with pride that this science originated in this land. It is not just a set of exercises but a way of life, much needed in this age and time when the balance of life has gone off-key rather badly. Of special note is the 'Science Diplomacy' column that focuses on Prime Minister Narendra Modi's Yoga Diplomacy in the US during his state visit to the country this month. The capsule of stories, including the Cover Story, centered on Yoga gives a comprehensive material to read on this ancient yet dynamic subject.

The edition carries all other regular columns among which the profile of the little-known Indian mathematician DR Kaprekar is quite eye-opening. *Science India* continues to strive to unearth such hidden gems that lend immense heft to our scientific achievements, especially during colonial rule. The 'Science and Spirituality' column in this edition has highlighted how Stephen Hawking, one of the greatest physicists of our times and an atheist, went back on his previous beliefs about the creation of the Universe. The article elaborates on the last work of Hawking along with his collaborator and discusses how it goes hand-in-hand with Indian spirituality.

During his several meetings and informal discussions with the editorial team, Jayantji wanted the *Science India* magazine to go international. At the core of his heart he wanted that the readers at global level must know about Indian science and its rich heritage, which was suppressed by the British during the colonial rule.

Jayantji's dream and goal can be achieved with the support and blessings of our esteemed readers and valuable contributors. That will be a true tribute to this quintessential science aficionado, who remained dedicated till his last breath for the cause of Swadeshi Science Movement, as a true revolutionary.

Let's connect to make it happen, as this editorial column (Let's Connect) was also named by none other than Jayantji!

Yoga, today, is a raging phenomenon the world over and it swells every Indian heart with pride that this science originated in this land

Image Courtesy: Shutterstock

COVER STORY

CELEBRATING YOGA TILL ETERNITY

For a healthy and wholesome life, Yoga should be celebrated not just on one particular day but the entire year, and throughout one's life

■ Dr Rajiv Rastogi

This June 21, the world celebrates the ninth Yoga Day since its declaration and adoption by the United Nations General Assembly on December 11, 2014. In the crowd of celebration of different international days, the International Day of Yoga is perhaps one of the most popular with the highest number of public participation. The whole world, particularly the Yoga enthusiasts, start their preparations much in advance to celebrate this day as a great and memorable event. Different government organisations and ministries in India start the countdown to Yoga Day well ahead of the approaching day. Yoga festivals, Yogotsav and similar events are conducted at full extent with active public participation. The Yoga organisations are deeply engaged in celebrating this day as a memorable day. Everybody wants to be dipped in the colour of Yoga this day.

The ministry of AYUSH, the nodal ministry for cel-

ebration of International Day of Yoga, has created a Yoga portal which says that 'Yoga is a trend that has been flourishing over the years; rather, it has become a trendsetter in maintaining physical and mental well-being. Each Yogic activity is a key to improving flexibility, strength, balance, and harmony'. Yoga portal is a platform to help people embrace, practice, and enjoy Yoga daily. It is a perfect gateway to search for the best Yoga resources, Common Yoga Protocol training videos, Yoga Research, Yoga Centres, and the latest Yoga events to participate in. Different activities like Yoga classes, Yoga camps, awareness and sensitisation talk and discussions, live Yoga demonstrations, meditation classes, and other competitions are being organised for the youth to attract and motivate them towards the practice of Yoga. Higher educational institutions are already geared up with organisation of practice of common Yoga protocol, seminars, and webinars on various aspects of Yoga. Medical establishments are also equally engaged in celebrating International Day of Yoga because of the role and importance of Yoga in health and management of disease.

INCREASED AWARENESS ABOUT HEALTH

Since the celebration of the International Day of Yoga has been commenced, it is observed that we have started giving more attention to our body, our fitness, our weight, our flexibility, and our wellness. Now everybody wants to be healthy, fit, and flexible with the help of Yoga or some other form of exercise like walking or jogging or something else. Most of the people prefer Yoga practice and the main objective is gaining health and wellness. Interestingly, nobody wants to be unfit. Is it not so? Now, there is no apprehension in practicing Yoga. A lot of people can be seen regularly practicing Yoga in nearby parks and open grounds either in groups or alone.

The entire scenario of the country has been drastically changed. If you compare this situation before the year 2014, you can easily notice a big transformation. Transformation of thoughts, transformation of mind set, transformation of attitude, transformation of thinking about our own health and so on. We are more attentive and conscious now towards our health and wellness. The crowd in Yoga centres and increasing number of students pursuing higher studies in Yoga very clearly show the impact of Yoga on our mind. Yoga has a global recognition and appreciation. No doubt, the COVID-19 pandemic has strengthened our thoughts related to health and wellness in a convincing manner and made us realise that we need to think of health first and foremost.

We have started giving more attention to our body, fitness, weight, flexibility, and wellness ever since the celebration of the first International Day of Yoga on June 21, 2015

The practice of Yoga has proved a boon to the suffering mankind. Several research studies conducted globally have proved this many times and the research continues. Scientists and researchers are engaged in finding the way out in terms

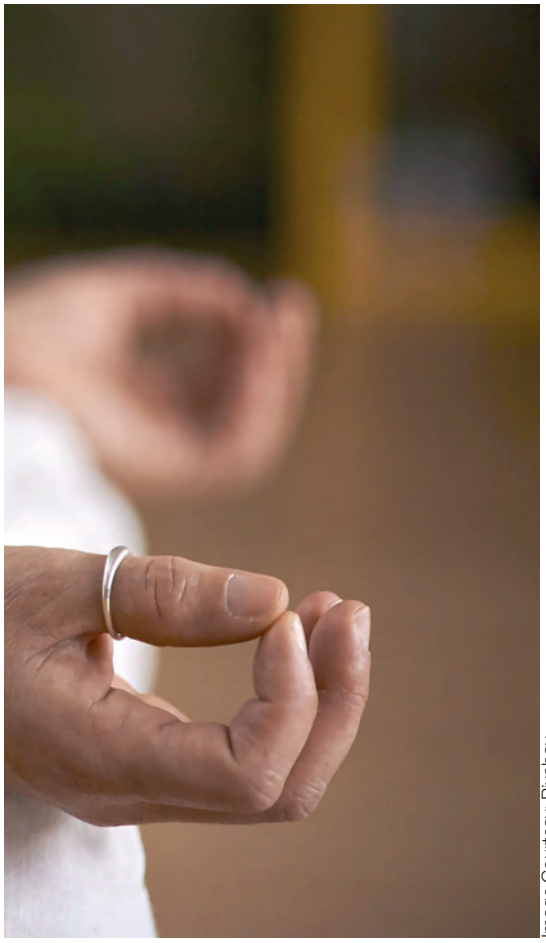


Image Courtesy: Pixabay

to discover the sense of oneness with ourselves, the world and nature. By changing our lifestyle and creating consciousness, it can help us to deal with climate change'.

YOGA, LIFESTYLE AND ENVIRONMENT

Yoga repeatedly talks about lifestyle modification and concerns with the nature and environment. In this context, it is not out of place to mention that the concept of 'Lifestyle for Environment' (LiFE) was introduced by the Prime Minister of India at COP26 in Glasgow on 1 November 2021, calling upon the global community of individuals and institutions to drive LiFE as an international mass movement towards 'mindful and deliberate utilisation, instead of mindless and destructive consumption' to protect and preserve the environment. It can be very well said that Yoga completely fits in this concept of 'Lifestyle for Environment' than any other system as Yoga emphasises upon the judicial use of the *panchamahabhuta*s. It works on the concept of simple living in accordance with nature.

Yoga is usually called a lifestyle, a way of healthy life, and a science as well as art of healthy and happy living. Yoga is an evergreen gift from India to mankind. It teaches us everything we want to learn, starting from daily routine to how to live gracefully and happily. Right from eating, thinking, dressing, sleeping, moving, talking, Yoga has all its principles which are very clear. Now, with the increased awareness about Yoga globally, it is our chance to inculcate it in our lifestyle to live a healthy and happy life. We should make it an inseparable part of daily routine. Today's unhealthy, mechanical, and stressful lifestyle is one of the major factors of so many illnesses. Non-communicable

Image Courtesy: Pixabay

of best practices to manage the havoc of lifestyle related disease conditions increasing at a fast pace. The world is badly suffering from the attack of non-communicable diseases, increasing issues related to mental health, situations arise due to post COVID-19 pandemic and is looking towards Yoga as a safe and sustainable solution and relief. Yoga practices have successfully proved their potential in strengthening immunity during the management of COVID-19 pandemic. Prime Minister Narendra Modi, while promoting and popularising Yoga, very rightly emphasises that 'Yoga is an invaluable gift of ancient Indian tradition. It embodies unity of mind and body; thought and action; restraint and fulfilment; harmony between man and nature and a holistic approach to health and well-being. Yoga is not about exercise but

diseases are spreading very fast, and we must act quickly to get rid of these. Yoga has been established and proved by the researchers as one of the easiest and effective tools to treat and manage unhealthy lifestyle and related disorders. It brings order to our lives, eliminating the causative factors of illness. So, why should we not consider celebrating Yoga Day the whole year instead of one day, to combat illnesses and promote happiness? In view of the above, every day should be Yoga Day for us.

We know that our life today is full of stress, anxiety, tensions, and worries. Besides, we have high expectations and desires which further increase our unease and stress. The whole day we face different situations, good or bad which affect our mood, our eating habits, sleeping patterns, behaviour, focus, and thought processes. If we are calm, we can face the adverse situations very easily whereas if our thoughts are not consistent, we may not be able to face the adverse situations. Yoga develops this confidence in us. It helps to make us self-reliant (*atmanirbhar*) in health care. The regular practice of Yoga makes you a different personality from others. A qualitative difference can be seen in a Yoga *sadhaka* in the level of confidence, calmness, patience, positivity, responsibility, etc. which can be rarely seen in others.

GETTING STARTED WITH YOGA

But despite the increasing craze for Yoga in public, it is felt that a lot of things are still required to be done. Still, so many people do not consider Yoga practice seriously. They start it when suffering from some chronic disorder where the life may be at risk. Sometimes, they wait until the condition moves beyond control and somebody advises them to practise Yoga. From here, the journey of exploring the social media, internet, Youtube, and WhatsApp starts, in search of yogic practices that need to be learnt. But this is not the correct way. It is always better and advisable to consult a physician and a Yoga therapist for making a Yoga related schedule or programme for you. After starting the practice, regularity and a follow up diary is also required to be maintained. Start with simple one, and gradually move towards hard practices if advised so. It is also seen that the practitioners feel themselves impatient after starting Yoga as they are looking for some quick results. But always it is advised to practice it for a particular period along with a yogic diet schedule and certain dos and don'ts. However, regular practice for longer days is always beneficial. Nothing is more beneficial if we could start our day with Yoga.

Yoga brings order to our lives, eliminating the causative factors of illness. So, why should we not consider celebrating Yoga Day the whole year instead of one day, to combat illnesses and promote happiness?

The basic thing in Yoga practice is the individual's involvement. It is observed several times that Yoga is practiced mechanically like an exercise because the practitioner is supposed to complete the task within a time frame which is not advisable. You can come across so many persons who have been practicing Yoga regularly for years but still have anxiety, stress, tension, anger,

Image Courtesy: Pixabay

Prime Minister Narendra Modi performed Yoga at the 9th annual International Day of Yoga 2023 celebrations at the UN Headquarters in New York on June 21

and uneasiness because they don't involve themselves in the practice. Rather, they practice Yoga in a mechanical way in a hurry without focussing their concentration on the practice they are doing and also the breathing pattern. At that time, their mind wanders somewhere else instead of focussing on the practice. Hence, complete involvement in the practice is always essential for optimum results.

FINDING BALANCE IN LIFE

In today's chaotic condition where things are scattered and expectations are at an unprecedented high, Yoga prepares and trains us for a healthy and happy life which includes regular daily routine, good eating habits, good thinking habits, and a good sleeping hygiene, besides so many other advantages. It balances the chaotic situation, makes things simple and understandable, and often paves the way to come out from those difficult situations. Besides this, daily practice of Yoga can give you numerous health benefits. Some of them are — overall health and general wellbeing, improved flexibility, correct posture, increased muscle strength and tone, proper maintenance of weight, better immunity, high energy level, good quality of sleep, due importance to food, healthy eating habits, better understanding and behaviour, strong social relationships, increased level of awareness, balanced metabolism, improved respiration, and vitality, freedom from stress and anxiety, high level of confidence, focussed approach, healthy attitude, positivitys, etc.

In this era of unhealth, Yoga is the only scientific way which motivates us towards the benefits of a traditional healthy lifestyle. Yoga promotes positive health, prevents disease, manages the disease conditions, and helps in restoring health in a holistic way. The whole world is looking eagerly towards Yoga for health and wellbeing. It deals with all aspects like physical, social, mental, moral, emotional, and spiritual, and makes the practitioner balanced in his thoughts and behaviour. A research study says: 'As a form of low-impact exercise, Yoga has been shown to lower stress hormones in our bodies while simultaneously increasing beneficial brain chemicals like endorphins and GABA (gamma-aminobutyric acid). These feel-good chemicals help decrease anxiety and improve mood'. Another research has shown that yoga practice can reduce risk factors for heart disease such as high blood pressure, high cholesterol, and abdominal obesity. Studies on older adults have shown significant improvements in balance, mobility, cognitive function and overall quality of life.

Here, we must understand that Yoga is not a workout like other form of exercises, rather it is a unique combination of different postures (*asanas*), breathing practices (*pranayama*), relaxation (*shithilikaran*), and meditation (*dhyana*), which are responsible for transformation of our health at different levels. Interestingly, Yoga is being used as an add-on

Yoga is not a workout like other forms of exercises but a unique combination of *asana*s, breathing exercises, relaxation and meditation techniques which are responsible for transformation of health at different levels

Image Courtesy: Shutterstock

therapy or adjuvant therapy in different research studies along with conventional medicine and other systems, establishing its importance globally.

A WAY OF LIFE

On the 8th International Day of Yoga in 2022, the Prime Minister of India Narendra Modi remarked that 'Yoga has now become a global festival as there is widespread acceptance of the ancient Indian practice. Yoga is not only for any individual, but for the entire humanity. Therefore, this time the theme of International Day of Yoga is — Yoga for humanity. This whole universe starts from our own body and soul. The universe starts from us, and Yoga makes us conscious of everything within us and builds a sense of awareness'.

Yoga is a spiritual discipline. The journey of Yoga starts from making ourselves a better person with better thoughts and better understanding. It creates a bond with us, with the family, with society, with the environment, with trees and animals, with rivers and mountains, and with the planet we live in. A bond of understanding and oneness. It makes us free from the unhealth. It relaxes and gives peace of mind. It is like a light in dark and closed room and revives our closed relations with fellow humans. Yoga heals and helps us in making our life happy and beautiful. Hence, Yoga is practiced for total health.

In the present scenario of unhealth, following the yogic way is the need of the hour. If you really want to save your health and live a healthy lifestyle, you must follow a yogic routine. It will empower you by making the foundation of your health strong and sustainable. We must understand that there is no shortcut for health. If you want to be healthy, you must follow the routine. Yoga is a mainstream activity now the world over and the way to achieve the best.

So, what are you waiting for? Make a resolution, get a *chatai*, identify some peaceful area, and start practicing Yoga from today itself, because tomorrow never comes. Don't think what will people say. Make it a habit and start feeling the difference. Do Yoga every day, because it is the safest and easiest way to deal with anxiety, hate and unease spreading in society. Sometimes, it appears that practicing Yoga may not be very helpful for a particular illness or a disease condition, but certainly people of all age groups and physical abilities can practice Yoga. Because it focusses, it motivates, it encourages, and spreads positivity around us. So don't wait for Yoga Day celebrations. Instead, celebrate Yoga every day, the whole month, the whole year, and the whole life. Celebrate it lifelong as a festival of balanced thoughts, peace and happiness, and transformation into a different personality to make all of us true citizens of the country and to become self-reliant in the matters of health.

**The writer is former Assistant Director (Naturopathy), CCRYN, Ministry of AYUSH, New Delhi. Presently, he is Director and Advisor at the upcoming Panchatatva Medical College and Research Centre of Naturopathy and Yogic Sciences, Samalkha, Haryana. He can be reached at rajivrastogi2018@gmail.com*

Image Courtesy: Pixabay

The Wholeness Paradigm

The Swadeshi Solution: Unleashing the Power of Yoga in Combating Diseases

■ **Dr Indranill Basu-Ray**

At the core of India's rich heritage lies an ancient practice that has been a beacon of health and wellness for centuries—Yoga. Beyond just a series of physical exercises, Yoga is a philosophy, a lifestyle that harmonises the body, mind, and spirit. As we confront the escalating burden of non-communicable diseases (NCDs), it's time we revisit this integral part of our heritage and culture, backed by science, i.e., Yoga.

The World Health Organization (WHO) identifies NCDs as the primary cause of death globally, accounting for 74% of all fatalities. The four primary NCDs include cardiovascular diseases, cancer, chronic respiratory diseases, and diabetes. In India, the situation is similarly critical, with NCDs contributing to about 65% of deaths.

Cardiovascular diseases (CVDs) pose a significant health challenge in India. In 2020, CVDs accounted for 27.4% of all deaths. The primary cause of CVDs in India is coronary heart disease (CHD), responsible for 53% of all CVD deaths. Stroke follows closely, causing 23% of all CVD deaths. Other prevalent CVDs in India include heart failure, peripheral artery disease, and congenital heart disease.

According to Apollo's *Annual Health of the Nation* reports, between 2019 and 2022, India saw a 50% increase in obesity, an 18% rise in dyslipidemia and cholesterol irregularities, an 8% increase in diabetes, and an 11% surge in hypertension cases.

In this challenging health landscape, Yoga emerges as a beacon of hope. A study published in the *European Journal of Preventive Cardiology* suggests that yoga can significantly aid in the fight

Image Courtesy: Shutterstock

against heart disease by reducing risk factors such as high blood pressure and cholesterol levels. The *Journal of Cardiopulmonary Rehabilitation and Prevention* recognizes yoga as a potent form of mind-body exercise that can help manage and prevent CVDs.

The Public Health Foundation of India estimates that NCDs would cost India more than $6.2 trillion between 2012 and 2030, highlighting the urgent need for effective and sustainable solutions. With its combination of physical postures, breathing exercises, and meditation, yoga can play a crucial role in managing and preventing NCDs. A study in the *Indian Journal of Health Economics and Policy* found that preventive healthcare measures like yoga can reduce healthcare costs and increase productivity.

In India, about 77 million people over 18 years suffer from diabetes, and nearly 25 million are prediabetics. A systematic review in the *Journal of Diabetes Research* found that yoga may aid glycemic control and improve other metabolic and cardiovascular risk factors for type 2 diabetes, underscoring yoga's potential as a therapeutic intervention.

In the realm of mental health, yoga has shown promising results. In 2021, 197.3 million people (1 in 7) in India suffered from mental disorders. Depression is India's most common mental disorder, affecting 53.7 million people. Anxiety disorders are the second most common, affecting 45.8 million people. As revealed by a research review in the *Journal of Clinical Psychology*, yoga can help alleviate stress, sharpen focus, and bolster emotional health, making it a powerful tool in managing mental health disorders.

As a nation, we must integrate the ancient practice of Yoga into our healthcare system

In the face of the escalating burden of NCDs (Non-communicable Diseases), the time is ripe to embrace Yoga, our indigenous solution to a healthier future

But that is not all the effect Yoga can have on the brain. Incorporating the recent research on the effect of yoga and meditation on the brain, we can further understand the profound impact of these practices. Research has shown that yoga and meditation can significantly improve cognitive function, reduce stress, and enhance overall well-being.

In a study titled *Evolution and Yoga. Hypothesis: From Reptilian to Intuitional Brain* by Carlos Munoz, it is postulated that the human brain is still evolving and that the practice of yoga and meditation can contribute to this evolution. The study suggests that developing an 'intuitional brain' with neural networks that prevail in human noble qualities could be possible in the future. This aligns with the idea that the sages and yogis of the past would have achieved enlightenment through their lifelong practice of yoga and meditation.

In the face of the escalating burden of NCDs, the time is ripe to embrace Yoga, our indigenous solution. As a nation, we must integrate this ancient practice into our healthcare system, preserving our rich cultural heritage and fostering a healthier and more resilient India. Yoga is not merely a relic of our past; it is our pathway to a healthier future. It stands as a testament to our ancestors' wisdom, our people's resilience, and the power of our indigenous solutions.

Yoga, deeply rooted in our culture and philosophy, offers immense potential in combating the escalating burden of NCDs. It provides a holistic, sustainable solution to our health challenges. As we move forward, let's embrace Yoga, our indigenous solution, and strive to alleviate the burden of NCDs in our country. With the power of Yoga, we can not only manage these health challenges but also enhance the overall well-being of our people, paving the way for a healthier and more resilient India.

**The writer is a Cardiologist and a Professor of Cardiology & Public Health. He is the Founder-Chairman American Academy of Yoga in Medicine. @ibasuray*

Autonomous Train Protection System Developed in India

The recent calamitous train accident in Odisha has underscored the need of fortifying India's dense rail network as much as possible to prevent any future disasters, in which Kavach promises to be a highly reliable shield

Nearly 280 people died and over a thousand people were injured in the devastating train accident in Balasore district of Odisha on 2 June, and many more bodies are still missing.

Such tragic events demonstrate the necessity for strict safety controls, ongoing infrastructure and operating protocol improvement, and passenger and rail employee safety protection in order to avoid train collisions.

To prevent such mishaps, the Indian Railways and associated authorities try to raise safety standards and install cutting-edge technologies like autonomous train protection systems. To increase railway safety, the Indian Railway has created its own homegrown Automatic Railway Protection (ATP) System named Kavach.

Kavach is meant to provide protection by preventing trains from passing the signal at Danger (Red) and avoid collision. It activates the train braking system automatically if the driver fails to control the train as per the speed

■ Sonam Singh Subhedar

restrictions. In addition, it prevents collision between two locomotives equipped with functional KAVACH system. Kavach is one of the cheapest, Safety Integrity Level 4 (SIL-4) certified technologies with the probability of error of 1 in 10,000 years. Also, it opens avenues of export of this indigenous technology for railways.

WHAT IS KAVACH?

Kavach, which in Hindi means armour or shield is a Safety Integrity Level 4 (SIL-4) accredited technology, which guarantees a high level of safety with an exceptionally low probability of error (1 error in 10,000 years). The intention is to implement Kavach on a 2,000 km network as part of the Atmanirbhar Bharat plan in the years 2022–2023, while the entire system is expected to be operational by FY 2027-28. Along with increasing capacity and safety, this expansion will also present prospects for the export of local technology to other railways throughout the world.

Kavach, created by Research Design and Standards Organisation (RDSO) in association with three Indian vendors, has been chosen by Indian Railways as their National ATP System.

Kavach has a variety of uses. It permits train operation under difficult weather circumstances like thick fog and helps the loco pilot avoid Signal Passing At Danger (SPAD) and overspeeding.

"Kavach improves safety and effectiveness by managing the train's speed and applying the brakes automatically when necessary. The broadcasting of line-side signals to the train cab is one of Kavach's primary characteristics; this capability is especially useful in fast-moving and foggy conditions. It

Image Courtesy: Shutterstock

Image Courtesy: Twitter/BJP

Prime Minister Narendra Modi interacts with rescuers as he takes stock of the situation at the site of Balasore train accident in Odisha

can automatically blow the whistle at level crossing gates and continuously updates the train's movement authority," Yogesh Kumar Baweja, Director General (Public Relations) at the Ministry of Railways told Science India.

Although the Kavach system was created to avert rail accidents brought on by poor signalling, experts think that the Odisha train tragedy could not have been prevented because of a flaw in the electric interlocking system.

"Indian Railways places the highest importance on safety, and ongoing efforts are made to create homegrown equipment and implement other preventative measures like these to avoid train accidents. To prevent accidents caused by human error leading to Signal Passing at Danger and Over-Speeding, Indian Railways has created automatic train protection system that has been renamed Kavach (Train Collision Avoidance System)," said Baweja.

Other advantages of Kavach include slowing down trains by automatically applying the brakes as they approach turnouts, repeating signal aspects in the cab (helpful for faster speeds and foggy conditions), and automatic whistling at level crossing gates.

"It has been agreed to deploy Kavach in stages due to the complexity of the implementation process, which calls for all rolling stock, wayside stations, and track to be equipped with the technology. Kavach has so far been used for 1,455 kms route on the South Central Railway with 77 different locomotives. Kavach construction is now underway on the 3000-route km Delhi-Mumbai and Delhi-Howrah corridors," Baweja added.

Kavach is now being introduced on Indian Railways in stages. Additionally, there is prospective export potential for Kavach.

On the South Central Railway''s Lingamapalli-Vikarabad-Wadi and Vikarabad-Bidar sections, Kavach has undergone trials.

Three vendors received approval for additional development orders on

Image Courtesy: Twitter

Railways Minister Ashwini Vaishnaw at the live testing of Kavach, India's automatic train protection technology

Indian Railways after successful trials. The South Central Railway's Manmad-Mudkhed-Dhone-Guntakal and Bidar-Parbhani sections, totalling a combined 1,199 route km, are currently undergoing work to adopt Kavach.

A total of Rs 16.88 crore has been spent so far on the development of Kavach. The New Delhi-Howrah and New Delhi-Mumbai sections of Kavach are scheduled to be rolled out, with a completion date of March 2024. The knowledge acquired from these initial implementations will be used to inform subsequent rollouts.

GLOBALLY SIGNIFICANT AUTOMATIC RAILWAY PROTECTION SYSTEMS

To improve safety and prevent collisions, various nations and organisations have put in place various kinds of anti-collision systems for trains.

In several nations throughout the world, Automatic Train Protection (ATP) systems are in place to guarantee the security of train operations. Another well-known standardised system used in Europe to guarantee train safety and avert crashes is the European Train Control System (ETCS). To accomplish its goals, ETCS makes use of signalling, communication, and train control technology.

In order to meet the corporate goal of safety in train operations across Indian Railways, Research Designs and Standards Organisation (RDSO) created the KAVACH, an indigenous ATP system, in conjunction with Indian industry and trials facilitated by South Central Railway. It is a cutting-edge electronic system with a Safety Integrity Level of 4.

The Positive Train Control (PTC) ATP system is mostly utilised in the US. It makes use of onboard computers, wireless connection, and GPS to track and manage train movement. Train-to-train collisions, speed-related derailments, and illegal train movements are all things that PTC attempts to avoid.

In the UK, the Train Protection and Warning System (TPWS) is in use. It is intended to stop over-speeding and train crashes. Trackside transmitters and onboard receivers are used by TPWS to track train speed and enforce speed limits.

In North America, centralised traffic control, or CTC, is a common ATP system. To regulate train movements, track train positions, and avoid collisions, it integrates track circuits, signals, and centralised control.

Ansaldo STS, an Italian corporation, created the ATP system known as the Advanced Train Control System (ATCS). It is utilised in many nations throughout the world to ensure safe train operations by controlling train speeds, keeping a safe distance between trains, and giving controllers access to real-time information.

Kavach has been created by Research Designs and Standards Organisation

FEATURES OF KAVACH

- Prevention of Signal Passing at Danger (SPAD)
- Continuous update of Movement Authority with display of signal aspects in Driver Machine Interface (DMI) / Loco Pilot operation cum Indication Panel (LPOCIP)
- Automatic Braking for Prevention of Over-speeding
- Auto Whistling while approaching Level Crossing Gates
- Prevention of collision between two locomotives equipped with functional Kavach
- SoS messages during emergency situations
- Centralised live monitoring of train movements through Network Monitor System.

DEPLOYMENT STRATEGIES

As much as 96% of railway traffic is carried on Indian Railway High Density Network and Highly Used Network routes. To transport this traffic safely, Kavach works are being taken up in a focused manner as per following priority set by the Railway Board.

First Priority: High Density Routes and on New Delhi - Mumbai and New Delhi - Howrah sections for 160 kmph with Automatic Block Signalling and Centralized Traffic Control. These sections have higher chances of human errors on part of drivers resulting into accidents as trains run closer to each other.

Second Priority: On the Highly Used Networks with Automatic Block Signalling and Centralized Traffic Control.

Third Priority: On other Passenger High Density Routes with Automatic Block Signalling.

Fourth Priority: All other routes.

As part of the Atmanirbhar Bharat initiative, 2,000 km of network will be brought under Kavach for safety and capacity augmentation in 2022-23. Around 34,000 kms of network will be brought under Kavach eventually.

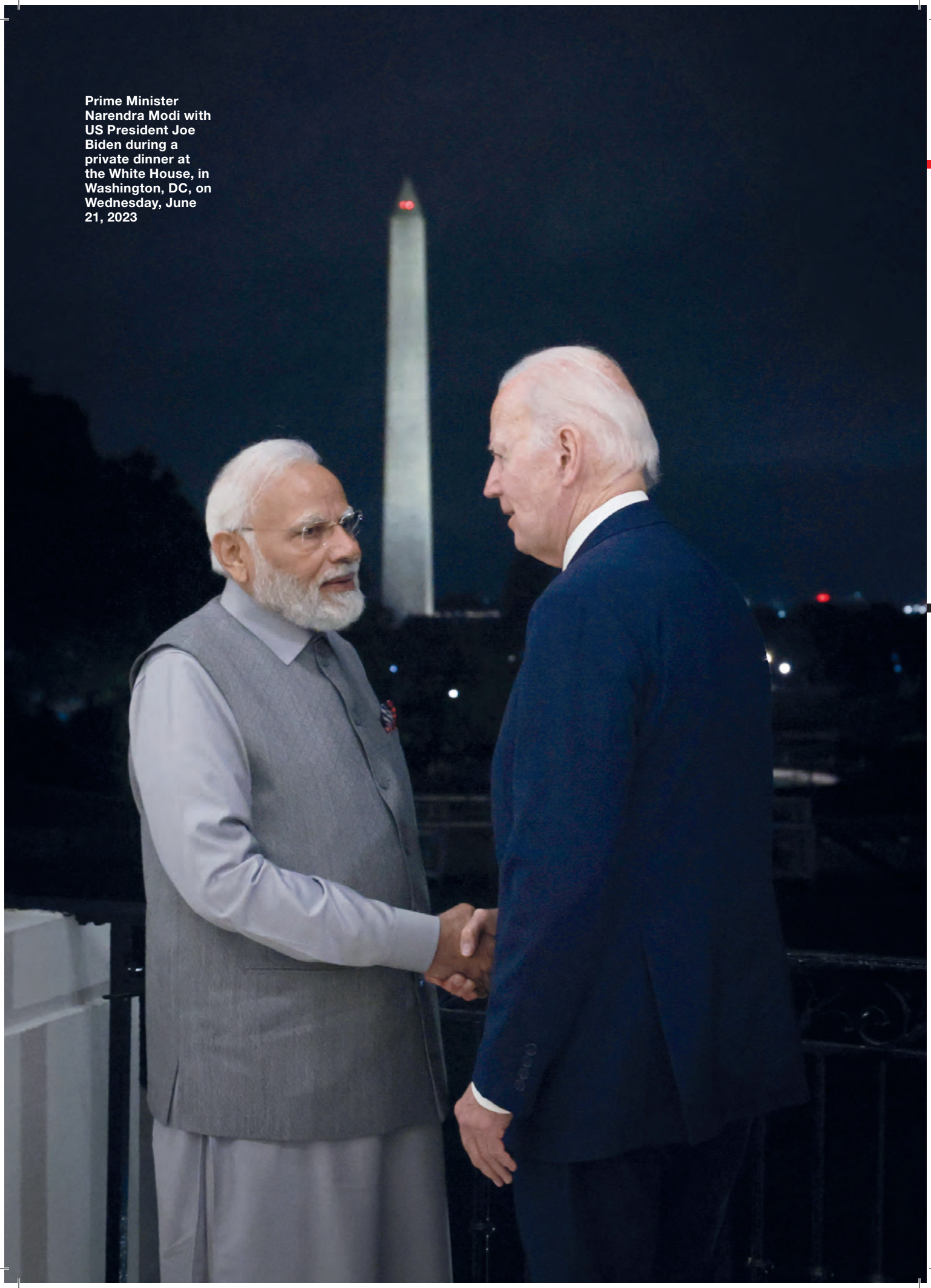
HOW MANY TRAINS HAVE KAVACH SYSTEM IN INDIA?

How many Indian trains are using the Kavach system? Can the Indian government's new technology prevent accidents and railway disasters there? Here is everything you require to know.

The Indian Railways operate over 13,169 passenger trains daily, but only 65 locomotives, 1445 kilometres of tracks, and 134 stations are currently equipped with the Kavach system.

The South Central Railway zone, which includes Maharashtra, Telangana, Karnataka, and Andhra Pradesh, is the only area where Kavach is now in use. As part of Mission Raftaar, it is also being implemented on the key lines between Delhi and Mumbai and Delhi and Howrah.

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



Prime Minister Narendra Modi with US President Joe Biden during a private dinner at the White House, in Washington, DC, on Wednesday, June 21, 2023

SCIENCE DIPLOMACY

Yoga, Technology, and Security: PM Modi Redefines Indian Diplomacy

From the seas to the stars, the PM's recent visit to the US left no corner of human enterprise untouched in forging partnership between the two nations. It will now be deepened by the defining role of technology

Image Courtesy: PIB

■ Uday Kumar Varma

Almost a decade ago, when in September 2014 Prime Minister Narendra Modi, while addressing the UNGA (United Nations General Assembly), first proposed including yoga for achieving the broader objectives of climatic sustainability, it took everyone, including the Indian Diplomatic Corps, by surprise. Yoga, he said is not just exercise. "By changing our lifestyle and creating consciousness, it can also help us deal with climate change." He then urged the nations present to support the adoption of an 'International Yoga Day'. By linking Yoga to climate change and health, the two cardinal challenges before the world body, he ensured that his proposal could not be ignored.

Nine years later, he led an esoteric and exclusive group of international diplomats in a yoga session on the lawns of UN Headquarters at New York. The global event with the participation of over 180 countries, alongside the presence of the President of the 77th UN General Assembly Casaba Korosi, New York City Mayor Eric Adams, actor Richard Gere, Grammy award winner Rickey Kej among others, was registered in the Guinness Book of World Record for witnessing the participation of most nationalities in a Yoga session.

And he said, "Yoga is unifying. It is for everyone: for all ethnicities, for all faiths and for all cultures." "Yoga is truly universal."

A more convincing demonstration of his assertion could not have seen such visible, vibrant and compelling evidence.

Stressing the nondenominational aspect of the practice that has roots in Hindu spirituality, he said, "I am told that almost every nationality is represented here today, and what an amazing cause to bring us all together." "Yoga is free from patents, royalty payments and copyrights."

After his remarks, the Prime Minister joined the crowd for yogic exercises.

If one were to cite an instance of India's rising global clout, it was this, a resounding endorsement of India's immense reservoir of soft power.

A DAUNTING TASK

But when he had first mooted the idea, the challenges were formidable. The proposal had to be implemented through a resolution that enjoyed the support of a majority of the UN's 193 member states. The link between yoga and health, within the broader framework of encouraging sustainable lifestyles and sustainable consumption, became a major argument in selling the idea.

To ensure that the proposal to designate an International Yoga Day contributed to addressing global problems, it was decided to table this proposal under the 'global health and foreign policy' head of the UNGA's already adopted agenda. The proposal addressed two ongoing processes in multilateral negotiations — the formulation of the sustainable development goals (SDGs)

Participants at the 9th International Day of Yoga event with Prime Minister Narendra Modi at the United Nations headquarters in New York City on June 21, 2023

to be adopted by the 2030 Agenda in September 2015 in New York, and climate change negotiations scheduled to conclude at the Conference of Parties meeting of the United Nations Framework Convention on Climate Change in Paris in December 2015.

That UNGA approved and adopted the proposal unanimously, becoming a historic moment both for India and UN.

The declaration, acceptance, and the subsequent popularity of International Yoga Day must be termed as one of the most far-reaching diplomatic initiatives successfully executed by India.

The seriousness of Indian government in expanding the framework in which people around the world think of yoga and its role, has seen fruition substantially. Today, from Colombia to New Zealand, from the icy Antarctica to the sizzling Africa, Yoga is seen as the new lifestyle, a new existential statement.

The declaration, acceptance, and subsequent popularity of International Yoga Day is one of the most far-reaching diplomatic initiatives successfully executed by India

DIPLOMATIC ASANA: DIPLOSANA, YOGA AS SOFT POWER

A young journalist while writing on India's yoga diplomacy, imaginatively described it as Diplosana. Indeed, Yoga has emerged as the most potent tool of Indian soft diplomacy in recent years.

Joseph S. Nye Jr., a former Dean of Harvard's Kennedy School of Government and one of the most influential thinkers on American foreign policy, describes soft power as the ability to shape preferences of others through appeal and attraction, and may be through aides. According to him, there are three pillars of soft power — political values, culture and foreign policy. As the binary of political values has become obsolete today, India's strategy to gain global clout must consider effectively propagating its cultural heritage. Yoga is its most pervasive and persistent symbol. The other strategy must necessarily be to follow independent foreign policy. The on-going Russia-Ukraine war has brought this independence prominently to fore.

Though India has long been an advocate of cultural diplomacy, the strategy wasn't compelling enough to propel her to the global stage, certainly not till Yoga became her most potent and popular cultural export. Propagating Yoga as an Indian contribution to the world for attaining a healthy lifestyle has become an effective instrument of diplomacy. Yoga is capturing the hearts and minds of the entire world.

In international relations, influence is conventionally understood in two contexts, military and economic might. India has already attained the status of the fifth-largest economy in the world, and is currently the fastest-growing one. As far as the military is concerned, the Global Firepower Index, 2022 suggests that India is the fourth most powerful military nation in the world.

And yet, successful states need both hard and soft power; as hard power (military and economic might) helps the nation exert influence, soft power helps shape long term attitudes and preferences, thus, promising a long-term alliance. India may happily achieve a sweet spot in which a mix of both hard and soft power could achieve the ideal goals for the nation. India has placed its bet, and the prognosis is promising.

BEYOND YOGA; TECHNOLOGY AND SECURITY SEAL TIES

Even if the grand show of 21st June at UN Headquarters is so gracelessly underplayed by some in India, the range of agreements and understandings reached during Modi's visit are enormous and unprecedented.

While trade conventionally finds primacy in such visits and the agreement to terminate six outstanding disputes at the World Trade Organization was a big gain, it were areas of advanced technology and defence that made the visit so different and so remarkable.

These areas comprise the forefronts of technology, significant security tie-ups and in their range encompass the stars and the seas.

The effort to make India a hub of semi-conductor manufacturing got a

Image Courtesy: PIB

big boost when US memory chip firm Micron Technology announced its intended investment up to $825 million in a new chip assembly and test plant in Gujarat, its first factory in India. The investment will scale up to $2.75 billion with Government of India and the state of Gujarat joining hands. US semiconductor toolmaker Applied Materials (AMAT.O) is set to invest $400 million over four years in a new engineering centre in India.

The other significant area relates to drones. India is set to procure 31 armed MQ-9B Sea Guardian drones made by General Atomics worth over $3 billion. These MQ-9Bs will be assembled in India in new facilities to be established by them.

But the really historic agreement has materialised in the area of Fighter Jet manufacturing. General Electric's aero-

In the long-term perspective, various defence agreements between India and US are a huge initiative

space unit has signed an agreement with India's state-owned Hindustan Aeronautics Ltd to make fighter jet engines for the Indian Air Force. This landmark arrangement includes the potential joint production of GE Aerospace's F414 engines in India to be used to power Tejas fighter jets.

In the long-term perspective, the agreement to work together for the creation of logistic, repair, and maintenance infrastructure for aircraft and vessels in India and the launch of the India-US Defence Acceleration Ecosystem (INDUS-X), a network of universities, start-ups, industry and think tanks, is a huge initiative. To begin with, Boeing will invest $100 million on infrastructure and programmes to train pilots in India, supporting the country's need for 31,000 new pilots over the next 20 years. Boeing also announced its completion of a C-17 aftermarket support facility for MRO and a new parts logistics centre in India.

India's National Quantum Mission will find support from US on Advanced Computing. A joint Indo-US Quantum Coordination Mechanism to facilitate joint research between the public and private sectors across both the countries has been put in place, unleashing endless possibilities. A $2-million grant programme for joint development of AI and jointly funded research projects on cybersecurity is another hallmark.

Likewise, in the area of space explo-

Image Courtesy: Shutterstock

ration India agreed to join the US-led Artemis Accords on space exploration and to work with NASA on a joint mission to the International Space Station in 2024.

A less publicised but far reaching outcome was India joining the US led Minerals Security Partnership (MSP), to create reliable supply chains of critical energy minerals like Lithium and Cobalt. India will join 12 other partner countries, plus the European Union. India's Epsilon Carbon Limited will invest $650 million in a greenfield electric vehicle battery component factory, hiring over 500 employees over the course of five years.

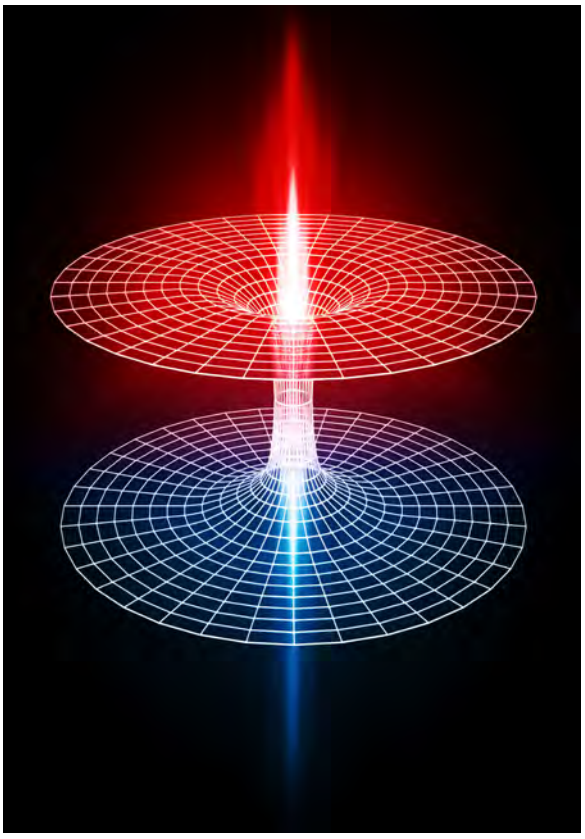
The area of green energy found an unprecedented pitch. For the first time, an Indian company Vikram Solar Ltd is partnering an investment in a US solar energy supply chain, beginning with a factory in Colorado next year.

Image Courtesy: Wikimedia

Above: Applied Materials is slated to invest $400 million over four years to establish a new engineering centre in India; Top: An understanding was reached on facilitating visas for Indians going to the US

The newly formed company, VSK Energy LLC, will pump in $1.5 billion to aid the US push to build a clean energy manufacturing sector to compete with China. Another platform aimed at accelerating cooperation in green hydrogen, offshore and onshore wind, and other emerging technologies was also announced.

In non-technology area, an instantly visible understanding was about visa renewals and facilitating the Indians coming to US. The State Department has announced that a small number of Indians and other foreign workers on H-1B visas will be able to renew those visas in the U.S. without having to travel abroad, part of a pilot programme that could be expanded in coming years. New US consulates in Bengaluru and Ahmedabad and an Indian consulate in Seattle were also announced.



The implications and the impact of the announcements made during Modi's visit are monumental and unprecedent. No corner of human enterprise had been left untouched by the partnership between the two nations. From the seas to the stars, this partnership will now be deepened by the defining role of technology.

The Joint Statement was unequivocal. "From expanding bilateral technology partnership with a focus on tech-sharing and co-production to creating first of its kind platforms on financing renewables and closer industry tie-ups on space, the strategic global tie-ups are aimed at keeping India and the US as the closest partners in the world".

The echo of a definitive incorporation of the key Indian demand of greater technology sharing, while also ensuring co-development, and co-production opportunities was unmistakable. The chosen areas of inter alia AI, Quantum technology, Advanced Computing, and Space underlined the vision and foresightedness of the two leaderships.

In fact, the term 'technology' was mentioned as many as 44 times in the joint statement. It had found just five mentions the last time both nations released a joint statement, back in February 2020.

A BRIGHT FUTURE

Prime Minister Modi has given a new dimension, a new direction, and a new dynamism to the Indo-US ties. Its advantages may take a little while to unfold, but a firm foundation has been laid based on India's perception and standing as an emerging superpower on the world stage. It also conveys a message that India has arrived, and the remainder of the century is to be likely known as India's century.

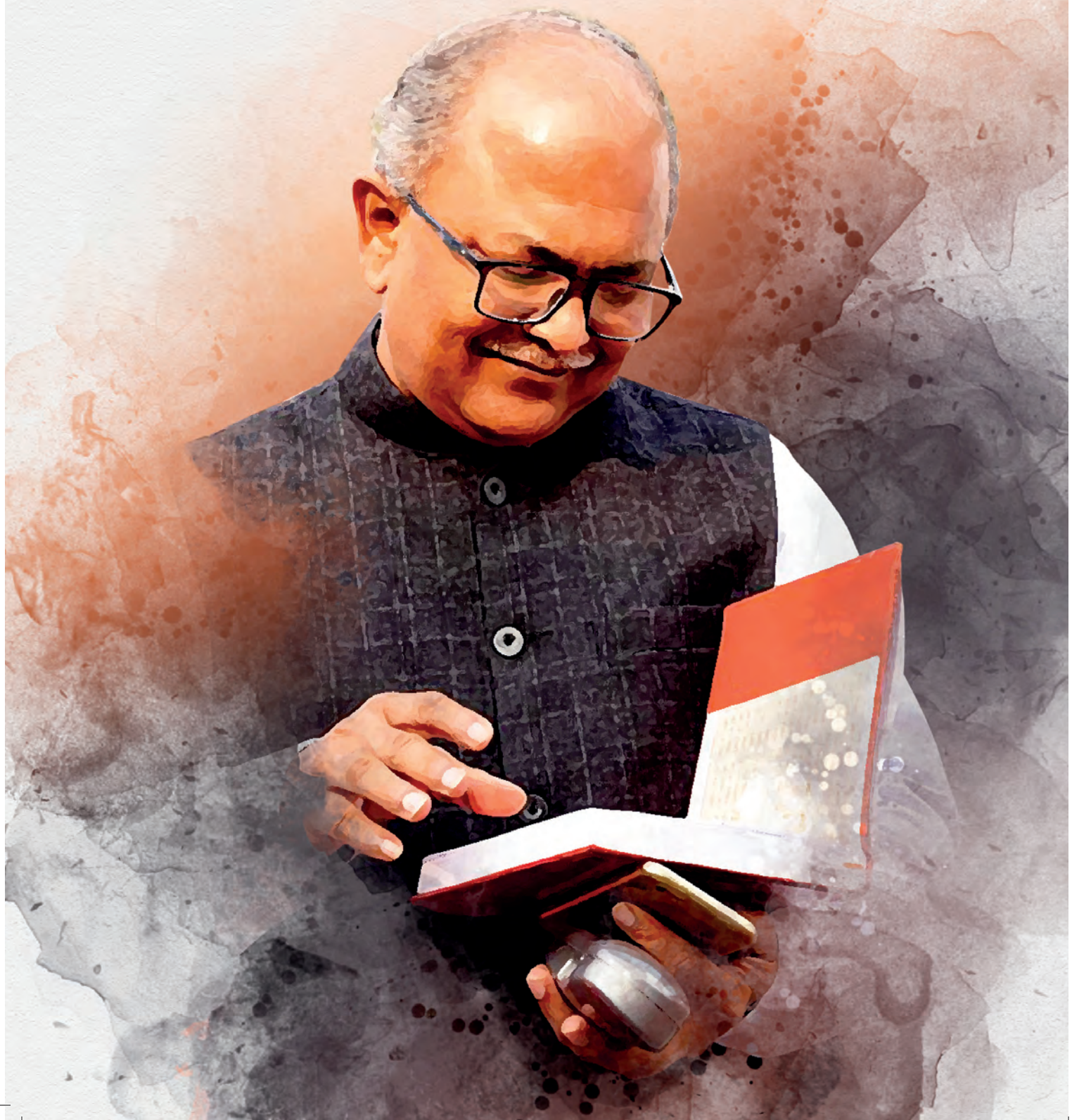
**The writer, a Harvard educated civil servant, is a former Secretary to the Government of India. He also served on the Central Administrative Tribunal and as Secretary General of ASSOCHAM. He commands extensive expertise in the fields including Media and Information, Industrial and Labour Reforms, and Public Policy.*

Image Courtesy: Wikipedia

General Electric's aerospace unit has signed an agreement with HAL to make fighter jet engines for the Indian Air Force (Representational image)

Jayant Sahasrabudhe

17 April 1966 - 2 June 2023



He Brought Focus on Contributions of Indian Scientists to Freedom Struggle

■ **Dr Shekhar Mande**

Jayantrao and I met for the first time when he visited the National Centre for Cell Science, Pune, and we had an informal meeting in Dr Yogesh Shouche's house over dinner. From that day until the unfortunate end, we remained close friends, colleagues, and as a family.

During our meetings, almost all our conversations would invariably move towards the contributions of scientists in India, the traditional practices followed by our people and how these were firmly grounded on rational thinking, on how science had been developed from ancient times, and how we could leverage the good ancient cultural practices for our own progress. Jayantrao was a staunch nation-lover, and the interests of our people was very close to his heart. Consequently, he devoted all his life to the welfare of our society with a firm belief that some of the cultural practices be followed closely.

As our friendship grew, we came to know each other better, and many topics of mutual interests would come up for discussions. He had studied Swami Vivekananda deeply, and incidences from Swamiji's life were always fascinating to hear from Jayantrao. Swamiji's book on Indian music — *Sangeet Kalpataru*, which I was unaware until then, was ordered by me very soon afterwards. The details of Swamiji's conversations with many greats —Nikola Tesla, JN Tata and others — were very intricately described by Jayantrao. It is needless to mention and is well-known that these conversations left a deep impression on the leading personalities of the time. Much has been described in open literature about these incidences, but Jayantrao's mastery was in synthesizing. He presented these ideas with great clarity and eloquently. Soon, he began talking about Swamiji's life on public platforms, and not surprisingly, he received invitations from many scientific organisations to speak about the same.

Beyond Swamiji, Jayantrao became interested in the contributions of Indian scientists in the pre-independent era. It is principally due to Jayantrao's efforts, massive ones, that the realisation of scientists of India and their contributions in the freedom struggle could be brought to the public. Whether it be Acharya PC Ray's initiation of Chemical Industry in India, or Acharya JC Bose's Satyagraha, Jayantrao very passionately brought forward the nationalistic spirit of pre-independence scientists. All the examples that he narrated were convincing enough to realise that, indeed, such efforts were not only targeted towards improving the country's S&T ecosystem, but also towards uprising against the suppressive colonial powers. That the scientists worked towards this objective was a revealing fact to many in the society, and became a talking point in many places. The commemorative volume of *Science India* in this direction remains a master piece for this narrative.

Jayantrao was also deeply concerned about silos in which modern scientific establishments appeared to work in India. He often organised meetings in different cities so that scientific leadership in those cities came on the same platform and started interacting with each other. The culmination of these efforts was the conference of Science leaders in India in Hyderabad in March 2022, which saw participation of many scientific leaders across different scientific organisations and departments of the government coming together. Such was the impression of this meeting, that most people after returning home from the meeting, started discussions among other institutions to forge a path forward through scientific collaborations.

Jayantrao touched lives of many individuals and families wherever he travelled. His fine personality and deep understanding about Indian traditional knowledge system was unparalleled. With this understanding, he remains in the memory of all those with whom in came in touch. His gentle presence, scholarship on issues of history of Science, cultural practices and bringing together scientific leadership will be missed by the scientific community of India.

**The writer is President, Vijnana Bharati, and former Director General of CSIR (Council for Scientific and Industrial Research).*

A Humble Pracharak, Jayantji Took the Indian Science Movement to the Skies

■ **Praveen Ramdas**

Honourable Jayantji passed away on 2 June 2023 and ever since, I have been in innumerable tribute programmes, prayer meets and condolence meetings. Even after being the secretary of Vijnana Bharati, I could not dare to say a few words for him, because I felt that I didn't have the power to say anything about him. Some people are such that their life becomes an ideal for the entire nation and society. Honourable Jayantji had such a life.

Among those who give up everything to work for society and build the nation, Jayant Sahasrabudheji will remain a pioneer.

Jayantji was a meritorious student throughout and he used to go to the Shakha since his childhood as his parents were associated with the Sangh. His father Shrikant Sahasrabudhe had two children — Jayantji and Vinayak, who is two years younger than him. After completing BSc Tech from Mumbai University, Jayantji became a Sangh Pracharak in 1989. After two years, his brother also became a *pracharak*.

Pracharaks lead a life where they leave their home and family. As both Jayantji and his younger brother — who is an architect — turned *pracharak*s, there was no one to look after the family and soon, problems started cropping up. The brothers discussed the matter and the opportunity went to the elder brother.

Jayantji worked as a *pracharak* for a long time — he worked as a *pracharak* in every corner of Maharashtra, and as a *zila pracharak* and *vibhag pracharak* in Goa for a considerable length of time.

Wherever he went, he did complete survey and research about the life and history of that place. He did the same with Goa. When we think of Goa, we think about tourism, the beaches, and the Portuguese invasion. As *vibhag pracharak* in Goa, Jayantji learnt the history of the state and worked on rebuilding all the temples that had been destroyed. Jayantji did a great job of changing the mentality of slavery and westernisation within the society there. When Jayantji became a part of Vijnana Bharati, I went to Goa many times with him. I saw that people from every corner of Goa knew him — whether an elite family or a fisherman, Jayantji was known to all.

Vibhag Prachark is a big responsibility in the Sangh as the position holder leads the entire province. Jaytantji was Vibhag Pracharak of Konkan province — that extends from Mumbai to Goa — from 2001 to 2009. I met him for the first time in March 2009. There is a very big meeting of our Sangh, called the Pratinidhi Sabha where Jayantji was given the responsibility of Vijnana Bharati. I also used to work for Vijnana Bharati at that time, so I went to meet a senior

prachark, who was given the responsibility of Vijnana Bharati. He was such a simple person, just standing quietly in the corner. I asked him why was he standing there. He said that he was expecting someone from Vijnana Bharati would come and meet him . Jayakumarji and I met him. He told us that he didn't know much science but would do it.

A month later, he had an extensive travel plan. I had the responsibility of Madhya Pradesh at that time. I took him to every city in Madhya Pradesh to introduce him. I used to listen to his speeches and Jayantji used to speak as if he had been working with Vijnana Bharati for a decade, and not just a month. He stayed in Mumbai for a month and did a lot of research about India's contribution to science. His speeches were so powerful that I realised that I had not heard such eloquent speeches before even while being a part of Vijnana Bharati.

He used to say that the purpose of Vijnana Bharati was to spread knowledge about the tradition of science in India. When he came to Vijnana Bharati, he said that ours was an indigenous science movement. Swadeshi science is the tagline for Vijnana Bharati. Jayantji always used to say that we should aim to awaken the Swadeshi spirit as the world thought that India had no science and the British taught us modern science.

Once Jayantji and I went to Trichy, to a big, centuries-old temple. It is usually very hot in Tamil Nadu but in that temple, there was no heat. It felt as if it was air-conditioned. So I told Jayantji: "Brother, see how good the technology is!" He said, "Praveen, what did you think when you saw this temple? This temple is thousands of years old, so have you ever thought what technology would be there in India when this temple was being built, how high the technology was in our country? Workers of Vijnana Bharati should think like this.'

He said, and I agreed, that the knowledge of Indian architecture and workmanship were of the highest level.

He further said that to make sculptures, tools were needed, which implied that the level of our metallurgy would be superlative and many people would be involved in metalcraft. This implies the strength of India's technology to extract metal from the soil, our town planning, or knowledge of transportation to bring such big stones from different places in the country. He said, "Praveen, this entire temple is built in such good symmetry. At that time our science of measurement would have been of a very high level."

As a worker of Vijnana Bharati, he had this point of view. He tried to start a kind of 'Sanskar Ek Paddhati' in Vijnana Bharati .

After coming to Vijnana Bharati, he started many programmes. One of those was a new idea, called Tech for Seva or Technology for Seva. He narrated that once Dr APJ Abdul Kalam went to Jaipur and saw the prosthetic Jaipur leg. But it was very heavy. So Kalamji put a lot of mind to it. He used the fibre used in making rockets, which is lightweight. So, the erstwhile heavy Jaipur leg became lightweight and a blessing for those in need.

> Jayantji always used to say that the purpose of Vijnana Bharati was to **awaken the Swadeshi spirit among people and** spread knowledge about the tradition of science in India far and wide

There are many such people in the country doing small, wonderful things. Due to this, there is a change somewhere in the society. That's why, the person doing research in the lab and working in the field of technology should feel motivated to work on such problems.

What was the second objective of Tech for Seva? There are many problems in our society. Who should the people tell their problems? To redress these issues, Jayantji created a platform such as Tech for Seva. To provide motivation to scientists to create technologies to improve the lives of rural people. Second, a platform for people to tell their problems to scientists.

The talk of Vivekananda Sardha Shati was going on, everyone said that good programmes should be organised for Vivekanandaji's 150th birth anniversary. We, the workers of Vijnana Bharati, did not know what to do. Jayantji came up with a very good topic — Vivekananda and science. And he gave lectures on that subject all over India.

His lecture was, indeed, powerful, after which we understood Swami Vivekananda's great thoughts about science. He not only spoke about Swami Vivekananda's contribution to the formation of the Indian Institute of Science but also the role he and Sister Nivedita played in the life of Acharya Jagadish Chandra Bose. How did his approach to research develop after meeting Swami Vivekananda? How was Vivekananda ji related to the American scientist Nikola Tesla? We did not know about these things. We did not even know that Vivekanandaji had prepared many research papers. But Jayantji brought the entire topic in front of the society.

He always used to say that JC Bose and Acharya Prafulla Chandra Ray were ideal for the workers of Vijnana Bharati as these two men were world-class scientists whose contributions to modern science shook the world but their ethos remained Indian, making the country proud.

That is why Jayantji said that Acharya JC Bose and Acharya PC Ray were ideal for today's scientists. He said that Vijnana Bharati was established in 1991 but its right workers were Acharya Ray and CV Raman.

Jayantji held a huge seminar about a town planner named Patrick Geddes,

about whom nobody knew for long. Geddes was a British biologist and pioneering town planner who came to India and did the entire town planning of many cities, such as Indore, Jaipur, and Udaipur. His work was based on Indian Vaastu Shastra.

After that, when it came to the Azadi ka Amrit Mahotsav, Jayantji did humungous amount of research at that time, so much material came to the fore. How the British looted India using science? How and why was the Survey of India established? Survey of India was founded to map the natural resources of India, to loot India, and carry India's wealth to Britain. After that Botanical Survey of India was formed.

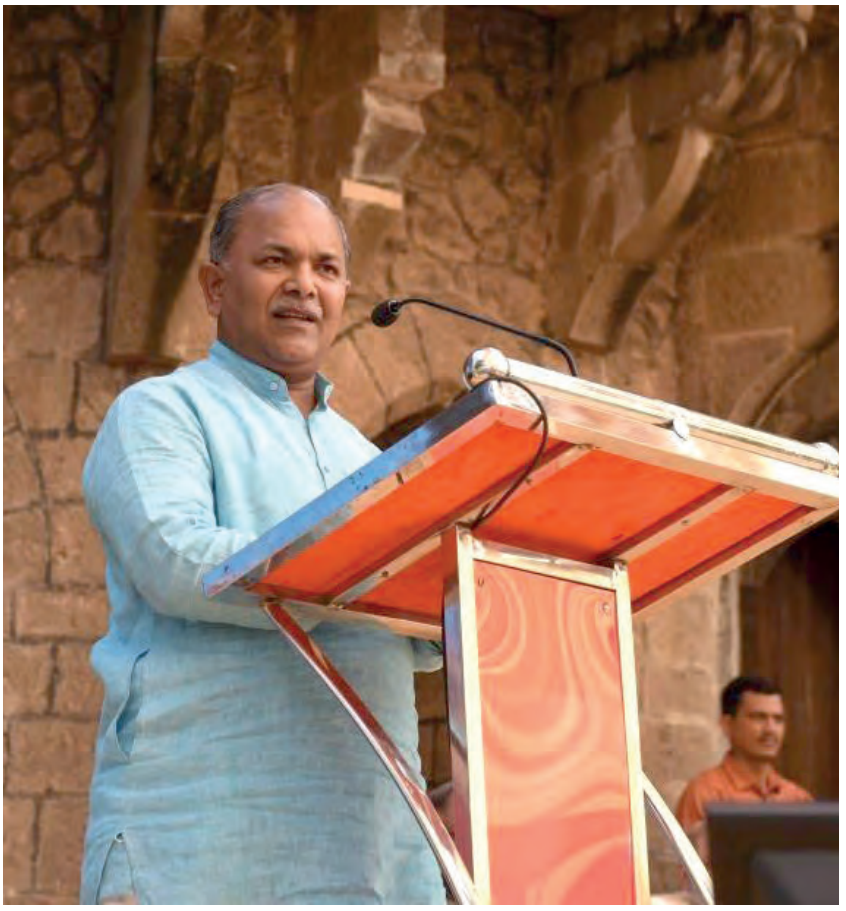
The reason for the construction of the railways in India was also to collect India's resources and transport them to the port and from there to England where the industrial revolution was going on. Jayantiji did a lot of work on how the British used science and technology to loot India.

And how did the Indian scientists respond to that? How did an organisation like the Indian Association of Cultivation of Science become strong? How did people like Acharya Ray and CV Raman answer it? Jayantji gave very detailed information about this also.

When he delivered a speech at NDMC Delhi on the contribution of scientists to India's freedom struggle, the cultural secretary heard that and suggested that Jayantji do this programme all over the country. And now around August 15, the show is going to run for a whole month at India Gate of which four days have been given to Vijnana Bharati.

Jayantji did a lot of research on this subject, gathered a lot of material and wrote many articles. And today people are discussing it. So I think that Jayant Sahasrabudhe was a very big Bhagirath in the ideological map of India.

Jayantji was very mindful of every little act of his. Whenever we would travel, he would compare carbon emission by different modes of transport. Therefore, he always chose train over flight.



I saw his life very closely. His was the life of a preacher. There was never a day in his life when he did not exercise, did not wash his clothes or did not study for an hour. He used to say: "If I eat food, I will also exercise, wash my clothes and study for an hour. Otherwise, I will not even eat food. If I have time to eat I have time to do everything."

He didn't wash his clothes with soap. When I asked him the reason, he said that he used soap for his clothes only once a week as otherwise, it would have an adverse impact on soil. Another example of his life's principles is that he never ate apples. When I asked him the reason, he said that he would eat apples if he went to Shimla or Kashmir. "If we eat apples in Kerala then what is its carbon emission? How much carbon does it bring?" he reasoned.

Doing the cruellest, the most difficult for yourself, is what Jayantji's life was all about. He raised Vijnana Bharati as an ideological movement. He led a meaningful life and lent meaning to the life of thousands of workers. His life will serve as a beacon for the workers to follow.

We can see thousands of people in the Pracharak tradition of the Sangh. But Jayant Sahasrabudhe ji was an ideal.

I pay my humble tribute to him on behalf of all the science workers.

**The writer is national secretary, Vijnana Bharati and member, Advisory Board, Science India.*

A Great Organiser and Motivator With Buddha-like Serenity

■ **Prof SK Tomar**

I met Shri Jayant Sahasrabudhe in 2015 in Chandigarh where Prof KN Pathak, former Vice Chancellor of Panjab University, Chandigarh, introduced me to him. Right since the first day, I was impressed by his unassuming, grounded personality, his Buddha-like ever smiling face and his organisational ability. There was much to learn from him. He had the uncanny knack of identifying the right individuals who could work for the cause and he could motivate people to contribute voluntarily.

In Chandigarh, he helped us establish the state unit of Vijnana Bharati, Chandigarh, which we decided to name Chandigarh Vigyan Parishad. Since its inception, Chandigarh Vigyan Parishad has been active in organising programmes and bringing people with interest in Science, on the platform of ViBha. Jayantji's cooperation, advice, guidance and mentoring held our hands and showed us the path. Today, our chapter has a vibrant membership of scientists from premier institutes, academicians, media persons, college and school teachers who are dedicatedly working to fulfill the dream that Jayantji had planted in our hearts.

However, his contribution is much more than establishing ViBha. He, singlehandedly, initiated a new discourse in Science in India by identifying, researching and disseminating information on several untouched areas of history of

Indian Science, like the role of scientists of pre-independence era, Indian calendars, etc. His contribution in establishing *Science India* — a magazine 'connecting Science and people with an Indian perspective' is well-known. With Jayantji's concerted efforts, within a few years, *Science India* has created a niche for its well-researched articles written by eminent writers in Science, presented in a lucid and comprehensible manner for every citizen. The goal of the magazine to develop scientific temper is being approached steadily.

His farsighted vision for India's scientific development took shape in the form of innovative programmes like Vidyarthi Vigyan Manthan, Vibha Vani, NASYA and Tech4Seva, etc. Tech-

Many people remember how Jayantji, through **his simple life, taught them a lesson in humility,** dedication, sustainability and selfless service

4Seva was one of his beloved missions, which is working very well under the G20 mission of digital health for all.

In the memorial meeting which the Chandigarh Vigyan Parishad held for the remembrance of Jayantji, everyone in the congregation fondly recalled their encounters with Jayantji and realised how he has enriched their lives. His impact on the lives of people he met was indelible as he left reverent memories in their hearts. Some remembered how he taught them a lesson in humility, sustainability, dedication or selfless service. Dr Arvind Garg remembered that Jayantji, many a times, travelled through train in sleeper class though he was entitled for air travel, stating that we should save public money. Another teacher reminded how Jayantji would never waste even a grain of rice in his plate, or that while bathing, he used minimum water needed. Someone told how he refused any special treatment given to him. Many people remembered getting motivated by his speeches which invoked national pride, curiosity and a desire for service.

Jayantji's demise is a cruel blow not only to all these people whose lives he touched but more so for the country, which, after 75 years of independence, was just opening its eyes to recognise and appreciate the indigenous scientific legacy which it has inherited. But this pain only steels us in our determination to take Jayantji's dream of Swadeshi Science movement forward with frothing zeal. We are determined to do it. This is our tribute to Jayantji.

**The writer is Vice Chancellor, JC Bose University of Science and Technology, Faridabad, Haryana.*

Jayant Sahasrabudhe: The Approachable Sage

■ **Dr Chaitanya Giri**

Not very often, we mechanised creatures of the modern world are blessed to come close to sages. Yes, many of us go to wise men and women for guidance, especially when seeking solutions to problems in our lives. Often, these wise men and women are made to sit on an altar; some do sit and enjoy the reverence that society pays them. However, some wise sages choose to guide the society not from an ivory tower, not from an altar, but working within the society. I am happy that I met one such selfless and visionary sage, our Jayantji. But I am equally sad that we all are now left with paying tributes to his noble departed soul, something none of us wanted to happen.

It is no secret for those who met Jayantji that he was a multifaceted personality. An impressive ability to seize the attention in boardrooms on one end and *chappals* on the other. He spoke of science, the history of science and the future with no loss of panache and elan. To this day, despite speaking regularly on public platforms, I err with filler words. Jayantji was right up there for me. The best orator I have come across in my life. He was not in the profession of making rousing political speeches nor had anything to gain from his oration. He did not yearn for followers, but being the *swayamsevi* hermit, I was in awe of his penchant for finesse. Jayantji had an exceptional understanding of how society works and what it needs to sustain.

His sharp intellect was operating a real-world **network theory where he could see people with the** right skills and aptitudes in the correct assignments

This comprehension led him to bring in people from all walks of life to contribute to Vijnana Bharati. Had he not had that vision, he wouldn't have championed VIBHA from the top business houses of Mumbai to the power alleys of Delhi, from the schools of Odisha and Konkan to the universities of Kashi and Kerala. This sage was incessantly on the move.

We all have our memories of Jayantji. I understand some of us want to keep some of these memories to ourselves. Some of these may be too sacrosanct. However, it is essential to chronicling the greatness of a man who did not yearn for any adulation but to the service of science in India.

I met Jayantji quite serendipitously in 2018. That was when I moved back

home to Mumbai after finishing a few years of postdoctoral experience overseas. I had switched my career from astrochemistry to strategy analyses. I was no more a scientist but a full-time think tanker working on foreign policy. Then, my father-in-law was heading one of Maharashtra's premier scientific laboratories and was regularly in touch with Jayantji. Both used to periodically touch base on the new and old of the scientific world and somehow, in one of their conversations, my mention arose. One fine morning, I heard his serene voice over a phone call. He asked to see me soon, and I readily agreed, but it took another few months for our meeting to happen. Then the VIBHA-led Underwater Domain Awareness conference in Pune happened, for which he thought of me. We did not interact much that day, but we did exchange pleasantries. The day went fine, he heard my talk, and since we were coincidentally in the city the next day, we did meet.

After a nice whirlwind conversation on that rainy and pleasant Pune morning, he realised I had deliberately chosen my career path. He knew about the science I did; he knew I was reasonably good in my bygone scientific career. He knew I had no plans to return back to the lab. He asked me a simple question — "Would you like to do something for India's science diplomacy?" That question was pregnant with possibilities. Jayantji wasn't assuring me of a position, nor was I asking for one. He perhaps had no concrete project in mind, but he had some vague plans. As an early-career professional who had switched careers, he could empathise with the tribulations of such a decision. His question sort of relieved me that, after all, the switch was beginning to make sense. We continued meeting on various occasions whenever he used to be in Mumbai, and later, in the mid of 2020, he revealed his plans to revive the *Science India* magazine. He knew what I was cut for, and since the magazine's first issue, I have been writing its 'Science Diplomacy' column.

In the relatively few years I have known him, I learned about his incredible people connections. None of it was a coincidence. His sharp intellect was operating a real-world network theory where he could see people with the right skills and aptitudes in the correct assignments. He knew how to make the right people meet at the right time and for the right cause. I remember vividly him telling me his experiences while initiating the Science India Forum in the Gulf countries and how he sensed a complete lack of human resources that would export India's scientific innovations and success stories to the erstwhile colonised countries. These observations later became crucial to drive a review of India's international cooperation agreements on science and technology to understand our strengths and weaknesses. His efforts through the Global Indian Scientists and Technocrats Forum (GIST) continue to be part of diaspora linkages and India's track-2 science diplomacy. In his last active months, just like he connected people, he began connecting various ministries to collaborate on joint scientific initiatives. I know of no more outstanding promoter of transdisciplinarity than him. After working on three continents and in some of the world's top institutions, I say that.

His efforts through the Global Indian Scientists and Technocrats Forum **(GIST) continue to be part of diaspora linkages and** India's track-2 science diplomacy

The sad part is that he was working on something significant and impactful, and we would not know easily or probably never know.

Jayantji to some, including me, Bhaisaab to others, Jayantrao to some others and Jayanta to some of his oldest friends and family, he was respected and loved by all. He had a peculiar sense of humour, was extremely witty, and had a temper. Although I have dared call him a sage, he was just like us, yet better than many of us. He spent his life without a scintilla of personal gains or profits. *Kaal* may have taken him away from us, but the impact of his service to our Bharat will be felt for a long time. Very often, we smarten our acts by speaking too much about the abstractions of the 21st century. But, I will muster my ego and submit it to the vast seas of time to admit that it is not the lip service but the immense *seva* and *tyaga* of Jayantji and the likes of him that will make India the leading light of the world in the 21st century and beyond. His life, lit by the *mantra* — 'Sarve Bhavantu Sukhinaha' — will continue to be a beacon for all of us. *Jayantji aap amar rahe*!

**The author is a Space Policy & Diplomacy Consultant at the Ministry of External Affairs' autonomous think tank, Research and Information System for Developing Countries (RIS), New Delhi. He has an award-winning PhD in Astrochemistry and spent his doctoral and postdoctoral years in Germany, France, Japan, and the United States. He was a crew member of the European Space Agency's Rosetta Mission.*

A Humble yet Towering Foot Soldier of Indian Science

■ **Debobrat Ghose**

As I sat down to write this obituary piece on Shri Jayant Sahasrabudhe, who left for heavenly abode on 2 June, after being in coma for over eight months following a road accident, I couldn't convince myself that he is no more among us. We, the members of the editorial team of *Science India* magazine will never be able to interact with him and exchange valuable notes again.

Writing an obituary piece is a sad experience, but when it comes to someone who is close to you, whose loss deeply impacts your psyche, writing becomes much more painful, heavy in heart.

Jayant Sahasrabudhe, whom we used to address as 'Jayantji', was called by many variously, as Jayantrao or Bhaisaab. Besides being the national organising secretary of Vijnana Bharati (Vibha), he was the chief editorial advisor of *Science India* magazine. He was the nucleus of this magazine and the chief architect, who was instrumental in the revival of this 25-year-old magazine and gave it the shape of a professional mainstream magazine with an international look by hiring a small team of editorial professionals. Ideas were his, and we implemented them.

Jayantji's unique quality as the fountain head of our editorial board was his non-intrusive, non-intimidating nature. In my 25 years of journalism career in the mainstream media where I had the opportunity to work with some of the top shot editors from print to digital media, the qualities I personally witnessed in Jayantji make him standout among others.

My first meeting with Jayantji was held in an informal setup in New Delhi in August 2020, when Vibha was looking for an editor to revive this magazine. I was amazed by the knowledge of this soft-spoken gentleman clad in a white *kurta-pyjama*. During our discussion, he told me several things about Indian science, which I was completely unaware of. And later, we converted his ideas into exclusive stories.

Before Vibha, the publisher of *Science India*, and I could reach any final decision, I made up my mind to take up this new challenge as an editor of a science magazine. The only reason — I was looking forward to working closely with Jayantji.

A die-hard fan — almost a devotee — of Indian scientists of colonial era such as Acharya Jagadish Chandra Bose, Acharya PC Ray and Dr Mahendralal Sircar, Jayantji shared many untold stories about them and their pathbreaking work which are not easily available in public domain. This later fructified into two memorable Collector's Editions in 2021 and 2022 under 'Swatantrata ka Amrut Mahotsava'— the underlying narrative of India's indigenous science and its rich heritage was built by him, which he took across the country through lectures and talks.

Despite being a scholar with deep knowledge not only related to science and technology, but in every other field, he never had an iota of pride or ego in him. He never boasted his knowledge in front of others. He was a good listener and always gave others opportunity and time to speak. Whenever he had to present his opinion or view, he would politely say, "*Mujhe aisa lagta hai…* (I feel so…)", instead of showing his authority. But alongside his polite and cordial demeanour, which was full of humility, he was also a firm individual who could make people accomplish the most difficult of tasks.

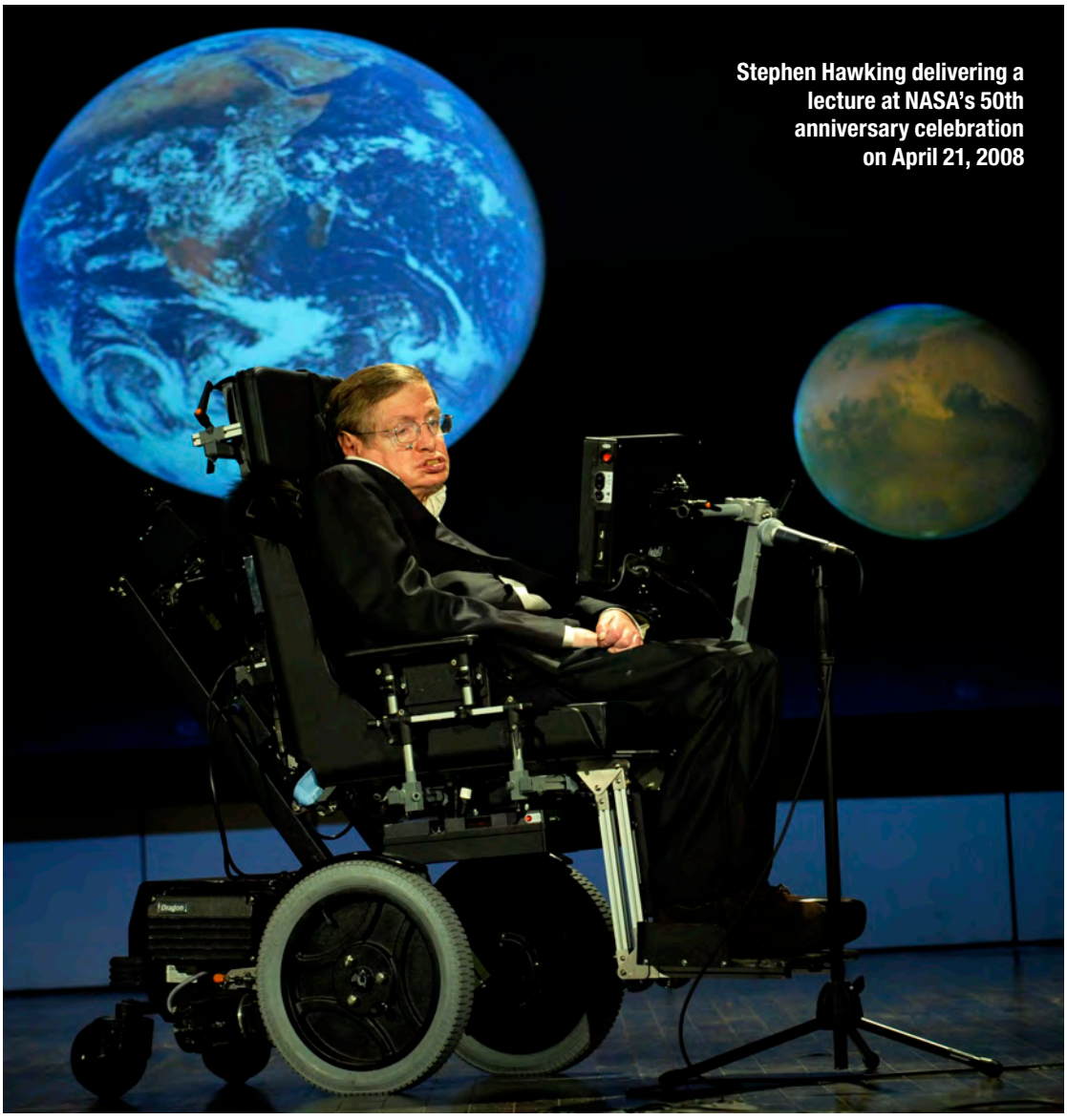
A quintessential science aficionado, Jayantji always looked for solutions to problems and also provided solutions to *Science India* and Vibha. He truly wore scientific temperament on his sleeve. Once he told us, "One may be a part of Vibha, but it needs to be seen how much Vijnana Bharati (principles) is within him."

The editorial team will ever miss those *samosas*, cookies and *chai*, which used to be an integral part of our meetings with Jayantji. Whenever he called me for a meeting, he would begin, "Debobrat ji, *kaise hain? Samosa intezaar kar raha; kya hum log kal mil sakte hain*?"

However, it was not those *samosas*, but the fond affection of Jayantji which we the core editorial team members — Sonam Singh Subhedar, Praveen Singh and I will miss forever.

Although we all are aware of the undefeatable law of Mother Nature of taking away people from us, many a times this seems unfair. Probably the Mother Nature understood the genius of Jayantiji better than us. When in school, I read this adage somewhere: 'Whom God loves, dies young'. So was Jayant Shrikant Sahasrabudhe.

**The writer is Editor, Science India.*



Stephen Hawking delivering a lecture at NASA's 50th anniversary celebration on April 21, 2008

Image Courtesy: Wikimedia

SCIENCE AND SPIRITUALITY

Stephen Hawking's Link to Spirituality

Some of the best contemporary scientists were forced to look beyond Big Bang theory for the creation of Universe, a concept studied in great detail in ancient Indian texts

■ **Prof VPN Nampoori**

Stephen Hawking was an internationally famous cosmologist who was born in 1942, on the 300th death anniversary of Galileo's death – 1642. In 1998, a Belgian student Thomas Hertog met Stephen Hawking in his office at Cambridge University. This historical meeting accelerated the chemical reactions progressing in the brain of Hawking to clear his confusion about a designed Universe and existence of God. A Brief History of Time "attempts to describe the creation and evolution of our universe from what Hawking would call a 'God's eye perspective'". But because "we are within the universe" and not outside looking in, our theories cannot be decoupled from our perspective. Hawking confessed that 'A Brief History of Time' was written from the wrong perspective. The story on Hawking's realisation on a designed Universe is detailed in Hertog's book The Story of Time. The present article tries to bring about the details of the last work of Hawking along with his collaborator and discusses how it goes hand-in-hand with Indian spirituality.

HOW WAS THE UNIVERSE BORN?

Internationally famous physicist Stephen Hawking went back on his previous beliefs about the creation of the Universe, stating in a book that physics, not God, made the Big Bang. But in his book, The Grand Design, Hawking states that new theories show that a creator is "not necessary". Because there is a law such as gravity, the universe can and will create itself from nothing. It is not necessary to invoke God to light the blue touch paper and set the universe going."

Hawking put his faith into a form of string theory called the M-theory, which hopes to present a unified theory in 11 dimensions that can account for every type of physical behaviour. Theorists believe that a formulation of M-theory will require an entirely new mathematical language to be developed.

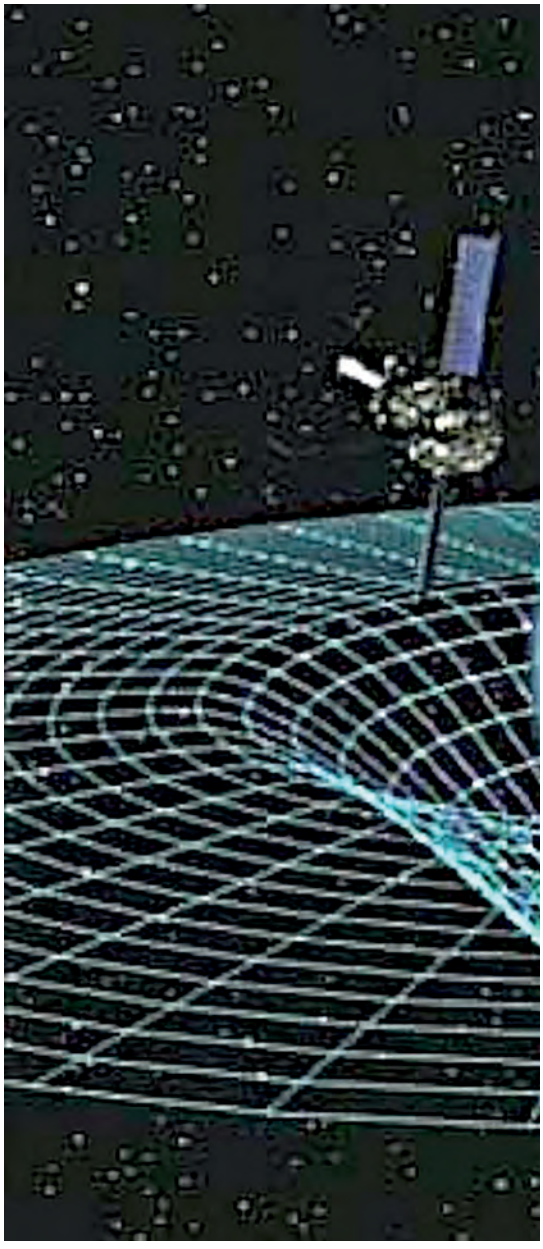
Hawking said that if we discover a complete theory, it should in time, be understandable in broad principle by everyone, not just a few scientists to discuss questions like why we and universe exist. It will declare the triumph of man whose reasoning will make us know the mind of God

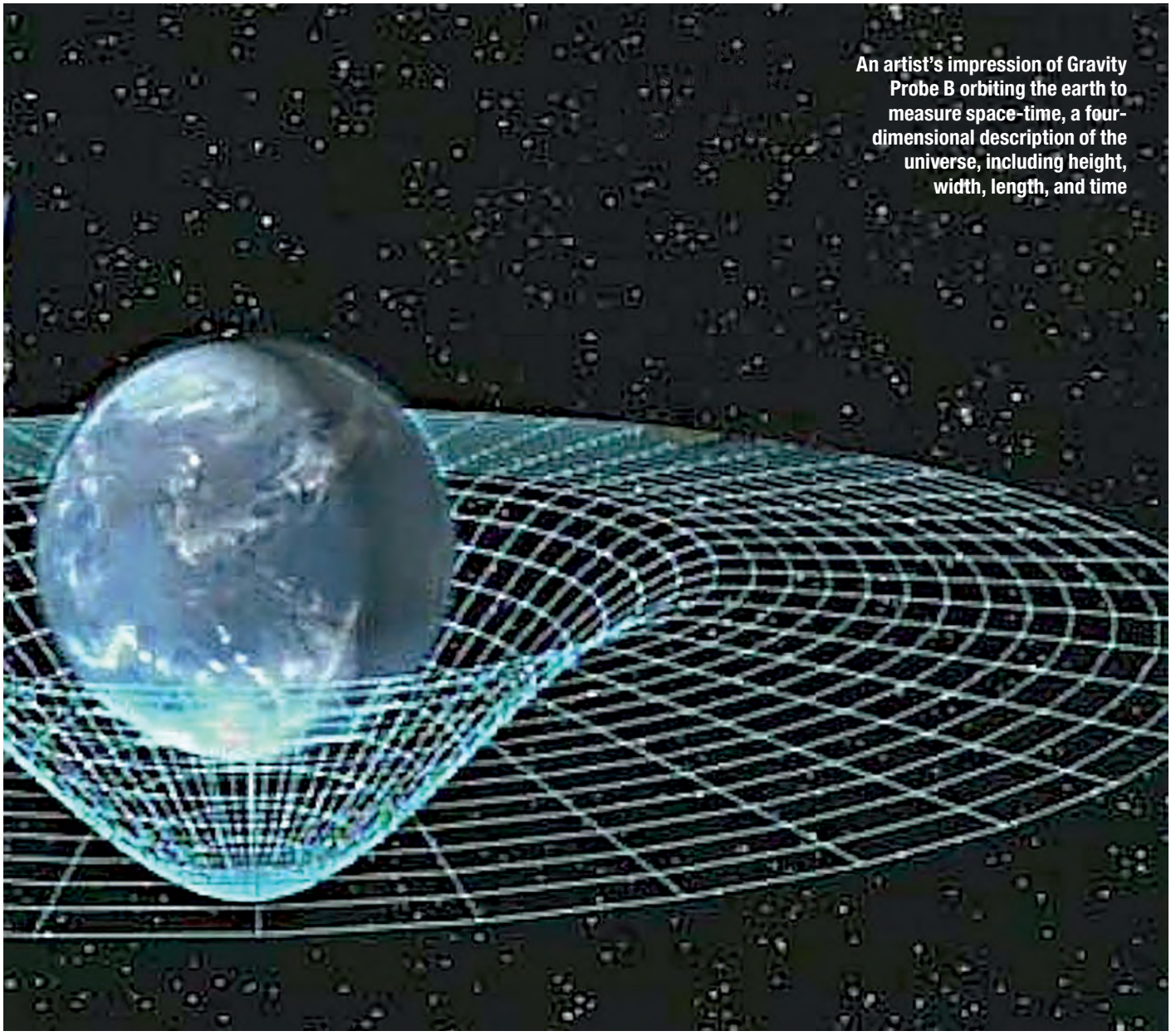
During their first meeting at Cambridge University in 1998, Hawking wasted no time in bringing up the problem bothering him to Hertog. "The universe we observe appears designed," Hawking told Hertog, communicating via a clicker connected to a speech machine. Hertog explained that "the laws of physics — the rules on which the universe runs — turn out to be just perfect for the universe to be habitable, for life to be possible." This remarkable string of good luck stretches from the delicate balance that makes it possible for atoms to form molecules necessary for chemistry to the expansion of the universe itself, which allows for vast cosmic structures such as galaxies.

A few years into their collaboration, "it began to sink in" that they were missing something fundamental, Hertog said. A Brief History of Time "attempts to describe the creation and evolution of our universe from what Hawking would call a 'God's eye perspective'. But because "we are within the universe" and not outside looking in, our theories cannot be decoupled from our perspective, he added. "That was why (Hawking) said that 'A Brief History of Time' is written from the wrong perspective."

THE THEORIES

To get a clear picture, let us just have a brief visit to the history of theoretical and experimental developments in Cosmology and Astronomy related to the modeling of the universe. The edifice of 20th century physics rests on the two pillars, namely Theory of Relativity and Quantum Mechanics. These two revolutions in Physics led to a paradigm shift, resulting in progress in both micro and macroscopic world, ultimately making it possible to have space travel and landing on the moon, including India's





An artist's impression of Gravity Probe B orbiting the earth to measure space-time, a four-dimensional description of the universe, including height, width, length, and time

Image Courtesy: Wikimedia

Mangalyaan. General Theory of Relativity (GTR) is the theory of gravitation which explains the free fall of an apple onto the surface of the earth instead of going up. GTR says that the space-time structure around a massive object like earth gets wrapped to a curved surface with the object at the centre. A small object like apple takes its shortest path to reach the earth as a curved path, looking as though the apple is falling down to the ground. When mass of the object become large, like that of the sun, even light from a distant star passing near the sun will get curved so that we can observe an apparent shift in the position of the star in the sky. This phenomenon was experimentally confirmed during the complete solar eclipse expedition to South Africa in 1919 under the leadership of Arthur S Eddington.

GTR or General Theory of Relativity is the theory of gravitation which explains the free fall of an apple onto the surface of the earth instead of going up

In 1921, Georges Lemaitre, a Bel-

gian priest, discovered an unusual solution to Einstein's GTR equation which allows the expansion of universe. If one goes back in time, we can reach the state of the universe of zero volume and infinite density with infinite energy. This infinite energy will burst into a Big Bang, resulting into increase in space and starting of time. Einstein did not approve the work of Lemaitre. However, the expansion of universe was experimentally confirmed by Edward Hubble in 1928 and the Big Bang theory was confirmed as the theory of the origin of universe. Technically, the Big Bang (B-B) hypothesis brings about a singularity (zero volume) in which laws of physics may not hold. Such is the singularity describing the black hole from which even light cannot escape.

Initial force of expansion was so fast that within first few seconds of B-B, energy was converted into mass and elementary particles like electrons and protons. Within first three minutes, atoms and molecules were created. As the expansion energy depleted, the rate of expansion also got reduced resulting into cooling of the universe. As the universe started cooling, stars, galaxies and nebulae started to appear and after about 13 billion years of time we have our universe in the present form with universal temperature 2.7 K.

Image Courtesy: NASA

This photograph of the coil-shaped Helix Nebula is one of the largest and most detailed celestial images ever made

BIG BANG AND SINGULARITY

Although we have a theory of creation of universe through Big Bang, crucial problem was the singularity, and one does not have a way to handle the singularity. Jim Hartle and Hawking argued that as the size of the universe reaches to the Plank scale, quantum mechanics enforces smearing of space-time structure due to Heisenberg's uncertainty principle. This means that individuality of time and space is lost. Rotation of time axis to horizontal makes imaginary time and takes the character of space. Now we have a wave function of universe and singularity is thus removed by invoking quantum mechanics. This ingenuous way of fusing GTR and QM solved such problem whose solution was being searched by several physicists. Since the starting point of universe is not a point but a surface of a sphere, one can have a smooth travel without invoking the origin of time. This picture says that there is no sense in asking what was there before Big Bang since time does not exist before B-B. This is just like asking what is the south of the south pole or north of the north pole of the earth? One has smooth trajectory on the surface of the earth with two cardinal points called NP and SP. Hartle and Hawking's approach of solving the singularity problem with a wave function is named as no-boundary conditions.

Although we have a theory of the creation of universe through Big Bang, crucial problem was the singularity, and one does not have a way to handle the singularity

Around 600 BC Anaximander conjectured the existence of laws obeyed by Nature just like the existence of human society. Hartley and Hawking addressed this question by reframing it to as: Why is it that the mathematical form of laws of nature as it is to allow the hu-

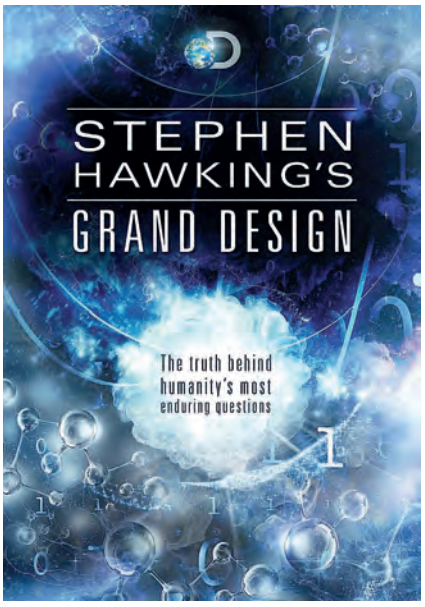


Image Courtesy: Internet

man life possible with its highest state of thinking power? At the origin, time takes the character of space and we have now space atoms with size to that of the Planck cell. The concept of space atoms has been studied in detail by the Italian Physicist Carlo Rovelli and his group.

A MEETING OF MINDS

It was at this juncture that Thomas Hertog was allowed to register for PhD by Hawking under his mentorship. When Hertog was first summoned to Hawking's office in the late 1990s, there was an instant connection between the young Belgian researcher and the legendary British theoretical physicist.

"Something clicked between us," Hertog said.

That connection would continue even as Hawking's debilitating disease ALS robbed him of his last ways to communicate, allowing the pair to complete a new theory that aims to turn how science looks at the universe.

The theory, which would be Hawking's last before his death in 2018, has been laid out in full for the first time in Hertog's book *On the Origin of Time*, published in the UK last month. The cosmologist spoke about their 20-year collaboration, how they communicated via facial expression, and why Hawking ultimately decided to write his landmark book, *A Brief of History of Time*. Finally, the last theory of universe put Man back in the Centre.

In his book, *On The Origin of Time*, published last month in the UK, Thomas Hertog writes at length about his 20-year association with Stephen Hawking and why the latter decided to write his landmark book, *A Brief History of Time*

HAWKING'S FINAL THEORY OF UNIVERSE AND INDIAN SPIRITUALITY

Unlike in the case of western science, Mind as a tool for seeking Truth is an important component in spirituality contributing to Indian systems of knowledge development. Mind developed the phenomenon of consciousness which is not included in the western scientific method whereas Mind as well as Consciousness are the cornerstones of Indian systems of knowledge research.

Indian invention of Yoga and Meditation prepare mind to get coherent coupling with the Universe. From ancient period, the practice of meditation has been employed to get resonance with the Universe and knowledge flows into the mind without any need of another media like language. Many of the mathematical formulae and secret of nature have been revealed by this method as we have fine examples of Srinivas Ramanujan, Sangamagrama Madhavan, Aryabhata, Varahamihira, Brahmagupta. Some of the formulae discovered by Ramanujan are being applied is diverse fields like cosmology, data mining coding and decoding, etc. For example, explorations of quantum black holes in string theory have led to fascinating connections with the work of Ramanujan on partitions and mock theta functions, which in turn relate to diverse topics in number theory and enumerative geometry.

Ramanujan's work on number theory is being proved to be a binding force between gravitational field and quantum mechanics, thereby yielding valuable knowledge on the nature and dynamics of black holes.

Sangamagrama Madhavan's discoveries related to infinite series and fixing the position of moon in the sky at regular intervals of about one hour, Neelakanta Somayaji's work on transformation of geocentric data to heliocentric data to explore planetary orbits around the sun are some of the examples

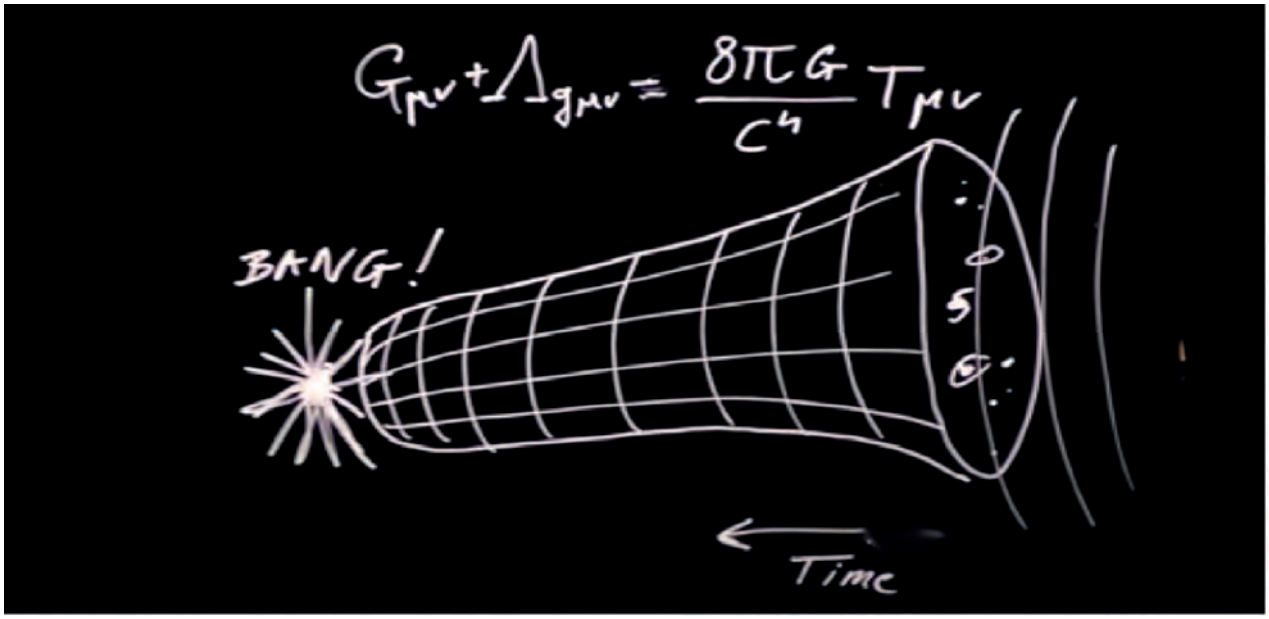


Image Courtesy: VPN Nampoori

A picture depicting Big Bang and expansion of universe along with Einstein's famous gravitational field equation

where Indian knowledge system succeeded to uncover the secrets of the universe. Above all, the *Nasadiya Suktha* or the Song of the Creation in Rigveda describes the nature of the Universe before Big Bang.

SCIENCE'S ANCIENT ROOTS IN INDIA

Modern science in the west starting with Galileo has only 500 years of existence whereas in India, documentary history starts from the 8th century BC with the works of Sulbakaras in the field of mathematics and astronomy. The roots are deep seated and are hidden in the dark. In fact, Sulbakaras are about 500 years ahead of Euclid. Sulbakaras were surveyors whose Sulbasutras were handbooks describing how to construct yagasalas. Aryabhata (5th century AD), Varahamihira and Brahmagupta (6th century), Bhaskarachraya (12th century), Guru-Shishya *parampara* established by Sangamagrama Madhavan are pinnacles in the knowledge-landscape of ancient India. For example, when Europe in the middle age period was arguing and witnessing war between supporters of geocentric and heliocentric models of solar system, Neelakanta Somayaji of Madhava School showed how one can have mathematical transformation of geocentric model to heliocentric model. Mathematical and astronomical works of Sangamagrama Madhava are examples to prove the Indian legacy in mathematics and astronomy.

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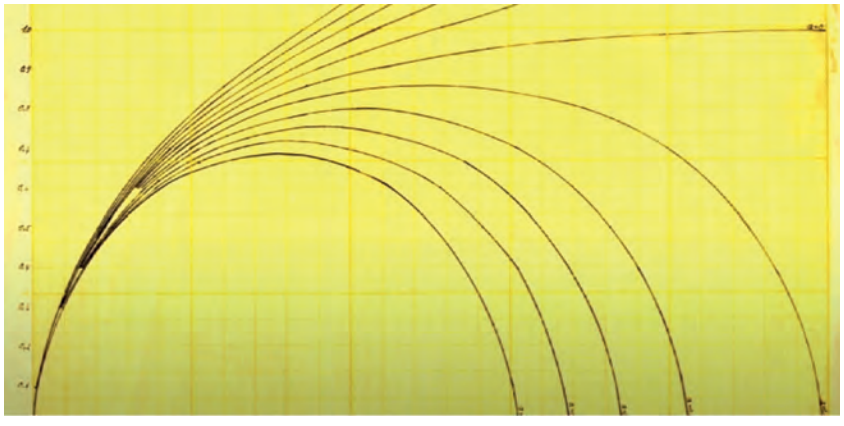

Image Courtesy: VPN Nampoori

An image showcasing the possible scenario for expanding universe

The practice of Ayurveda and practical psychology detailed by Patanjali in his *Yoga Sutra* are still being followed all over the world. India had a rich legacy in the field of metallurgy and architecture as evidenced by rust-free pillar in Delhi and Brihadeswara temple in Tamil Nadu. Ophthalmological works of Charaka and surgical practices of Susrutha are well known. Foundation of Indian philosophy is laid down by

In his 2004 book, *Quantum Gravity*, Carlo Rovelli, an Italian theoretical physicist, developed a formulation of classical and quantum mechanics that does not make explicit reference to the notion of time

Image Courtesy: Internet

the prastahnathraya (three descriptions) namely, Upanishads, Bhagavat Gita and Brahma Sutra. These philosophical discourses have created the Hindu way of life called Sanatana Dharma and a unique culture which have continued to exist since more than the last two thousand years without any break. Indian culture is the only one which can claim this prolonged duration of existence. However, due to new education policy designed and executed by British rulers during the 19th century, the Indian way of acquiring knowledge became unknown to the present generation of Indians.

SCIENCE, SPIRITUALITY AND NOBEL LAUREATES

Interconnection between science and spirituality can be traced back to interaction between Nobel Laureate physicist Wolfgang Pauli and psychoanalyst Carl Jung who developed the idea of archetypes and synchronicity. This story is elaborated in a previous issue of Science India. Science is the pursuit and application of knowledge and understanding of the natural and social world following a systematic methodology based on evidence. In this context, the works of Stephen Hawking and Thomas Hertog are important and are centered on the existence of a designer or God who modeled the universe so as to support the flourishing of human species on the earth. They ascertained that there is no question on what was there before the Big Bang since time and laws of physics started at the instant of the creation of the universe. It is at this point where Indian knowledge system differs.

The famous *Nasadiya Suktha* in Rigveda describes the story of universe not starting from the Big Bang but well before that so that we have an answer to the question on what was there before the B-B. Sound in all its form propagates through space. It will reach us even after travelling a distance of thousands of light years. This is what we hear, the sound emitted by merging black holes detected by scientists.

The famous *Nasadiya Suktha* in Rigveda describes the story of universe not starting from the Big Bang but well before that so that we have an answer to the question on what was there before the Big Bang

NADA BRAHMA

The original source of sound energy creating waves through super fluid aether (super fluid property of aether was described by ECG Sudarshan and his colleagues. See previous issues of *Science India*) is the Nada Brahma. Nada Brahma is the form taken up by the formless Brahma through a will or tapas, which

Image Courtesy: Internet

Thomas Hertog is a Belgian cosmologist at KU Leuven university and was a key collaborator of Professor Stephen Hawking

can be considered as a phase transition from formless Brahma to the one with the form. Creation of states through phase transition generates errors so that one cannot get a true copy of the state .

Repeated phase transitions will increase these errors. After several phase transitions, these errors get corrected and the state gets identical to that of the original one, namely to that of the self-existent Brahma. For individual souls, it is *Brahma saujya*, thereby getting escaped from the chain of birth and death. For the whole universe, it is the case of the night for Brahma till the next chain of creation begins.

Then at one point, called the origin of the universe, the seed (Hiranyagarbha) with infinite density explodes and expands first through inflationary mode and then cools down to reach the present state. Modern science starts from this point of the creation of Universe through Big Bang.

DISCOVERING A COMPLETE THEORY ON THE BIRTH OF THE UNIVERSE

We conclude by repeating what Hawking believed. Hawking said that if we discover a complete theory, it should in time, be understandable in broad principle by everyone, not just a few scientists to discuss questions like why we and universe exist. It will declare the triumph of man whose reasoning will make us know the mind of God. The complete theory may not be what is called M-theory but the knowledge discussed in *Nasadiya Sukth*a. Or to wrap it in a nut shell, the long tradition of Indian spirituality in knowledge seeking will complement and supplement the works of Stephen Hawking and Thomas Hertog by extending their work well beyond the Big Bang and India will rise to the status of Viswa Guru.

The long tradition of Indian spirituality in knowledge seeking will complement and supplement the works of Stephen Hawking and Thomas Hertog by extending their work well beyond the Big Bang

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PROFILE OF THE MONTH: DR KAPREKAR

Seeker of the Joy of Mathematical Pursuits

Known as Ganitanand, DR Kaprekar practiced what is called 'recreational mathematics,' ameliorating the intensity of this 'difficult' subject, yet remains almost obscure in the universe of Indian mathematics

Image Courtesy: Wikimedia Commons

■ Jayanti Dutta

> *'A drunkard wants to go on drinking to remain in the pleasurable state. The same is the case with me in so far as numbers are concerned'*
> **— DR Kaprekar, Mathematician**

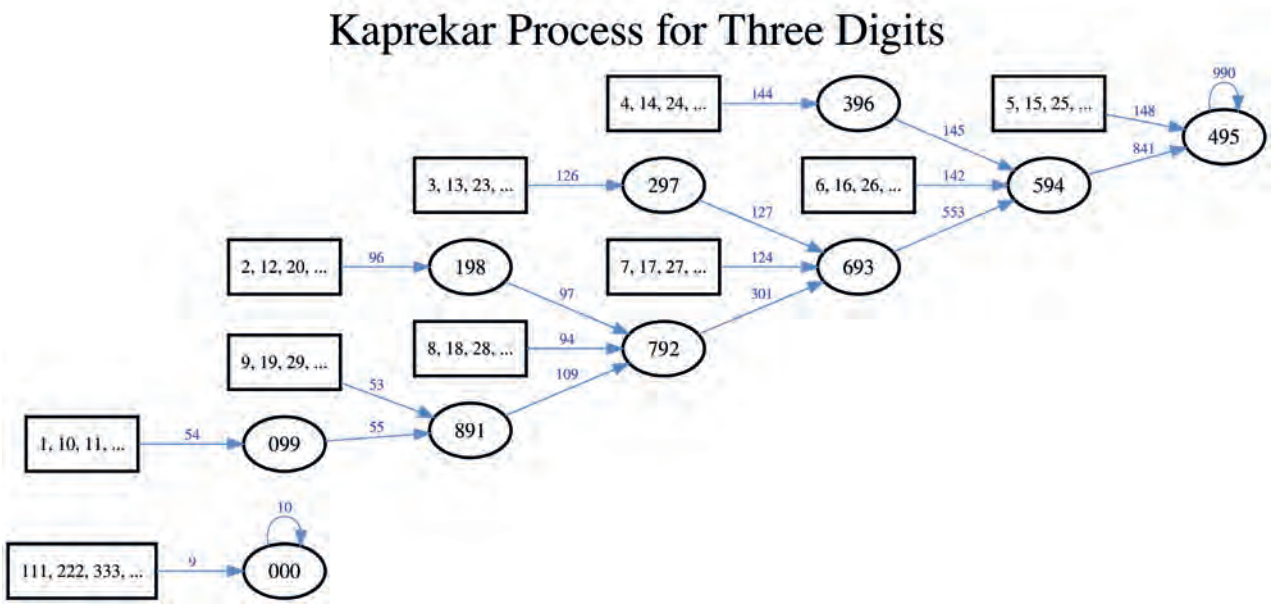
Discovering the existence of 'Harshad numbers' was a source of great joy to me, it was apt since the word 'Harshad'— a Sanskrit/ Hindi which word means 'the giver of joy'. My joy was twofold, firstly, I was happy to identify the indigenous roots of a world renowned term and secondly, because playing with them did make me happy. There was more to come, I came to know about 'Demlo numbers' named after a train station Demlo (Now called Dombivili) in Mumbai and Devlali numbers named after a town in Maharashtra also called Swayambhu numbers meaning self-born numbers. But to top them all was the term 'Kaprekar constant'. All these terms are mathematical discoveries recognised the world over and described by Dattatreya Ramchandra Kaprekar, an Indian mathematician. In Indian mathematical landscape, Ramanujan is one of the most shining stars, whose mysterious brilliance in the discipline is very impressive. DR Kaprekar's passion for Mathematics is equally remarkable and astonishing, though he is not much known outside mathematical circles.

KNOWING DR KAPREKAR

DR Kaprekar was born on 17 January 1905 at Dahanu, near Mumbai. His mother died when he was young. It can be speculated that he was initiated into Mathematics through Astrology by his father who was a clerk and practiced it on the side. Practising astrological calculations, Dattatreya discovered his fascination for numbers which thrilled him no end. He would spend long hours playing with numbers and solving mathematical puzzles.

Dattatreya passed his higher secondary school from Thane, a suburb of Mumbai. For higher education he went to Fergusson College in Pune from 1923 to 1929. While in college, he won a prestigious prize in Mathematics awarded in the name of another illustrious son of India — Ragunath Purushottam Paranjpe — a mathematician and social reformer. The award, called the RP Paranjpe Mathematical prize was awarded to Dattatreya in 1927 for an original piece of work in Mathematics. Immediately after completing his BSc degree, he was appointed as a school teacher in Government Junior School in Devlali where he spent his life in humble circumstances teaching Mathematics immersed in his passion for numbers. He was known for his zeal for the subject and was often invited to speak on recreational Mathematics to the local college students. He retired in 1962 and died in 1986 at the age of eighty-one. There is hardly any more information about the personal life of this mathematician after whom certain numbers have been named.

Kaprekar's life trajectory is as modest as his personality, a glimpse of which we get by looking at his only available picture wherein he wears a simple Indian dress and head gear. He was a different kind of mathematician, not highly educated, certainly not a PhD or a postgraduate, not associated with prestigious national or international institutes, not widely travelled. However, Kaprekar is unique in his devotion to Mathematics. He recognised his obsession for number theory



and equated it with the addiction of a drunkard. 'A drunkard,' he says, 'wants to go on drinking to remain in the pleasurable state. The same is the case with me in so far as numbers are concerned'. Mathematics is a strange subject, perceived in extremes. For people who have no taste for it, studying it is hard labour, they sweat and toil to discern the abstract concepts, proofs and calculations. While for those who love it, taking on mathematical challenges is an indulgence from which they derive immense pleasure. Kaprekar was on this extreme as thinking about numbers, juggling them, playing with them, and drinking constantly from the abstract cup of Mathematics gave him so much joy that he was locally known as 'Ganitanand' — one who derives joy from Mathematics. It is through this devotion and constant contemplation that he reached interesting findings regarding properties of numbers.

Image Courtesy: www.unicoos.com

6174 is known as Kaprekar's constant as it was discovered by Indian mathematician DR Kaprekar in 1946

RECREATIONAL MATHEMATICS AND MARTIN GARDNER'S INTERVENTION

Though he published widely, all his publications containing his ideas and inventions were published as pamphlets which bear the inscription, 'privately printed' or 'published by the author' or in low level journals indicating his initial location on the margins of the academic mainstream initially. It was clear that he was not taken seriously in Indian mathematical circles. This obscurity was to end, ironically by the intervention of an American popular science writer Martin Gardner. In March 1975, an article by Gardner about Kaprekar and his recreational Mathematics appeared in *Scientific American* in the column Mathematical games. This earned Kaprekar, at the age of 70 years, a fair reputation and recognition in the country. Many of his papers were reviewed in *Mathematical Reviews* and later one of his papers on Kaprekar numbers was published in the *Journal of Recreational Mathematics* in 1980. Many mathematicians also carried forward his work. Now we find

Wikipedia pages and YouTube channels on his interesting findings. A discussion on Kaprekar number is available in a popular Mathematics YouTube channel, called Numberphile.

Kaprekar dealt with what is called recreational Mathematics, a term which is defined as Mathematics practiced for recreation and entertainment as compared to that carried out for the causes of research or application. Though for doing recreational Math one doesn't need a thorough understanding of higher Math, deep ideas are implicit in its practice, which inspires Math enthusiasts to look for hidden patterns, combinations, coincidences or properties of numbers. The aim of recreational Mathematics is to experience the joy by discovering these patterns and designs

That he named the numbers on the local railway station, his town or a suitable Sanskrit adjective, endears him to us and indicates his indigenous consciousness seeped in the values completely rooted in his native ecosystem

in numbers. Kaprekar worked on recurring decimals, solitaire games, magic squares and integers with special properties. He discovered Demlo numbers in 1938, Kaprekar constant in 1946, Harshad numbers in 1955, Devlali numbers in 1963, and Kaprekar numbers in 1980, thus showing his consistent engagement with his passion. That he named the numbers on the local railway station, his town or a suitable Sanskrit adjective, endears him to us and indicates his indigenous consciousness seeped in the values completely rooted in his native ecosystem. His nomenclature of his number findings lends us a reason to flex as we are wont to do when we find some international achievements associated in some way to India.

Kaprekar's life and work raise important questions for Indian Science. What if Gardner had not written about Kaprekar's work? Would his numbers have remained shrouded in obscurity? Are there other Kaprekars in India waiting to be discovered? Is the subject of Mathematics a victim of misunderstanding? How can we inculcate curiosity and the spirit of Science for Science's sake in a country dominated by coaching institutes to hack science education? If there is one takeaway from Kaprekar's life that is to engage with Science only for the undiluted joy granted by its pursuit and not for a rat-race through a dark tunnel at the end of which lies a fat pay packet.

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DR KAPREKAR's PLAY WITH NUMBERS

Kaprekar Constant

The number 6174 is called the Kaprekar constant. Kaprekar showed that it has got an interesting property. Take any four digit number in which not all digits are alike. Arrange the digits in descending order and in ascending order. If one subtracts the smaller number out of the greater number and keeps repeating this process with the remainders, eventually, in eight steps or more, the number 6174 is arrived at. Example: If we start with the number 2831, we have:
8321 – 1238 = 7083, then
8730 – 0378 = 8352, and
8532 – 2358 = 6174
7641 – 1467 = 6174

Harshad numbers or Niven numbers

These numbers are defined by the property that they are divisible by the sum of their digits. They were later also called Niven numbers after a lecture on these numbers was given by Ivan M Niven, a Canadian mathematician. The distribution, frequency, etc. of the Harshad numbers have been worked on by researchers and these numbers are of interest in number theory.

Example: 12, which is divisible by 1+2=3 is a Harshad number. Numbers which are Harshad in all bases, i.e., 1, 2, 4 and 6 are called All-Harshad numbers.

Devlali numbers or Swayambhu numbers or Self numbers

Defined by Kaprekar as the integer that cannot be generated by taking some other number and adding its own digit to it. He also gave a test for verifying this property in any number.

Kaprekar Number and Kaprekar Operation

A Kaprekar number is a natural number with the property that if it is squared, then its representation can be partitioned into two parts whose sum is equal to the original number (e.g. 45, since 452=2025, and 20+25=45, also 9, 55, 99, etc. are Kaprekar numbers). However, there is a restriction that the two numbers should be positive; for example, 100 is not a Kaprekar number even though 1002=10000, and 100+00 = 100. This operation, of taking the rightmost digits of a square, and adding it to the integer formed by its leftmost digits, is known as the Kaprekar operation.

CSIR-Institute of Minerals and Materials Technology, Bhubaneswar

IN FOCUS: CSIR-IMMT, BHUBANESWAR

At the Forefront of Sustainable Exploitation of Natural Resources

Located in Odisha, one of the richest Indian states in terms of natural wealth, CSIR-IMMT is redefining the use of natural materials for viable development

The Council of Scientific and Industrial Research (CSIR), New Delhi, oversaw the establishment of the CSIR-Institute of Minerals and Materials Technology (IMMT) in the eastern region of India on April 13, 1964 as a Regional Research Laboratory. Located at Bhubaneswar, it was given a new name in 2007 with the goal of becoming a pioneer in the field of mineral and material resource engineering.

For the purpose of addressing the R&D issues in the mining, mineral, and metals sectors and ensuring their sustainable development, the institute has experience conducting basic research and technology-oriented programmes in a wide range of areas.

The primary goal of R&D at CSIR-IMMT for the past ten years has been to equip Indian industries with the knowledge and expertise necessary to successfully exploit natural resources commercially through the use of public-private partnerships (PPPs).

Many industries that rely on minerals now choose CSIR-IMMT as their institute of choice. Additionally, it is aiming to improve the resource usage efficiency of essential raw materials and carving out a niche in the processing of advanced materials for increased value addition.

DEPARTMENTS

Advanced Materials Technology (AMT)

The AMT department's mandate involves conducting exploratory research in the field of advanced materials as well as developing acceptable techniques for the production of industrial and strategic materials employing plasma technology. For the successful preparation of various metals, ferroalloys, and composites, the department has created a number of plasma processes for melting, smelting, and the synthesis of carbides, oxides, as well as for smelting and melting metals.

For the development of bench scale technology, numerous techniques use ore and minerals, industrial and agricultural wastes, e-wastes, etc. Thin films, green steel, and nanomaterials have all seen significant research and development.

Central Characterisation

For the purpose of providing analytical and testing services, the department of Central Characterization coordinates the utilisation of sophisticated instruments.

All Images Courtesy: CSIR-IMMT

Materials Chemistry

This department's goal is to do top-notch fundamental and technologically focused research in the cutting-edge fields of colloids and functional materials. In order to conduct cutting-edge, cross-disciplinary research to address the underlying issues in the fields of colloids, biomaterials, energy materials, hierarchical nanostructures, polymers, functional-inorganic materials, hybrid materials, and coatings, this department has brought together scientists with a variety of backgrounds (from physics, chemistry, to metallurgy). The department has all the cutting-edge equipment required to synthesise, characterise, and quantify such functional materials' physico-chemical, mechanical, electrical, optical, and catalytic properties, among others. Additionally, it is actively interested in providing short courses on instrumentation training and colloids and materials chemistry training.

Design & Project Engineering

The department creates technology and related goods to industrialise rural areas and enhance the standard of living there. The department has created, spread, and commercialised a number of low-cost technologies.

The goal of the department is to provide a variety of need-based technologies that will lower energy costs, reduce pollution, and boost industrial output in rural India.

Environment & Sustainability

This department monitors and controls environmental pollution near factories, mines, ports, the ocean, and other urban and rural areas. It also undertakes basic and applied research for the use of bioresources.

Many industries that rely on minerals now choose CSIR-IMMT as their institute of choice

Electrometallurgy and Hydro

Utilising hydro and electrometallurgy as a foundation, the department is working to develop environmentally safe and eco-friendly technologies to utilise a variety of primary and secondary resources. It is highly equipped with all current and sophisticated infrastructural facilities to handle the projects on a turnkey basis. It has expertise in the creation of pre-feasibility reports, and fundamental engineering process packages based on the flow sheet generated.

Mineral Processing

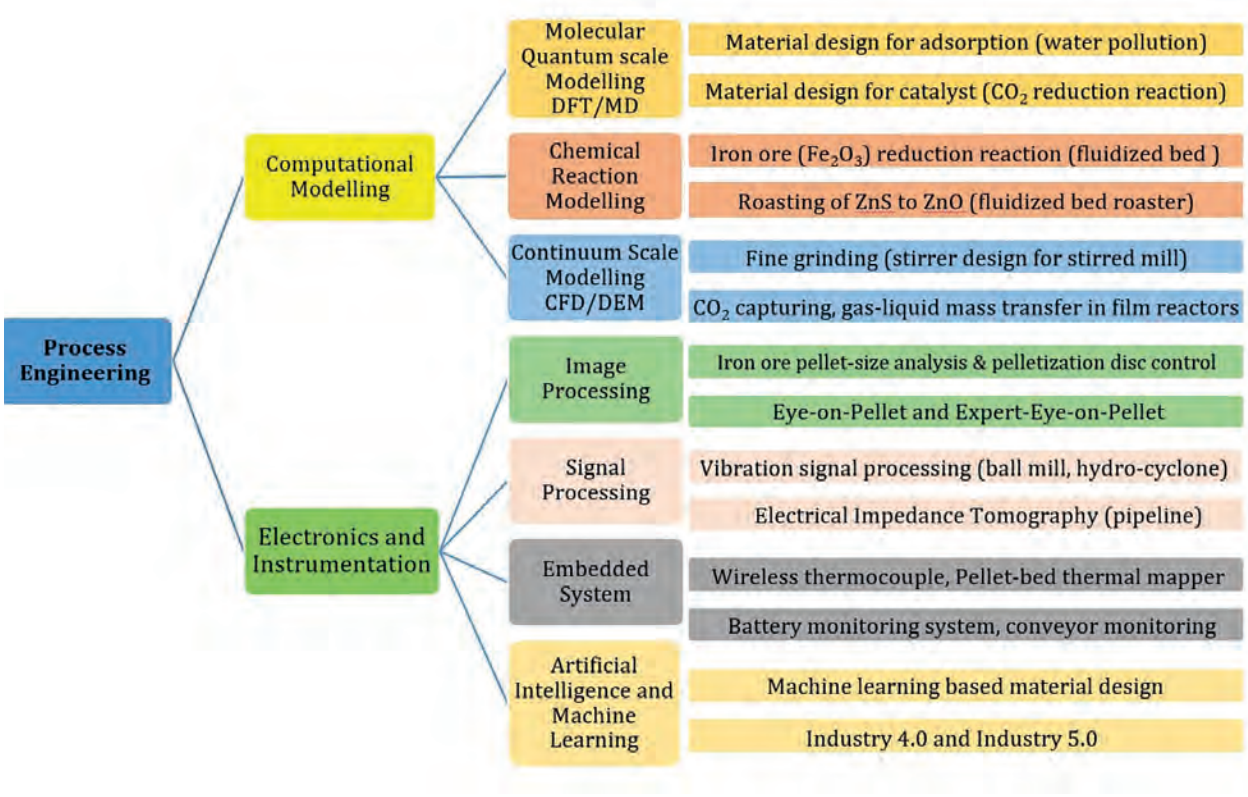
Since the establishment of the laboratory in 1964, the mineral beneficiation activities at IMMT, Bhubaneswar, have been a component of the Minerals and Metals division. The recently reorganised Mineral Processing Department (formerly Mineral Processing Technology Department) reoriented itself towards solving the R&D problems related to utilisation of lean and off grade ores in response to the significant changes in the scenario of mineral production and utilisation in the country as a result of the new policy of liberalisation and globalisation. The development of technologies for recovering value from wastes and byproducts of the mining industries, as well as energy and environmental issues of processing various ores and minerals, are the other focus areas.

OBJECTIVES

- Assessing low-grade ores and minerals to create appropriate flow sheets.
- Creation of scale-up design data.
- Creation of novel and innovative methods for using difficult ores.
- Creation of procedures for extracting valuables from byproducts and garbage.
- Modifying existing plants to increase their performance.
- Energy efficiency improvements in mineral processing unit operations.
- Research on environmental contamination in the chemical, metallurgical, and mining industries.
- Basic and fundamental study to assist the aforementioned actions.

Process Engineering & Instrumentation

Process Engineering & Instrumentation department's responsibilities include taking on and supporting a variety of projects for molecular level modelling, process level modelling, simulation, mechanisation, prototyping, instrumentation, measurement, data acquisition, monitoring, control, data analysis, and AI/ML based information retrieval for new and existing processes. Modelling and simulation tools including ANSYS, COMSOlL Quantum ATK, Gaussian, Matlab, LabVIEW, and Quantum Espresso are among the facilities offered.



Additionally, the department utilises open source applications like Python and OpenFOAM. The department also includes various hardware for instrument development and quick prototyping.

Process Modelling and Simulation

• Process modelling and simulation of mineral processing and extractive metallurgy unit operations using first principles.
•Data driven based models using Design of Experiment techniques, and process parameter optimisation using traditional optimisation techniques as well as evolutionary methods.
• Artificial Neural Networks based models for prediction of properties.
• Molecular modelling for selection of extractants for solvent extraction.

Instrumentation

• Intelligent instrumentation.
• Microcontroller based system.
• LabVIEW and dSpace based rapid prototyping.
• Image processing based monitoring and control system.
• Vibration analysis based fault monitoring system.
• Thermal Plasma Diagnostics using Spectroscopy.

Process Design

• Design, development & commissioning of a 4 ton/hr continuous billet reheating coal fired furnace for re-rolling mill belonging to Industrial Development Corporation Ltd., Orissa, located in Hirakud.
• Engineering consultancy for design, equipment specification, and installation of 10TPD (Technology Proving Plant) for production of nickel from Sukinda chromite overburden.
• An integrated approach for processing of tree-borne oil seeds and value addition to products and byproducts.
• Integrated utilisation of under explored non-traditional oil seeds growing wildly in the forests of Orissa.

Mathematical Models

• Mathematical models for various mineral processing unit operations such as hydrocyclone, magnetic separator, spiral concentrator, fluidised bed, etc.
• Design of a microfluidic device for separation of charged gold nanoparticles.
• Mathematical model of a multiple hearth furnace for reduction roasting of chromite overburden for extraction of Nickel.
• Hydrodynamic modelling and simulation of a pulsed sieve-plate extraction column .
• Software development for estimating influence co-efficients and concentration of unknown samples for a XRF unit.
• Neural network control of froth depth for a flotation column.

Instrumentation

• Eye-on-Pellet: An online image processing system developed for obtaining the pellet size distribution trend in a pelletisation plant.
• Active Noise Control: Development and evaluation of many ANC novel algorithms.
• Plasma Spectroscopy: Optical Emission Spectroscopic study of plasma using Echelle and Czerny Turner spectrographs with ICCD camera.

With regard to its material resources and mineral reserves, Odisha is India's most significant state. Numerous industries are approaching the state to establish bases there, and IMMT is working with them, assisting them in their setups, which will ultimately serve to grow the sector and strengthen the state's economy.

YOUNG SCIENTIST/ SAATHVIK KANNAN

Indian American wins USA's most prestigious award for STEM project

The 17-year-old comes in a long line of Indian American students winning awards at USA's oldest science competition for high schoolers

■ Science India Bureau

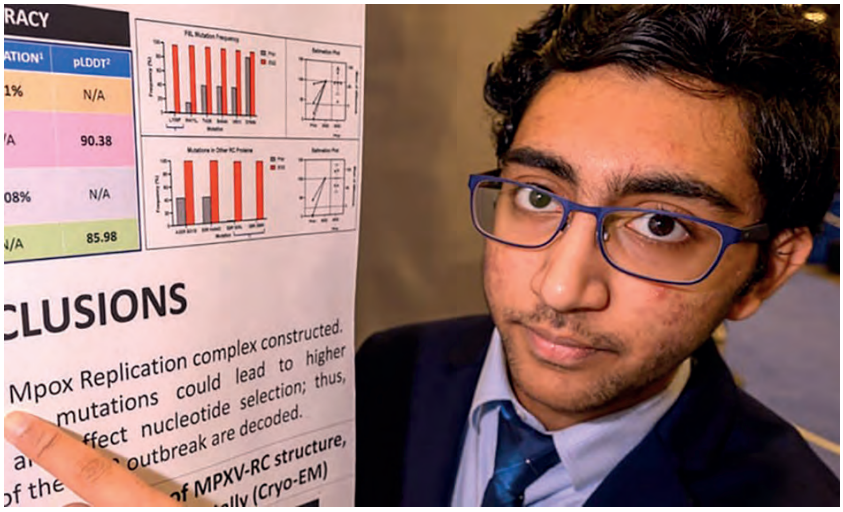


Image Courtesy: Internet

The resounding acclaim that erupted when eighth-grader Dev Shah was announced the winner of the 2023 Scripps National Spelling Bee in US is still audible in both America and India. Saathvik Kannan, a young prodigy of Indian descent, has made a fantastic accomplishment that has given this momentum. In the Regeneron Science Talent Search, 17-year-old Kannan from Hickman High School was among the top 10 young STEM leaders and took home a $50,000 cash prize.

Saathvik Kannan of Columbia, Missouri, won one of two $50,000 Regeneron Young Scientist Awards for his use of biocomputational techniques to comprehend the reasons for the illness mpox's increased infectiousness once it re-emerged in 2022. Kannan's method, called Bioplex, decodes structures like those that allow the mpox virus to proliferate by combining machine learning with three-dimensional comparative protein modelling. This made it possible for him to spot the virus's mutations, which likely made it more contagious and other modifications that might have made it resistant to antibiotics. Kannan is certain that researchers will be able to employ Bioplex to combat future viral epidemics.

The two worst dangers to the continuation of life on our planet are viruses and nuclear weapons. International treaties between nations serve as safeguards to reduce the global threat of nuclear terrorism, but it takes years to contain the threat of an infectious virus. Understanding the origins of a virus outbreak's inception or revival is essential to stopping future outbreaks. This is where Kannan's research comes into play.

He used bio-computational models in his Regeneron Science Talent Search project to identify and comprehend the causes causing infectious diseases like monkeypox, which reappeared in 2022 as the COVID-19 epidemic started to fade. An individual who had travelled to Nigeria, where monkeypox was an endemic disease, was the first person infected with the mpox virus in May 2022 in London.

Kannan's work lays the ground for comprehending the variables that are most likely to result in fresh virus outbreaks in the future. "It is clear from the COVID-19 pandemic's several waves that any virus can quickly emerge from a dormant state. As a result, my research has a great deal of potential to contribute in understanding the underlying factors behind upcoming outbreaks," wrote Kannan in a social media post. According to reports, the CDC (Centre for Disease Control and Prevention) issued an alert on May 15 regarding a potential summertime outbreak of monkeypox.

The 2023 Regeneron International Science and Engineering Fair had more than 1,600 young scientists and engineers from 64 nations and 49 states competing. Additionally, Kannan won first place and $5,000 in the competition's computational biology and bioinformatics category.

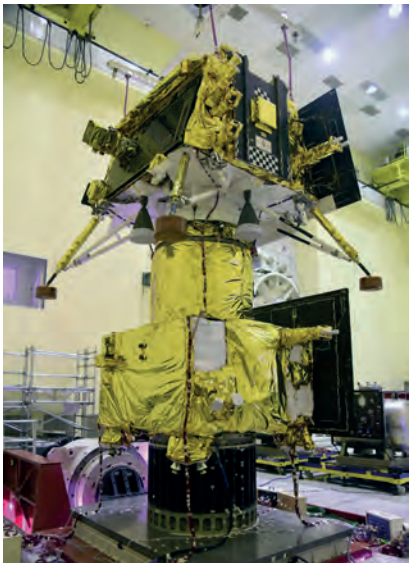
The winners were chosen for their dedication to innovation in addressing difficult scientific topics, employing real research practises, and coming up with answers to problems of the future, according to Regeneron, a leading biotechnology business.

Kannan gave Kamlendra Singh, an assistant professor at the University of Missouri, credit for being his mentor.

Another Indian American student from Portland, Rishab Jain, received the same honour the previous year for creating an AI-based methodology that enables quick and affordable medicine synthesis utilising synthetic DNA engineering, such as the production of recombinant COVID-19 vaccines.

Chandrayaan-3 will be launched mid-July, says ISRO Chairman

S Somnath, the chairman of the Indian Space Research Organisation (ISRO), announced that the organisation intends to launch the Chandrayaan-3 moon mission in the middle of July.



ISRO chairman S Somanath said the timing for launch of Chandrayaan-3 mission has been fixed

He shared this at the SMOPS-2023 International Conference on Spacecraft Mission Operations. The Chandrayaan-3 satellite has already been relocated from Bengaluru's UR Rao Satellite Centre to Sriharikota's Satish Dhawan Space Centre. The initial satellite inspection procedures, which involve both the lander and rover, and the propulsion module, are currently underway.

Over 101 million people diabetic in India, Goa leads the list

According to a recent Lancet report, India has 101 million people with diabetes and 136 million people with prediabetes, indicating that the metabolic condition affects roughly 11.4 percent of the country's population. The Indian Council of Medical Research (ICMR) and the Ministry of Health and Family Welfare jointly funded the country's largest epidemiological research on diabetes and

Urban areas had a higher incidence of all metabolic NCDs than rural ones

chronic noncommunicable diseases. The study includes all 28 states, two union territories, and the nation's capital, Delhi. The study used samples from a total of 1,13,043 persons. The outcomes of the study were published in the prestigious medical journal *The Lancet Diabetes and Endocrinology*. The worst affected is Goa, the fourth smallest state in the country, with 26.4% of its population affected by the disease.

Drug-resistant infections a major impediment to malaria control

South East Asian countries account for 79% of all malaria cases worldwide.

An estimated 79% of global cases of malaria come from South East Asian countries

Drug-resistant infections are a major impediment to malaria control and eradication. A team of Indian researchers sequenced 53 complete genomes of isolates of malaria-infected patient samples to better understand how malaria parasites develop medication resistance. The World Health Organisation (WHO) currently recommends Artemisinin combination therapy (ACT) for the treatment of malaria, which has long been considered the gold standard. Many countries in Southeast Asia and Africa with high malaria prevalence have reported drug-resistant illnesses.

Indian, Korean researchers develop light-powered supercapacitors

In a multinational initiative comprising institutions in India and South Korea, a group of researchers developed a portable supercapacitor that can be charged by light. The technology has the potential to replace traditional lithium-ion batteries in portable and

Supercapacitors have great power density and specific capacitance

All Images Courtesy: Internet

wearable devices such as smartphones, tablets, laptop computers, and smartwatches. Researchers from University College, Thiruvananthapuram, IIT Guwahati, Gwangju Institute of Science and Technology, Korea Institute of Energy Technology, and Chonnam National University in South Korea collaborated on the study.

Indian scientists find alien planet 13 times bigger than Jupiter

Professor Abhijit Chakraborty of the Physical Research Laboratory (PRL), Ahmedabad, led a team of scientists who identified the densest extraterrestrial planet, which is 13 times larger than Jupiter. This is the third exoplanet discovered. A team of scientists from India, Germany, Switzerland, and the United States measured the planet's mass precisely using the indigenous PRL Advanced Radial-velocity Abusky Search spectrograph (PARAS) at the Gurushikhar Observatory in Mt. Abu. The exoplanet weighs 14 g/cm3.

First ever 'Virgin Birth' documented in a crocodile

Scientists have discovered that a female crocodile, living alone in a wildlife park for almost 16 years, laid more than a dozen eggs in 2018. Parthenogenesis, or 'virgin birth', is the process

All Images Courtesy: Internet

First evidence of virgin birth in crocodiles has been reported in a captive American crocodile

by which a female reproduces herself. A team of researchers publish that the baby crocodile was a parthenogen — the child of a virgin birth carrying only genetic material from its mother. Parthenogenesis has previously been discovered in king cobras, sawfish, and California condors, but this is the first time it has been seen in crocodiles. Because crocodiles are on the tree of life, it implies that pterosaurs and dinosaurs were also capable of such feats of reproduction.

Mountain peaks higher than Mt. Everest found near Earth's core

According to scientists, deep below the Earth in Antarctica, mountains with peaks three to four times taller than the Mount Everest have been discovered. When researchers examined seismic waves generated by 25 earthquakes during the investigation, they discovered that these waves slowed down strangely when they reached a jagged region on the core-mantle border. The mountains, according to the researchers, are sections of the Earth's lower mantle that have been superheated due to their proximity to the incandescent core. While the mantle can reach 3,700 degrees Celsius (6,692 degrees Fahrenheit), the core can reach atom-bending temperatures of 5,500 degrees Celsius (9,932 degrees Fahrenheit), which is not far from the temperature at the Sun's surface.

Underground mountains may play a critical role in how heat escapes the Earth's core

Astronauts may start frying food in space soon

As international space organisations work to take humans to the Moon and beyond for longer-duration missions, the aim is to feed them well, and nothing beats comfort food. A group of experts is developing culinary technologies for frying meals in space. Sometimes it takes more than a chef to create pleasant food for you; after all, even if frying potatoes is done all across the world, it includes sophisticated physics and chemistry. This becomes significantly more difficult in an airless environment.

A team of scientists is working to develop cooking methods for frying food in space

World warming at record 0.2 degrees Celsius per decade

A group of 50 top scientists from around the world has issued an alert, saying that the earth is warming at a rate of 0.2 degrees Celsius every decade. From 2013 through 2022, 'human-induced warming has been increasing at an unprecedented rate of over 0.2 degrees Celsius per decade,' the researchers wrote in a peer-reviewed study aimed at policymakers.

Human-induced climate change is warming world at an unprecedented rate of over 0.2°C per decade

'Space travel messes up the brain'

A new study has revealed what happens to astronauts' brains when they travel and work in zero gravity. Brain scans of 30 astronauts were investigated before and after space travel. Astronauts who spent at least six months aboard the International Space Station (ISS) or NASA space shuttles saw considerable expansion of the cerebral ventricles, which are areas in the centre of the brain that hold cerebrospinal fluid.

The study involved 23 male and seven female astronauts from USA, Canada and Europe

QUIZ: Yoga

1.The International Day of Yoga was first celebrated in which year?
A.2013
B.2014
C.2015
D.None of the above

2.Which of these is a benefit of yoga?
A.Fitness
B.Relaxation
C.Flexibility
D.All of the above

3.Anantasana is a type of?
A.Sitting asana
B.Balancing asana
C.Reclining asana
D.None of the above

4.Which amongst these is a sitting asana?
A.Simhasana
B.Tadasana
C.Trikonasana
D.None of the above

5.In Yoga, the handstand is also called?
A.Adho Mukha Shvanasana
B.Adho Mukha Vrikshasana
C.Bhujangasana
D.None of the above

6.What is the meaning of prana?
A.Air
B.Oxygen
C.Vital life force
D.None of the above

7.Which of these is a hand-balancing asana?
A.Pashasana
B.Dandasana
C.Mayurasana
D.None of the above

8.Which asana is also known as the 'wind-relieving pose'?
A.Bhujangasana
B.Padangustasana
C.Pavanamuktasana
D.None of the above

9.Which of these asanas gives a good stretch to the spinal column?
A.Halasana
B.Bhujangasana
C.Bidalasana
D.None of the above

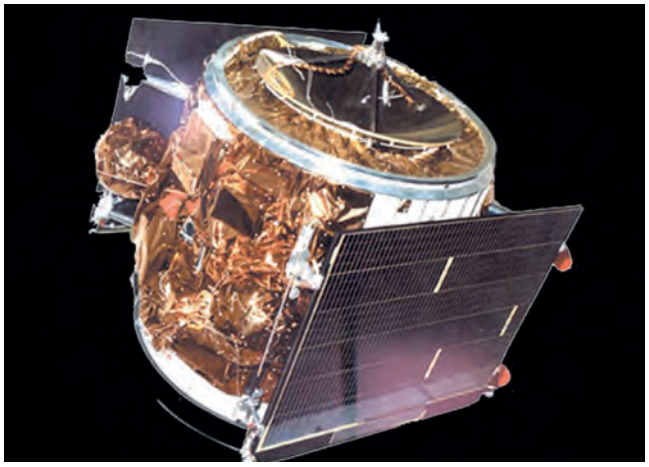
10.What is the technique of controlling breath called?
A.Pranayama
B.Surya Namaskar
C.Asana
D.None of the above

Enrich Yourself with Facts on APPLE Satellite

■ The Ariane Passenger PayLoad Experiment (APPLE), an experimental communication satellite with a C-Band transponder, was launched by the Indian Space Research Organisation on June 19, 1981, from the Centre Spatial Guyanais near Kourou in French Guiana. Ariane was a launch vehicle of the European Space Agency (ESA).

■ APPLE was India's first experimental geostationary three-axis stabilised communication satellite. It was positioned at 102° E longitude on July 16, 1981.

■ Despite one solar panel failing to deploy, the 672 kilogramme satellite acted as a testbed for the Indian space relay system for communications. The fourth stage of SLV-3 was used to create the solid-propellant-based Apogee Boost Motor to circularise APPLE's orbit.



Ariane Passenger PayLoad Experiment (APPLE) was India's first experimental geostationary communication satellite

■ It was utilised in a number of communication experiments, including radio networking and TV programme relay. The spacecraft was a cylindrical shape with a 1.2 m diameter and 1.2 m height.

■ Its payload included a 0.9 m-diameter parabolic antenna and two 6/4 GHz transponders. It stopped being used from September 19, 1983. RM Vasagam oversaw projects at APPLE from 1977 until 1983.

■ For about two years, comprehensive studies on time, frequency, and code division multiple access systems, radio networking computer interconnect, random access, and packet switching experiments were conducted using APPLE.

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

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Darshan Ranganathan

Image Courtesy: Wikipedia

Organic chemist, known for her work in bio-organic chemistry, including pioneering work in 'protein-folding', Darshan Ranganathan was born on June 4, 1941 in Delhi. She received a PhD from Delhi University and went on to conduct postdoctoral work at Imperial College, London. Married to fellow scientist Subramania Ranganathan, she passed away on her 60th birthday due to cancer.

June
2023

Celebrating Science This Month

JUNE 1
National Aerospace Laboratory (NAL), India's largest aerospace firm, was established by CSIR in Delhi in 1959. Its headquarters were shifted to Bangalore in 1960.

Tata Institute of Fundamental Research (TIFR) was founded in 1945, by JRD Tata, then chairman of the Tata Group. Nuclear physicist Homi Bhabha, known as the Father of Atomic Energy in India, was its first director.

World Milk Day.

JUNE 2
The first AIIMS — All India Institute of Medical Sciences — was established in 1956 in New Delhi.

JUNE 3
Ruchi Ram Sahni, scientist and educationist in pre-Partition Punjab, passed away in 1948. He was a pioneering meteorologist and physicist and was the father of renowned paleobotanist Birbal Sahni.

JUNE 4
INSAT-2D, identical to INSAT-2C, was launched in 1997.

Darshan Ranganathan, well-known for her work in bio-organic chemistry, was born in 1941. She passed away, too, on this day in 2001.

JUNE 5
World Environment Day is observed annually.

GSAT-19 satellite was launched by GSLV Mk III-D1 in 2017, from the Second Launch Pad (SLP) at Satish Dhawan Space Centre SHAR, Sriharikota.

Manipur University was established in 1980.

JUNE 7
Mathematician Prof MS Narasimhan was born in 1932. He was the first chairman of the National Board for Higher Mathematics and the only Indian to win the King Faisal International Prize for Science from Saudi Arabia.

Bhaskara-I, the first experimental Remote Sensing Satellite built in India, was launched in 1979 from Volgograd Launch Station (presently in Russia).

JUNE 12
INSAT-1D was launched in 1990 by Delta 4925 to conclude the first generation INSAT series.

JUNE 15
DN Wadia, a pioneering geologist in India, passed away in 1969. He was among the first Indian scientists to work in the Geological Survey of India and is remembered for his work on the stratigraphy of the Himalayas.

JUNE 16
Acharya Sir Prafulla Chandra Ray, known as the Father of Indian Chemistry, passed away in 1944.

Guru Ghasidas Vishwavidyalaya was established in 1983 in Bilaspur, in present-day Chhattisgarh. It is now a Central University.

JUNE 18
Kamala Sohonie, who became the first Indian woman to receive a PhD in a scientific discipline, was born in 1912. She passed away on June 28, 1998.

Sir Trichnopoly Chelvaraj Anand Kumar, the creator of the second scientifically documented test tube baby in India, was born in 1936.

JUNE 19
World Sickle Cell Day is observed to raise awareness about this genetic disorder in which normal and round blood cells turn sickle-shaped, resulting in severe pain.

The Ariane Passenger Payload Experiment (APPLE), ISRO's first experimental communication satellite, was launched from Kourou in French Guyana in 1981.

JUNE 20
Sir Salim Ali, ornithologist and naturalist who was also known as the 'Birdman of India', passed away in 1987.

JUNE 21
International Yoga Day is celebrated globally.

Summer Solstice is observed each year, which marks the longest day — longest duration of sunlight — in northern hemisphere,

JUNE 22
The Cartosat-2 Series Satellite, the primary satellite carried by PSLV-C34, was launched in 2016.

JUNE 28
Sir PC Mahalanobis, the Father of Modern Statistics in India, passed away in 1972. He was born on June 29, 1893.

JUNE 29
Ashutosh Mukherjee, educator, jurist, barrister and mathematician was born in 1864. First student to be awarded a dual degree from Calcutta University, he founded the Bengal Technical Institute in 1906, which later became Jadavpur University. He also founded the Calcutta Mathematical Society in 1908.

India's latest communication satellite, GSAT-17 was launched on June 29, 2017 from Kourou, French Guyana.

JUNE 30
Sir CNR Rao, the only living Indian scientist to be honoured with the Bharat Ratna, was born in 1934.

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