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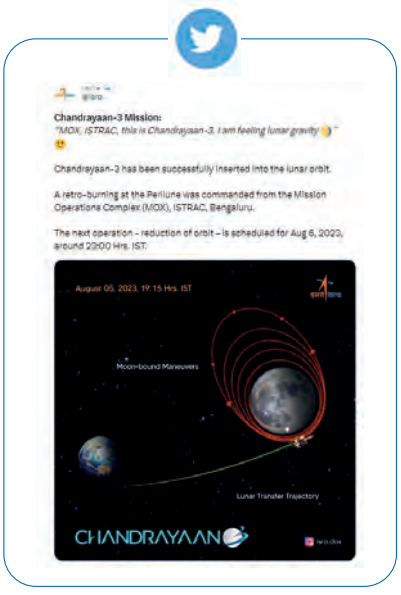
What's Inside

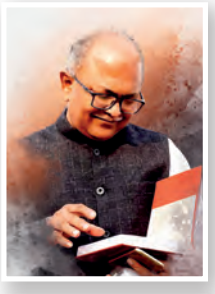
COVER STORY

Image Courtesy: ISRO

Cover image courtesy: Shutterstock



CELEBRATING THE REMARKABLE LIFE OF JAYANT SAHASRABUDHE, A GUIDING FORCE IN INDIA'S SCIENTIFIC COMMUNITY



Dear Editor,

I am writing to express my profound appreciation for the recent edition of *Science India*, which beautifully commemorates the life and contributions of Jayant Sahasrabudhe — a distinguished pillar within India's scientific fraternity. His invaluable role in shaping science communication and highlighting the significance of scientists in India's struggle for Independence truly deserves the due recognition.

It is with great pleasure that I share my privilege of having conducted an enlightening interview with Jayant Sahasrabudheji for the India Science/DD Science channel. Engaging in dialogue with a visionary of his stature was an exceptional experience. During our conversation, Sahasrabudheji graciously shared profound insights into the India International Science Festival (IISF), offering viewers a unique glimpse into the event's mission of promoting scientific awareness and nurturing a spirit of inquiry among the public.

Furthermore, having had the honour of hosting the prestigious IISF on several occasions, I am profoundly grateful for the visionary leadership and guidance of Jayant Sahasrabudheji. His instrumental role has rendered these events not only enriching but also unforgettable experiences, leaving an indelible mark on all the participants.

In the current digital era, it is essential to acknowledge the profound significance of Yoga. The articles underlining the importance of Yoga serve as enlightening beacons, illuminating the profound impact of this ancient practice on our physical, mental, and spiritual well-being. These articles delve into Yoga's rich history, tracing its evolution and seamlessly demonstrating its relevance in our fast-paced lives as a source of balance and harmony.

The article on 'Science Diplomacy' brilliantly explores the pivotal role of scientific collaboration in fostering international understanding and cooperation for addressing global challenges.

I extend my heartfelt commendation to *Science India* magazine for its commitment to showcasing exceptional individuals and their diverse journeys. May Jayant Sahasrabudheji's legacy continue to inspire present and future generations alike. I applaud your unwavering dedication to fostering a deeper appreciation for the interconnectedness of science, culture, and personal growth.

Sincerely,

Prof Maan Bardhan Kanth, Associate Professor,
DY Patil International University, Akurdi, Pune

Send your letters to editor@scienceindia.in

Let's Connect

Dear Readers,
This month of July is special for India's science fraternity as it sees the much- anticipated launch of Chandrayaan-3, the mission that aims to achieve 'soft landing' on the Moon's southern pole by the end of next month. *Science India* takes this opportunity to congratulate all members of India's science fraternity on this mission, and also congratulates all the science enthusiasts of the country who have immense faith in our scientists pushing forward India's unique and brilliant space programme.

India's space programme, truly, is a unique success story in the world and there is no need to repeat it here as it is a story well-known to all Indians, and something which gives all of us great pride.

While our cover story looks at the possibilities Chandrayaan-3 opens up for India to become a global space power, it also throws light on the fact that the rest of the Moon-faring nations are not in the race for simple exploration and research. Read on to find why Chandrayaan-3, therefore, is a hare among the hounds.

The 'Science Diplomacy' column too goes deeper into the topic, but argues why diplomacy, especially in the context of India's growing space prowess, is a necessity and not a choice for India anymore.

This month in India's calendar is also the one that brings news of calamity, largely due to monsoon rains. Calamities due to heavy rainfall have become a rather recurring feature in one or the other part of the country — whether it is urban flooding due to heavy rains as happened in the capital New Delhi or disasters caused as a corollary to the ongoing climate change, exacerbated by monsoon rains in the mountains, the news is not often good. Is there a solution to these issues? A story 'Calamities in the Himalayas' analyses the reasons behind regular natural disasters in the mighty mountains despite technological advancements.

This edition also puts spotlight on India's eminent scientist-teacher, Dr Daulat Singh Kothari, whose birth anniversary falls this month on July 6. A scientist-teacher in the tradition of pre-Independence scholars of India, Dr Kothari made immense contribution to science, teaching and institution-building in the country. Readers would recall that he was also the head of the famed Kothari Commission that made far-reaching changes in the imparting of education in India.

It has remained the endeavour of *Science India* magazine to bring such stories as the profile of Dr DS Kothari to mass readership so that contributions such as these don't go unheralded in the India of today. It is, after all, on the foundations laid by such luminaries that the country is able to march confidently forward into the future.

The team hopes that the readers will enjoy all the stories that we have put together for you all in this edition of *Science India*.

Calamities due to heavy rainfall have become a rather recurring feature in one or the other part of the country today

CALAMITIES IN THE HIMALAYAS

What makes the Himalayan region susceptible to disasters during the rainy season despite our technological advancement?

■ **Dr Narendra Singh**

The Himalayas formed about 40 million years ago and are considered to be the youngest and fragile mountain system offering diverse and geologically active landscape which is very sensitive to the climate change. The Himalayan region is abode to beautiful landscapes and unique ecosystems, but home to natural disasters as well, especially, during rainy season.

Despite our scientific and technological advances, the states with mountainous terrain still face severe floods, earthquakes, and environmental degradation. The steep terrain, loose soil, and complex tectonic processes make these mountains prone to landslides, in addition, to those exacerbated during heavy rains. Also, the effects of climate change, such as melting ice and changing monsoons, make

Image Courtesy: Shutterstock

The Himalayas are prone to extreme weather events owing to their complex topography and passage of major rain systems. This is the valley of Parvati river in Himachal Pradesh's Kasol destroyed after floods

the region more vulnerable to extreme weather conditions. Heavy rains combined with melting glaciers cause severe floods that pose threat to life and property. Hilly areas of Jammu & Kashmir, Himachal Pradesh and Uttarakhand are much prone to these extreme weather events owing to their complex topography and passage of major rain systems such as western disturbances in winter and moist air flow during monsoon.

FLOODS IN THE HIMALAYAS

The Glacial Lake Outbreak Flood (GLOF) is one of the serious threats to Himalayan region, especially during monsoon when heavy rains combine with melting glaciers. This combination causes the glacial lake to expand rapidly thereby creating an unstable situation where the flowing water puts great pressure on the small dams created by the surrounding moraine which is a mixture of rock, sand, and gravels. With continued rainfall, dams can weaken, break, or collapse, causing serious damage downstream. A GLOF can sweep away everything in its path, causing injury, social change, destruction, and ecosystem degradation and leads to massive river flow down the slopes of the Himalayas, reshaping the landscape and sometimes changing the river path.

Another severe and quick weather system is the cloud burst which is basically topography induced, primarily takes place along the slopes and over the mountain valleys favouring the convective lifts to the moist air. A cloud burst is defined as an extreme amount of rainfall taking place at the rate of 100 mm/hour or greater. A cloud burst originates from deep convective cloud and when the weight of the cloud supersedes the buoyant force from bottom of the cloud, a sudden downpour starts. It is pertinent to mention here that some of the most devastating events that have taken place in Himalayan region resulted from the interaction of western disturbances with monsoonal clouds which together make a cloud supercell as shown in the figure on the next page. Such a system transforms into very heavy widespread rainfall for longer duration and leads to flash floods and landslides across the region.

The steep terrain, loose soil, and complex tectonic processes make the Himalayas vulnerable to landslides such as in Dalhousie in Himachal Pradesh in this image

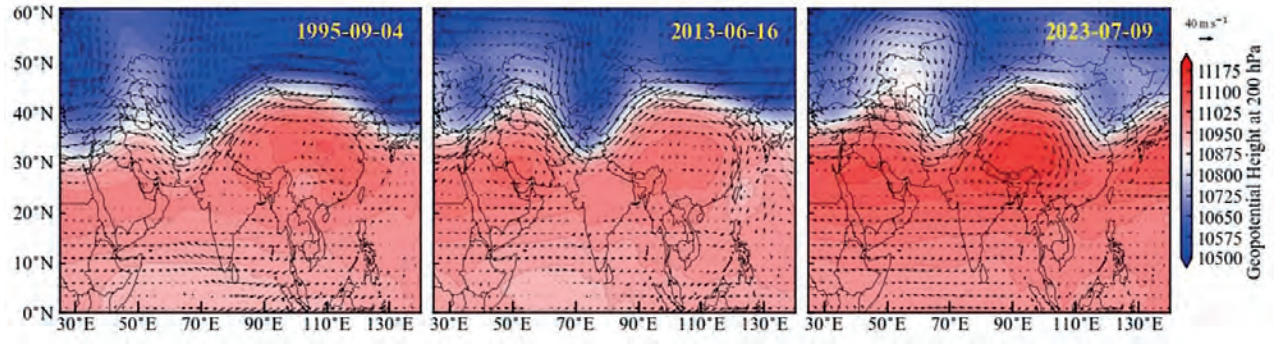
Image Courtesy: Twitter

A GLOF (Glacial Lake Outbreak Flood) can sweep away everything in its path, causing injury, social change, destruction, and ecosystem degradation, leading to massive river flow down the Himalayan slopes

Interaction of extratropical weather system (western disturbance) with monsoonal circulations resulted in calamities such as those in the Central-Eastern Himalaya (1995), Central Himalaya (2013, Kedar valley calamity) and Western Himalayan region (2023, Himachal floods).

One of the main reasons for the increased frequency and intensity of such events in the Himalayas is climate change. The Himalayan region is predicted to witness a rise of 5-7°C in the temperature by the end of this century that will adversely affect the Himalayan ecosystem. Urban heat pools resulting from the global warming induced by anthropogenic activities, boost the atmospheric dynamics and to some extent affect the weather systems. In addition, changes in the precipitation patterns, cause more intense rain, resulting in heavier and longer-lasting precipitation in the region, though the total number of rainy days are decreasing. Excess water from the monsoon, when combined with icy water, puts pressure on the glacial lakes and increases the risk of outbreak.

As climate change continues to affect the Himalayas, disaster cases will only increase, putting enormous pressure on disaster management and risk reduction. This article explores causes behind these disasters, status of technology based approaches, shares the ancient wisdom, and recommends remedies that urban planners and architects should adopt to prevent these extremes.



Some of the most devastating events that have taken place in Himalayan region have resulted from the interaction of western disturbances with monsoonal clouds which together make a cloud supercell as depicted in the figure above

TECHNOLOGICAL ADVANCES IN THE CONTEXT OF HIMALAYAN REGION

Measurement of the meteorological parameters and their documentation is essentially required to understand the processes and developing new methodologies for forecasting the extremes and mitigating the disaster. India Meteorological Department, various public and private agencies make such observations but mostly limited to accessible locations. The remote and logistically difficult Himalayan sites still lack such measurements or are rarely available. With the state-of-the-art technology, indispensable tools such as Radars, Lidars, moisture profilers and various other atmospheric devices are available for monitoring the extreme events in real time, but we still do not have a dense early warning network to deal with such events particularly across difficult terrain like Himalayas. However, recently a few Doppler weather radars have been installed in Uttarakhand and Himachal Pradesh, but these efforts are not adequate unless the real time data is integrated with other auxiliary surface and space borne observations, to model and predict the extremes in advance.

State governments are required to put serious efforts in the capacity building and establishing centres for data acquisition, analysis, prediction, and information dissemination. All hill states need to join for common policies to strengthen observational networks and to deal with the environmental aspects of the disaster-prone regions in rainy season. In order to deal with this issue, these states must have strict policies for land use, land cover and the forest conservation.

LEARNING FROM ANCIENT WISDOM

Hindu mythology and ancient science also emphasize respect for nature and water. Rivers like Ganges and Yamuna are sacred and worshiped for their vital properties. Our ancestors in the Himalayan region had a deep understanding of their environment and have adapted their lifestyle and habitat to coexist with nature. They built their houses and settlements on high ground with sloping roofs to avoid flood-prone areas and allow rainwater to run off easily. Traditional water management systems regulate water flow during heavy rains to prevent flash floods.

Ancient societies harvested rainwater during the monsoon season. Modern engineers can take inspiration from these practices to design stormwater harvesting systems that will reduce pressure on rivers and prevent urban flooding

Forests are revered for their role in soil conservation, flood control, and ecosystem balance. Learning from ancient wisdom is important not only for glacial lake outburst floods but also for preventing rain-induced flooding in the Himalayan region. Indigenous communities have developed sustainable practices that can be applied to contemporary flood mitigation strategies. Ancient societies used innovative water harvesting techniques to capture and store rainwater during the monsoon season. Modern engineers can take inspiration from these practices to design effective stormwater harvesting systems that reduce pressure on rivers and prevent urban flooding. Native farmers practiced contour farming, planting crops along natural contours to reduce runoff and reduce the risk of soil erosion and landslides. Implementation of agricultural contour in hilly areas can prevent soil degradation and increase agricultural resistance. Ancient societies respected ecological balance and protected natural habitats such as wetlands and forests that acted as natural buffers against floods. Incorporating this wisdom into modern conservation practices can protect critical ecosystems that regulate water flow and reduce flood risk.

MODERN CHALLENGES AND TECHNOLOGICAL SOLUTIONS

Reducing the problems caused by heavy rainfall and flooding in the Himalayas, including GLOFs, requires a comprehensive and regional approach that addresses the needs of rural and urban populations as well as other Himalayan ecosystems. In response to these prob-

Image Courtesy: Twitter

The development and implementation of robust early warning systems is crucial for disaster preparedness in the Himalayan region. Above: The Indian Air Force involved in evacuation process in Himachal Pradesh

lems, the state and central governments should focus on the implementation of strategic plans based on the characteristics of the mountain range and its foothills.

Developing accurate and impact-based weather and climate forecasts is important for the Himalayan region, where climate can change rapidly. Investing in advanced weather monitoring technologies such as weather radar and satellites will lead to accurate weather forecasting. Collecting and analysing data in collaboration with weather agencies and research centres will increase the accuracy of forecasts. In addition, an impact estimation that considers specific sectors such as agriculture, transport, and infrastructure will facilitate better planning and response.

Early Warning: The development and implementation of robust early warning systems is crucial for disaster preparedness in the Himalayan region. The installation of meteorological stations, hydrometers and lake ice monitoring stations will provide real-time information for early warning. The use of various means of communication, including cell phones, sirens, and community radios will ensure timely alerting of rural and urban communities. Raising public awareness on the importance of considering early warnings will help prevent disasters and reduce the risk of loss of life and property.

Planning and Awareness: A disaster preparedness plan and awareness are essential to educating the community on risks and safety precautions. These plans should be tailored to local conditions and include internships, community engagement and emergency kit development. Special attention should be paid to raising the awareness of vulnerable people, including women, children, and the elderly, to ensure that they are adequately prepared for emergencies.

Geospatial Mapping and Risk Assessment: The use of geospatial mapping, remote sensing data, and GIS techniques will aid in risk assessment of the Himalayan region. The data-driven approach will help identify high-risk areas for flooding and landslides and enable evidence-based decision-making in infrastructure planning and disaster management. Regular updating of these measures is essential to adapt to changing conditions and emerging risks.

Awareness should be raised among the vulnerable to ensure they are adequately prepared for emergencies

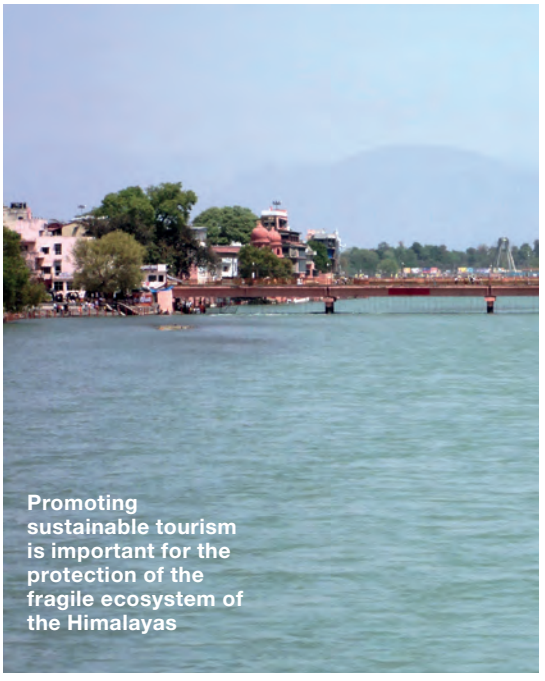


Image Courtesy: Pixabay

Promoting sustainable tourism is important for the protection of the fragile ecosystem of the Himalayas

Sustainable Planning and Infrastructure Improvement: It is important to implement urban and rural planning to reduce the impact of heavy rains and floods in the Himalayan region. Regulations should limit construction in flood-prone areas and encourage good infrastructure. Investing in strengthening roads, bridges, and buildings will make the region more resilient to disasters. In rural areas, using basic construction techniques and materials that can withstand extreme weather conditions will help build strength.

Flood Protection: Flood protection should be a priority in high-risk areas which should include dams, embank-

ments, and flood walls. Solutions such as wetland development and riparian naturalisation can complement traditional engineering techniques for managing excess water during the monsoon season. Erosion prevention measures such as gabion walls and stabilisation plants should be implemented along the coastline to prevent soil erosion and control water flow.

Forest protection and restoration: Forest protection and renewal in the Himalayan region is important for soil and water conservation, flood prevention, and ecological balance. The government should strictly enforce forestry laws and support community-based initiatives for sustainable forest management. Planting programs should be encouraged to restore degraded areas and reduce the risk of landslides in high-altitude areas.

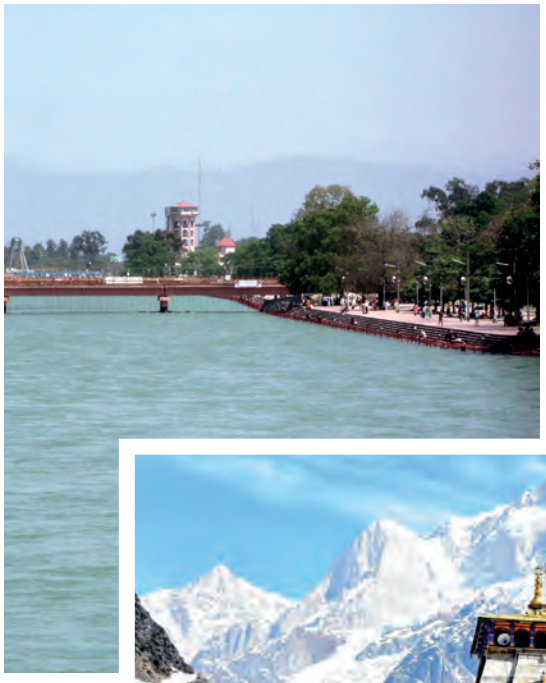


Image Courtesy: Uttarakhand Tourism

Sustainable Tourism Practices: Promoting sustainable tourism in the region is important for the protection of the fragile Himalayan ecosystem. The government should manage the waste management process, regulate related businesses, and promote the eco-friendly tourism industry to reduce environmental impact. Creating ecotourism projects in collaboration with local communities will allow the economy to benefit the region while maintaining its beauty.

Adaptation to climate change: Considering climate change in infrastructure planning is important for the Himalayan region. The government must follow design standards such as simple construction and design standards to prevent climate change. Integrating climate change considerations into development policies and disaster management plans will increase the region's ability to meet future climate challenges. Cooperation between neighbouring countries is also important for solving cross-border problems such as floods and earthquakes. The government should strengthen cooperation in disaster management, information sharing, and research initiative to have more cooperation and efficiency. Sharing best practices and lessons learned across borders will strengthen the region's resources to meet common challenges.

Environmental Impact Assessment (EIA): A rigorous EIA is required for any major development to identify potential hydrological, geological, and ecological impacts on the site. This process will assist in the development of appropriate measures to protect the Himalayan environment and communities. Integrating public consultation into the EIA process will ensure that community voices and concerns are considered in the decision-making process.

Prioritising the needs of rural and urban communities and integrating technological solutions will support recovery and sustainable development in ecologically sensitive areas. The collaboration of all stakeholders, including local communities, NGOs, and international partners, is essential to implement these policies and build a safer and stronger Himalayan region.

CONCLUSION

It is well understood that climate change has taken place and it is profoundly impacting the Himalayan ecosystem. In conclusion, prevention of flooding, calamities, and environmental disasters in the Himalayan region requires a multifaceted approach that combines ancient wisdom with modern solutions. Emphasising accurate and impact-based weather forecasting is crucial for early warning systems and tailored disaster risk reduction measures. By leveraging the available advanced weather monitoring technologies and collaborating with meteorological agencies, city planners and engineers can protect communities and infrastructure from extreme weather events. Integrating traditional knowledge from our ancestors is equally important and vital in urban planning, disaster-resilient infrastructure, and responsible tourism to preserve this majestic landscape. Respecting the delicate balance that sustains life in the region will ensure its protection for generations to come.

**The writer is Scientist F, Deputy Chair, Atmospheric Science Division, ARIES, Manora Peak, Nainital.*

What Makes Chandrayaan-3 Different From Chandrayaan-2

India's latest mission to moon hopes to rectify all the difficulties that its Chandrayaan-2 mission faced in its soft landing on the lunar surface in 2019

■ Sonam Singh Subhedar

The eagerly anticipated Chandrayaan-3 mission to the Moon was launched by the Indian Space Research Organisation (ISRO) on July 14. On board the Launch Vehicle Mark-III (LVM3) at the Satish Dhawan Space Centre in Sriharikota, the spacecraft launched flawlessly.

India's second attempt to set foot on the moon's surface was made with Chandrayaan-3, the third mission in the series, which is expected to have cost Rs 615 crore. It aspires to make India a member of the privileged moon faring nations' club.

By successfully placing the Chandrayaan-3 mission in a precise orbit, the LVM3 demonstrated its capability once more. Following the launch, the spacecraft detached from LVM3 after more than 900 seconds.

Now that the spacecraft is on its way to the Moon, ISRO will carry out the orbit-raising manoeuvres in the ensuing days. On August 5, Chandrayaan-3 is slated to enter lunar orbit, and by the end of the month, a soft-landing attempt is anticipated.

Till date, only three other nations have successfully landed a spacecraft on the Moon's surface — the US, Russia (erstwhile USSR), and China.

With Chandrayaan-3, India has sent a lander, rover, and propulsion module to the Moon. The lander-rover configuration will attempt the perilous touchdown while the Propulsion Module will put the spacecraft into lunar orbit. The lander will make an attempt to land in the Moon's Southern Polar Region after being separated.

The precise landing site has not yet been disclosed. Details suggest that it may be closer to the location of the 2019 Chandrayaan-2 crash landing. To connect with the ground stations on Earth,

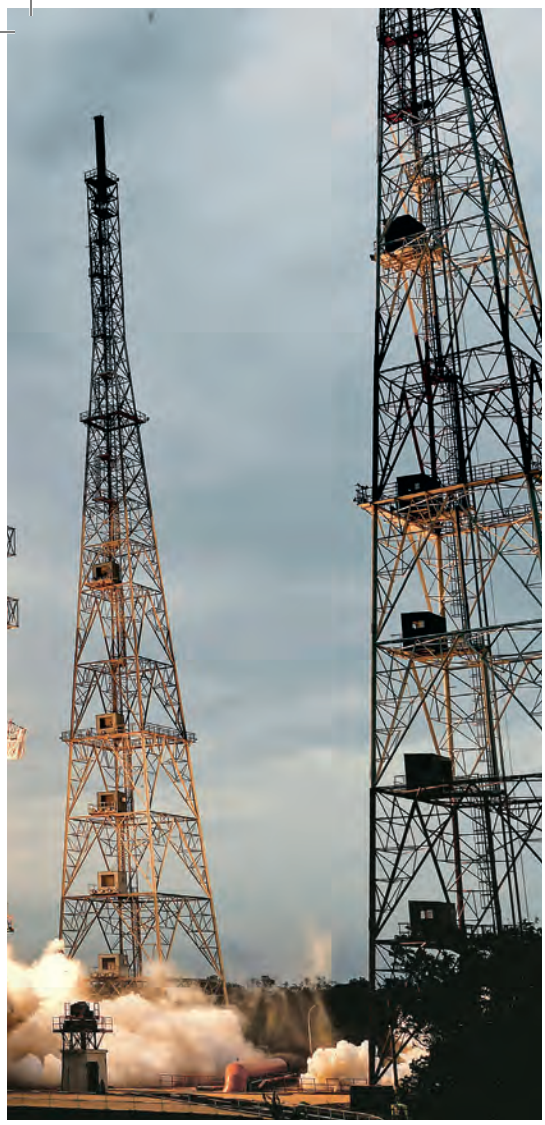


Image Courtesy: ISRO

Chandrayaan-3, currently on its way to the Moon, will attempt a soft landing on the lunar surface by the end of August

the Chandrayaan-2 orbiter, which is already in lunar orbit, will be used.

VIKRAM'S LANDING IN 2019

On September 6, 2019 — the day of landing, ISRO lost touch with Vikram when it was only 335 metres (0.335 km) from the Moon's surface. The malfunction was thought to have happened during the 'Fine braking phase' of Vikram's final flight (an altitude of 5 km to 400 m), which began when the lander was 5 km from the lunar surface, according to the space agency's Telemetry Tracking and Command Centre.

The centre's massive screens revealed that the lander's green line started to veer off course when it was just over 2 km in altitude, continued to veer off course and finally stopped at a place that was obviously below 1 km in height and somewhere close or below 500m.

The module was still travelling at a speed of 48.1 m/sec (about 173 km/hr) horizontally and 59 metres per second (212 km/hr) vertically at that time. The distance between the lander and its intended Moon landing location at that time was 1.09 km.

Planned to conduct a gentle vertical fall at 'walking pace', Vikram was scheduled to lose the majority of its momentum by the time it was 400 metres from the lunar surface and should have been hovering above the designated landing place. But because of its great speed, it struck the Moon's surface.

ISRO chief S Somanath, in a press conference detailed on Chandrayaan-3 and said, "...In a nutshell, if you tell what was the problem in Chandrayaan-2, it is simple to say that the ability to handle parameter variation or dispersion was very limited. So, what we did this time is simply expand it further. Look at what are the things that can go wrong. So, instead of success-based design in Chandrayaan-2, we are doing a failure-based design in Chandrayaan-3. What all can fail, and how to protect it — this is the approach that we have taken."

CHANDRAYAAN 2 V/S 3

There are some changes between the two missions even though the design remains the same. What is carried aboard the GSLV-MkIII rocket is where the two missions diverge most. Chandrayaan-3 is launched with merely a lander and a rover as opposed to Chandrayaan-2's combination of the Vikram lander, Pragyan rover, and an orbiter.

According to reports, Chandrayaan-3 would employ the Orbiter launched with Chandrayaan-2 and is currently circling the Moon to fulfil its communication and imaging needs.

'Lander hazard detection and avoidance cameras' are a feature of the Chandrayaan-3 lander mission that allow for communication with the orbiter and mission control throughout the Moon landing procedure. Chandrayaan-3 features two of these cameras, compared to Chandrayaan-2's single one.

The Vikram lander also has stronger legs than its predecessor. From 3 m/s to 2 m/s, the landing velocity has been increased. Accordingly, the lander won't crash or shatter (its legs) even at 3 m/s, said ISRO director Somanath.

"Vikram has also undergone the installation of more fuel, which will increase its ability to travel or handle dispersion. Additionally, a new sensor has been included. The laser doppler velocity metre, a new sensor that will examine the lunar surface, has been installed. Additionally, we will be able to obtain the components of three velocity vectors using laser source sounding. Redundancy in measurement will be achieved by adding this to the currently available instruments," he added.

The ISRO director had already discussed the specifics of what went wrong with the Vikram lander of Chandrayaan-2, which hurtled towards the designated landing location on the lunar surface while the engines intended to slow it down developed more thrust than anticipated. This time, the landing space has increased from 500m x 500m to four kilometres by 2.5 km.

The Vikram lander now has extra solar panels on different surfaces, according to Somnath, to ensure that it can generate power regardless of how it lands. While cranes were used to test the landing procedures, the spacecraft was also flown over various terrains to test its capacity to tolerate vibrations.

An astounding total of nine *in-situ* instruments, all of which are still in use in the Moon's orbit, were aboard the Chandrayaan-2 Orbiter when it was launched. In contrast, the Chandrayaan-3 mission's propulsion module only contains the Spectro-Polarimetry of Habitable Planetary Earth (SHAPE) instrument, which will be used to analyse the spectral and polarimetric measurements of Earth from the lunar orbit.

The Laser Retroreflector Array (LRA), a passive experiment to comprehend the dynamics of the Moon system, is being sent with the lander as an adjunct to the Chandrayaan-3 mission.

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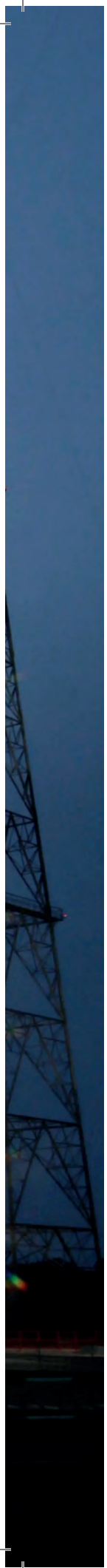
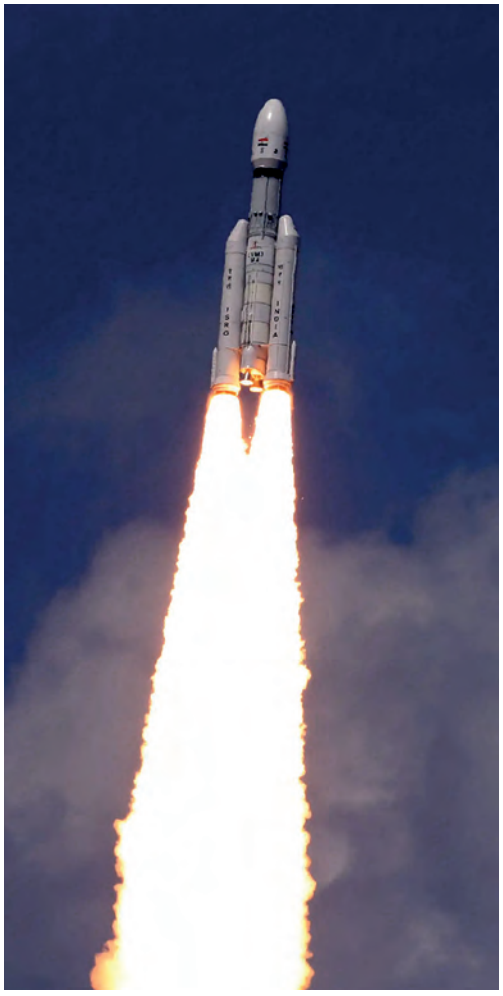


All Images Courtesy: ISRO

CHANDRAYAAN RUNS WITH THE HARES, MUST NOW HUNT WITH THE HOUNDS

The nation has to look beyond the momentary dopamine high given by Chandrayaan like missions and build up on the heft that is required to be a space power in this age



■ **Dr Chaitanya Giri**

On 14th July 2023, the news television channels in India had a busy broadcast day juggling between three significant events: the launch of Chandrayaan-3, the foreign sponsored-unrest in Manipur, and Prime Minister Narendra Modi's visit to Paris as the chief guest of the French National Day celebrations. For many, including the news channels, these three events were disconnected. But then that is where the problem lies. Most 'we-the-people' never see science, diplomacy and national security in the same context.

Like all of us, I am confident that Chandrayaan-3 will be a great technical success. Of course, our space agency will be more than satisfied with the soft landing on the Moon. But then, there are higher goals to achieve through our lunar pursuits — some pursuits may appear outlandish

to 'we-the-people' who are busy troubleshooting our socio-economic issues and think lunar missions are a luxury of science. Those who deem lunar aspirations a luxury, do a great disservice to India's geopolitical urgencies. Instead, they suffer from Arjuna Syndrome as many are naive and earnest believers in global commons. Like Arjuna, who saw a family in the warring Kauravas, most who matter to India's space programme are innocent internationalists. They rarely comprehend that countries resolute about their national interests have flourished well while those nations following innocent internationalism have found themselves in a ditch. Perhaps they know it but do not wish to offend those with a clear upper edge and intent to dominate in outer space.

Our scientific community was small in the pre-independence era; and thank the lords over us, they were not innocent internationalists but pragmatic nationalists. *Science India*, in its previous issues, has discussed the geopolitical and geo-economic foresight of many stakeholders of Indian science before independence. We seldom acknowledge them — our perception of the progenitors of the space programme rarely goes beyond Vikram Sarabhai, great in his own right, and our minds never ask about the roles played by numerous other characters who spent their lives for a better day of Indian science. Our narrative for outer space rarely goes beyond the technical achievements and making the population feel proud of being the second or fifth country to do something or be part of a club. 'We-the-people' still believe in joining existing clubs, not forming one where others join.

INDIA-MOON-FRANCE

No news channel, no space sector veteran, and no political leader were able to connect the two events that happened on 14th July. No Indian Prime Minister ever participated as a chief guest on the national day of any Western power. In the past 76 years of independence, there were hardly three days when we launched a spacecraft to the Moon. The PM being in Paris on the day Chandrayaan was launched should have been a reason to celebrate the India-Moon-France connection and acknowledge the massive unsung role of CV Raman and his protege Shishir Kumar Mitra in India's space programme.

Precisely 100 years ago, in 1923, Shishir Kumar Mitra, a prodigious physics graduate student of the Nobel Prize winner CV Raman, earned his second PhD from the University of Paris under the mentorship of the renowned French scientist Charles Fabry. That was an era when only a handful of Indian students managed to pursue PhDs in universities outside Vilayat — Britain. Here it gets more interesting — Charles Fabry and

SK Mitra have some connection with the Indian space programme, which finally began taking shape after 1957. So, after pursuing his postdoctoral research with another Nobel Prize winner, Marie Curie, SK Mitra returned to India and played a massive role in strengthening India's participation in the 1957 International Geophysical Year. The IGY-1957 had set the ball rolling for establishing space activities in India.

Coming to Fabry's connection. Do you recollect, one of the scientific objectives of the Mars Orbiter Mission, or Mangalyaan, was to detect gaseous methane in the Martian atmosphere? This detection was to happen by a scientific payload called Methane Sensor for Mars, a radiometer based on Fabry-Perot optical sensors invented by Charles Fabry and his colleague Jean-Baptiste Alfred Perot. Do you know what the Moon connection here is? All these three gents have a lunar crater named after them. The two Fabry and Mitra craters are present on the far side of the Moon, whereas the Raman crater is located on the western side of the Oceanus Procellarum. No, the craters were not named by India or ISRO. The International Astronomical Union named them. Overall, Mitra's second PhD matters a lot to India's scientific history and the Chandrayaan programme

The launcher identified for Chandrayaan-3 is LVM3 M4 which placed integrated module in an Elliptic Parking Orbit (EPO) of size ~170 x 36500 km

as it entrenched Indian scientists globally during the 1920s, the Golden Age of Physics, and the benefits that world science enjoys even today. What is emerging today — artificial intelligence and quantum science — got theorised during those momentous golden years.

But sadly, we do not go too far in history to acknowledge the role of our scientific *pitr*. 'We-the-people' are accustomed to revering convenient heroes and are too lazy to find many who are not told or written about.

WHY IS CHANDRANYAAN A HARE AMONG THE HOUNDS?

India's space exploration missions are enjoying tremendous media response worldwide. Ironically, this happens simultaneously when social media and conventional media are at loggerheads, and hype has become a currency of success. Therefore, there is a diminishing scope to rationale the next steps and strategic goals to be achieved from such missions. Governments across the world, to endure their seat of power, are fighting hyped criticism and countering it with hyped appreciation. However, little is being done to capitalise on such missions' soft power and eventually acquire hard power capabilities. And there is a legitimate exigency on why we should be doing it. A vast majority of India's scientific community is focused and simple-minded. They wish no ill for any culture or nation. If given ample resources, which eventually the growing Indian economy would afford, Indian scientists could achieve tremendous heights of scientific exploration of the Moon and other planets. But, the world's endeavour for the Moon is not as simple anymore. The exploitation of the Moon is beginning to take precedence over scientific exploration. Chandrayaan, in such a situation, is a hare among the hounds!

The world's endeavour for the Moon is not as simple anymore. The exploitation of the Moon is beginning to take precedence over scientific exploration

The Moon for the established spacefaring nations, primarily the US, China and their respective partners, is becoming the next colonial target, an extraterrestrial location to exert hegemony and dominance. We already know that the Anglophone nations — UK, Australia, Canada, and New Zealand — led by the US, which together form a group called Five Eyes, have gathered many countries to sign a non-binding document called the Artemis Accords. India and France have signed it, and both have substantial national space capabilities built independently of the US. If things are to be placed in context, India's Chandrayaan-3 is the first lunar-bound mission to fly after New Delhi signed the Artemis Accords. Perhaps, New Delhi today comprehends that its interests are better suited by partnering with the signatories of the Artemis Accords than the China-led group building the International Lunar Research Station.

Those questioning India's signing of this US-led agreement must understand that India's Chandrayaan and Mangalyaan missions have heavily depended on American technology support, particularly the ground communication support from the US's global Deep Space Network (DSN) based out of Spain, California, and Australia. The simplistic rationale often given is that such sharing of DSN fosters international collaborations. But had that been the case, why did Europe, Russia and China raise their own deep space networks? Of these, the Chinese space exploration programme began with India, and its Chang'e-1 mission and Chandrayaan-1 were launched around the same time, in 2007-08. Today China has its own DSN— in China, Namibia and Argentina — and is no longer dependent on the US's largesse; India is.

DOVE V/S WOLF IN OUTER SPACE

'We-the-people' have been too meek in using space to further India's strategic interests, and most of us gullibly believe in 'space as global commons.' If that was the case, did we ever do a comprehensive review of other space-faring nations and whether they operate a Janus-faced space programme?

In a recently published book titled "The Net Space Race: A Blueprint for American Primacy", authors Richard Harrison and Peter Garretson of the American Foreign Policy Council acknowledge that the US's civilian space agency NASA, along with the Pentagon's Space Force and other agencies must ensure US's dominance in space as China rises. Why do 'we-the-people' hold on to the dovish concept of global commons when the US, China, and Russia clearly enter outer space for dominance?

Public memory has shortened tremendously, and in this day and age of social media, we only remember the best and worst of episodic memories. Most of us have forgotten that India's scientific and peaceful missions do get attacked. The unconfirmed 2019 cyberattack by the North Korean group Lazarus during the Chandrayaan-2 launch is a testimony that the Indian space programme, despite its international friendliness, strong beliefs in global commons, and pacifist stances, still gets attacked. Why does a peaceful institution get cyber-attacked?

AS IS ALWAYS SAID, HISTORY REPEATS ITSELF

Indian space planners must become extremely serious about the nation's lunar plans. The global agenda for the Moon is rapidly becoming economic in nature. Stakes are running high about who controls the cislunar (Earth-Moon) communications and logistics network. While we feel content about landing on the moon, hardly anyone tells us about the US Air Force's Cislunar Highway Patrol System. The patrol system is meant to identify enemy spacecraft approaching the Moon under the pretext of space domain awareness. Another grave emerging risk is the cyber-attack on satellite constellations and space stations. The American cybersecurity establishment has recorded over 6000 cyber attacks on NASA assets on the ground and in space.

All countries with space capabilities, however friendly with others, are susceptible to cyber-attacks. Earlier in 2022-23, the US and its allies decided to voluntarily put a moratorium on using direct-ascent anti-satellite weapons and, while doing so, have taken a moral high ground in the name of sustainable operations in outer space. However, suppose kinetic anti-satellite weapons are not to be used anymore. In that case, we Indians, rarely

The Lander and the Rover have scientific payloads to carry out experiments on the lunar surface

ponder why cislunar patrolling systems are being raised, why so many cyber-attacks on spacecraft, satellites, and ground stations are happening, and why adversaries are targeting civilian space agencies. We rarely ponder over the gravitas of the more terrorising version of the new space race that now extends into the cislunar realms.

It will be futile and dangerous to assume the emerging space race to be anything like the world saw between the US and USSR. That yesteryear space race was more demonstrative; the new one has financial dimensions. Resources are to be extracted from the Moon, services offered from the lunar surface, lunar orbit and cislunar highways, and more so, enormous revenues are to be generated and controlled by a select few countries and their entities. Continuing to be simple-minded with designing Chandrayaan-like missions will land us nowhere, even if we land on the Moon.

Image courtesy: ISRO

Chandrayaan-3 consists of an indigenous Lander module (LM), Propulsion module (PM) and a Rover

WAKING UP TO POWER CONTEST IN SPACE

New Delhi will need to step up its lunar plans on a massive scale. It will have to push for galvanising the lunar programme in a way that ISRO has never done. There is a great power contest brewing, and New Delhi will have to think outside the box to use its space companies and startups. The government is correct in its recent attempt to make ISRO focus only on R&D. New Delhi will have to brainstorm intensely and stop merely using ISRO and the companies for their occasional glory.

And who has said that Artemis Accords is simply an understanding between the US and its signatories? It also indicates that the signatories can collaborate among themselves. India must flood the lunar market with components, technologies and services with a hallmark of 'Made in India' and 'Made only by India'. Not doing so, the Chandrayaan series will only give us a momentary dopamine high and, in the long run, will make us lose our metastrategic sense.

Furthermore, 'we-the-people' must remember that cyber-attacks, industrial espionage, sabotage, and violent merger and acquisitions are fast becoming a reality. With heightened competition between not one and two but many space-faring countries — corporate warfare between space sector companies — including those operating on the Moon — is not far away.

One feels sorry that 'we-the-people' are rosy about outer space, and there is hardly any analysis of threats from space in the media — the fourth pillar of democracy. The great man CV Raman, whose name is on the Moon, said something extremely important to a gathering of graduate students in 1969, which stands true even to this day. He said: "We have, I think, developed an inferiority complex. I think what is needed in India today is the destruction of that defeatist spirit. We need a spirit of victory, a spirit that will carry us to our rightful place under the sun, a spirit which can recognise that we, as inheritors of a proud civilization, are entitled to our rightful place on this planet. If that indomitable spirit were to arise, nothing could hold us from achieving our rightful destiny."

We rarely ponder over the gravitas of the more terrorising version of the new space race that now extends into the cislunar realms

If we put these great words in today's context, it is about time 'we-the-people' stopped living in a pacifist trance regarding outer space. There is a lot to learn from the generation of SK Mitra and CV Raman; they excelled in bridging science with diplomacy and the security of their goals of independence when the imperial regime was against their doing and excelling in science. Today, we have a polity that supports science and has strategic plans to set and achieve. It is time to end the strategic naivety regarding the Moon; Moon is the fountainhead of our national security. 'We-the-people' better realise this evolving reality or prepare to face a new form of imperialistic colonialism once again.

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SPACE GOES TO THE MASSES

Image Courtesy: ISRO

With an aim to showcase India's space mission and popularise it among the masses, especially children, the Indian Space Research Organisation (ISRO) has introduced 'Space on Wheels' initiative.

ISRO and Vijnana Bharati (Vibha) signed a Memorandum of Understanding (MoU) to share the Space on Wheels programme for conducting Space Science Outreach across the nation. In the presence of the Secretary of the Department of Science, it was signed on 24 January this year at the India International Science Festival 2022 in Bhopal. In accordance with the MoU, Vibha would transport the mobile 'Space on Wheels' display throughout the country for a period of five years. Vibha will also provide regional language explanations of the scientific components of ISRO's projects.

This Space on Wheels bus, which showcases India's space mission, will go to isolated parts of every district in the state. There are scale replicas of ISRO launch vehicles, satellites, space applications, and launchpads inside the bus. Dr Satish Wate, president of the Vigyan Bharati Vidarbha Pradesh Mandal and a former director of NEERI, has recently unveiled the Space on Wheels Mobile app. Space on Wheels will begin its next journey in Vidarbha Prant on the occasion of India's 77th Independence Day.

This programme has already received a good response from students. Some of the objects on display at 'Space on Wheels' are elaborated upon here.

— Information courtesy ISRO and Vijnana Bharati

SATELLITE LAUNCH VEHICLE: SLV-3 is a four stage rocket that ISRO fired between 1979 and 1983. Throughout its flight, the SLV employed solid propellant in each of its four stages. PBAN (Polybutadiene Acrylonitrile) was utilised in the first two stages, while HEF-20 was used in the final two stages.

The first SLV-3 was launched on August 10, 1979, with an experimental payload known as the 'Rohini Technology Payload (RTP)' to examine flight performance. The second stage control system malfunctioned during the launch, preventing it from reaching orbit.

All Images Courtesy: ISRO

AUGMENTED SATELLITE LAUNCH VEHICLE: Also known as ASLV, it served as an intermediary stage before being developed as an indigenous launcher capability for larger communication and remote sensing satellites. With a payload capacity of 150 kg, the ASLV varied from the SLV and could accommodate many more sensors. As opposed to SLV, which had four stages, ASLV had five stages to attain this higher payload. ASLV employed solid propellant in each stage, just like SLV. In order to launch high payloads, ASLV's first stage boosters had two straps. As opposed to SLV's open-loop guidance, which made it easier to place the satellite in a precise orbit, ASLV was made for closed-loop guidance.

POLAR SATELLITE LAUNCH VEHICLE:

The Polar Satellite Launch Vehicle (PSLV), commonly referred to as the workhorse of ISRO, was initially intended to launch satellites into Sun Synchronous Orbits (SSO) or Low Earth Orbits (LEOs). The PSLV's payload capacity was increased over the years from 1000 kg to 1900 kg, and its ability to carry satellites to various missions such as LEO, SSO, Sub-GTO, and GTO was expanded.

PSLV carried popular missions like

- Chandrayaan-1
- Mars Orbiter Mission
- 104 satellite in one mission
- Satellites for Indian navigation mission NAVIC
- One of the highest reliable vehicles in the world for the given payload

GEOSYNCHRONOUS SATELLITE LAUNCHING VEHICLE:

A three-stage launch vehicle is the Geosynchronous Satellite Launching Vehicle or the GSLV. The majority of the parts used in GSLV, such as the Vikas engine and booster motors, came from PSLV technology. In order to launch satellites into geosynchronous transfer orbits (GTO) and low earth orbits (LEO), which PSLV was unable to do, the three-staged GSLV with four rockets was created.

GSLV MK-III: The fourth generation launch vehicle for 4000 kg payloads is called the GSLV MK-III. MK-III employs only two rockets with solid propellant, in contrast to preceding GSLV models. The GSLV Mk III has a lot of distinctive characteristics. Since each booster employs 200 tonnes of HTPB-based solid propellants, they are regarded as the first stage. In contrast, the second stage employs a 110-ton hypergolic propellant combination of UH25+N2O4 and is propelled by two Vikas engines. A modified C20 cryogenic engine, which operates with the Hydrolox combination (LOX+LH2), is used in the topmost final stage.

All Images Courtesy: ISRO

Image Courtesy: ISRO

CREW ESCAPE SYSTEM: On July 5, 2018, ISRO conducted a significant technology demonstration, the first of several tests to qualify a Crew Escape System, a crucial technology important to human spaceflight. In the case of a launch abort, the Crew Escape System is an emergency escape mechanism created to swiftly draw the crew module and the astronauts away from the launch vehicle to a safe distance. The first test, known as the 'Pad Abort Test', showed how the crew module might be safely recovered in the event of a launch pad emergency.

The Crew Escape System and a simulated crew module with a mass of 12.6 tonnes were launched at 07:00 AM (IST) from the Satish Dhawan Space Centre in Sriharikota following a successful 5-hour countdown. The Crew Escape System and crew module flew upward during the test, then arced out over the Bay of Bengal before floating back to Earth under their parachute about 2.9 kilometres from Sriharikota. The test was completed in 259 seconds.

RLV-TD:

The Reusable Launch Vehicle Technology Demonstrator (RLV-TD) programme was the most difficult ISRO ever undertook. It is a combination of aeroplane and rocket technologies. In order to successfully complete the objective, it must preserve the integrity of both the systems. It can fly supersonic and hypersonic thanks to the scramjet engine. Everything involving RLV-TD is complicated, including the autonomous navigation guidance and control system, integrated flight management system, heat shield, and elevon controlled flying. Minor improvements and alterations to a design that will support the RLV-TD mission are developed through trials.

Image Courtesy: ISRO

All Images Courtesy: ISRO

HEAT SHIELD:

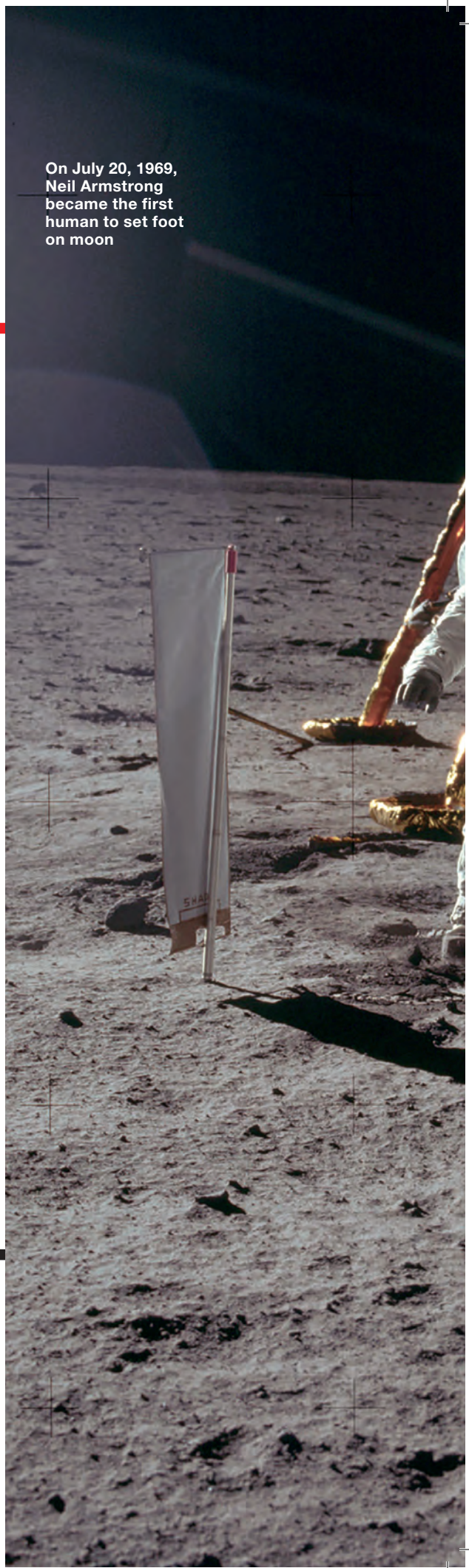
Standard heat shield/payload fairings are normally a cone-cylinder combination structure that surround the spacecraft/satellite and are typically the topmost component in the launch vehicle (due to aerodynamic considerations). When a spacecraft is launched into the atmosphere, it is utilised to shield the payload from the effects of dynamic pressure and aerodynamic heating.

At the end of the launch vehicle assembly, it is combined from two halves that are manufactured. It is made of lightweight materials like composites or aluminium alloys. It is a stiffness-based design since it encounters a lot of bending loads. As much heat is produced during the ascent phase in the atmosphere, it is painted with thermal protection paints. Once the launch vehicle crosses the atmospheric regime, the heat shield is removed and expelled. Based on the various dynamic loads, flow separation, vehicle trajectory, encountered Mach numbers, available TPS, etc., the finalised design of the heat shield is determined.

SCIENCE DIPLOMACY

India's Chandrayaan Mission: A Leap into Space Diplomacy

The high stakes that space exploration offers, and the legitimate appropriation of the gains arising out of it, most of which are still in the realm of speculation, make space diplomacy a necessity and not a choice for India



On July 20, 1969, Neil Armstrong became the first human to set foot on moon

Image Courtesy: PIB

■ Uday Kumar Varma

The impending success of Chandrayaan-3 has brought India on the cusp of a historic achievement. Set to land a rover on the moon's surface on August 23, India will become the fourth nation globally, after the erstwhile USSR, USA, and China, to accomplish this extraordinary feat. Despite competition from over nine other countries in lunar exploration, India stands tall with its remarkable technical prowess and ambitious objectives.

THE MOON'S ENDURING FASCINATION

The moon has fascinated and mesmerised humans ever since they evolved on this planet. This long distance romance reached a historic denouement when on July 20, 1969, Neil Armstrong and Buzz Aldrin set foot on its surface during the historic Apollo 11 mission. A decade earlier, in 1959, the USSR's Luna 2 became the first unmanned vehicle to land on the moon, followed closely by Luna 3, which sent back images from the moon's far side.

In the following decade, five more Apollo missions successfully landed astronauts on the moon, with Apollo 17 being the final mission in 1972. These missions provided a wealth of scientific data and lunar samples, vastly expanding our understanding of the moon's geology and history.

Lunar exploration continued with robotic missions in subsequent years. Various space agencies bearing several nationalities including NASA's Lunar Reconnaissance Orbiter (LRO) and India's Chandrayaan-1, sent probes, orbiters and landers to study the moon's surface, map its terrain, and analyse its composition.

INDIA'S TRYST WITH THE MOON

Chandrayaan-1, launched by the Indian Space Research Organisation (ISRO)

on October 22, 2008, was India's first lunar mission. Among its many significant findings, it discovered water molecules on the lunar surface, particularly in the Moon's poles. This discovery had profound implications for future lunar exploration and potential resource utilization. Although designed for a two-year mission, Chandrayaan-1 exceeded expectations, operating for nearly 312 days before facing communication failure on August 29, 2009.

The success of Chandrayaan-1 paved the way for India's subsequent lunar missions, including Chandrayaan-2, which had the ambitious goal of studying the Moon in greater detail, focusing on its south pole region. Despite some setbacks during the final stages of the mission, the orbiter of Chandrayaan-2 continued to function successfully, providing valuable data to scientists and researchers.

Chandrayaan-3, by far the most ambitious and sophisticated mission, was launched on July 14. It is poised to take India into an exclusive group of nations with successful lunar rover landings. This achievement will undoubtedly enhance India's standing in the field of space exploration.

Starship of SpaceX, one of the major private players in space exploration that will affect the future dynamics of space diplomacy

Image Courtesy: SpaceX

THE ASTROPOLITICAL BLOCS

While the scientific and technological developments in the field of space exploration have been unprecedented and much to be proud of, a parallel development of the politics of this exploration is no less exciting and notable. The world today is quickly organising itself into what can loosely be called Astropolitical Blocs. The most ostensible bloc is the one whose members are the signatories to the Artemis Accords. This US-led international cooperation agreement is aiming to return humans to the Moon in 2024 and make forays into deep space. The bloc now accommodates Canada, the United Kingdom, Italy, Luxembourg, Ukraine, the United Arab Emirates, Japan, Australia, New Zealand, South Korea, and others as signatory parties. These countries, apart from political gain, also foresee a considerable return-on-investment by hitching on to the Artemis goals, driven by an ambition for high-risk-high-reward business gains in a collaborative diplomatic spirit. The US leads the pack.

Quite naturally and expectedly, a competitor to the Artemis Accord quickly emerged. The coming together of so many economically advanced nations promptly activated a rival and parallel effort and while it may not have taken as concrete and formal a shape as the Artemis, it is serious work in progress. Russia and China are coming together to collaborate building on and around the Moon. The Sino-Russian International Lunar Research Station (ILRS) could become a robotic and human habitat infrastructure network on the lunar surface and in lunar orbit. Independently and regardless of its nascent cooperation with Moscow, Beijing hopes to realise a potential to the tune of a 10 trillion USD return on investments by 2050 from its ambitious Earth-Moon Special Economic Zone megaproject.

So a Duopoly in space exploration is increasingly becoming evident with some very interesting and game-changing manoeuvres in the offing. One such development is the emergence of private players in this field.

INDIA JOINS ARTEMIS BLOC

India took its time in deciding whether to join any such group. Artemis was however a natural choice. 'Even the sky is not the limit,' declared the Indian Prime Minister on June 25, 2023, on a state visit to the US, while announcing that India has decided to join the Artemis Accords, marking a leap in Indo-US space cooperation. It signifies a major step in space diplomacy. India's involvement in this initiative aligns its space programme with those of other advanced nations and opens up new avenues for collaboration.

Historically, India engaged in space diplomacy with echelon-1 nations (those nations who were the pioneers) like Europe, Russia, and the USA but maintained caution with China due to geopolitical concerns. The emerging astropolitical duopoly between the US-led bloc and the Sino-Russian International Lunar Research Station has global implications. An additional dimension of engagement will be the non-governmental entities who have begun to play a significant role in space exploration and are sure to be inevitably drawn into the dynamics of space diplomacy.

ECONOMIC GAINS OUT OF SPACE EXPLORATION

Space exploration has fast evolved into a thriving business, with robotic moon missions projected to generate substan-

tial revenue. The commercial aspect of the explorations has been recognised by the private enterprise and been seized with great anticipation. Private sector engagement is a reality today and expected to increase exponentially. It will also become crucial in space diplomacy over time. SpaceX of Elon Musk and Virgin Galactic of Richard Branson are the two among major private players that may affect the future dynamics.

The ambitious plans to establish connectivity between the Earth-Moon, and Moon-Mars systems, have created a stake for private entities. The private space industry, especially that based out of echelon-1 and echelon-2 nations, is expected to make major investments in production, operations, and services in the coming years. With such responsibilities, the industry will be an essential constituent of track 2 business-to-business and track 1.5 business-to-government space diplomacy. Clearly, a new locus of influence bearing diplomatic consequences is quickly emerging. The diplomatic heft of such companies will be directly proportional to their market capitalisation, their product's quality, and their ability to curate top-notch space technologies, giving them the rare ability to invest in overseas innovation companies and start-ups strategically. The fear, however, will be that the clout and commercial interests of such private companies may overwhelm national competencies and strategic interests.

So, from the point of view of India, while such foreign direct investments are desirable, India's strategic autonomy will continue only if her own competencies are superior and she employs the private resources the way they best serve her interests. India has to selectively piggy back on investors, while keeping the course control firmly in hand.

FUTURE OF SPACE DIPLOMACY

Space Diplomacy in the future will largely depend on the Interplay of Astropolitical Blocs. The idea that space exploration could lead to the democratisation of outer space is, in reality, impractical and a denial of human history. Therefore, the growing significance

Erstwhile USSR's Luna 2, the first spacecraft to reach lunar surface

of space diplomacy assumes critical salience for India.

The successful launch of Chandrayaan-3 enhances India's space diplomacy and elevates its standing on the world stage. As more countries venture into space, India must leverage opportunities and challenges in space diplomacy to accomplish its ambitious goals and secure its place in the international space community.

THE LEADERSHIP

Sooner than later, India will have to slip into a leadership role. The initial disadvantage of being a late comer, will soon have to be overcome by a committed scientific and technological work force. The talent and the capability is aplenty and has been evidently demonstrated. It will be the political leadership, its foresight and sagacity that will determine the vector and velocity of India's progress in this realm. The next decade is going to decide where India shall be seen among the comity of nations; in the front rank as a confident leader or as a meek follower.

An equally or even more critical aspect will be the commitment and integrity of our scientific community. It will require more than just talent and competence, it calls for a very high degree of focused dedication and a character that must have the timber and tenacity of the most exalted patriotism, one that does neither get compromised nor diluted under the most enticing temptations.

A PROMISING FUTURE

As the world delves deeper into space, India must strategically prepare to master space diplomacy and achieve its holistic objectives on the world stage.

A few months back, India embarked upon an ambitious 'National Quantum Mission', an initiative of far reaching consequences. The present standing of India's leadership had never seen such global recognition and appreciation. A dominance in the world theatre must come from an all-round effort encompassing sciences, engineering, technology, agriculture and commerce, even art, culture and philosophy. Space diplomacy has to accommodate all these areas and more, to truly emerge as India's strong suit. Her ability to uphold her strategic autonomy will heavily draw on her ability to master space diplomacy. The effort to do so has begun. It needs to be given considerable traction.

India today is the world's fifth biggest economic power. In another decade, it hopes to grow as the third biggest power and by 2075 the second biggest power. This evolution will not happen on account of economic growth alone; it will be accomplished by a combination of both hard and soft power. The high stakes that space exploration offers, and the legitimate appropriation of the gains arising out of it, most of which are still in the realm of speculation, make space diplomacy a necessity and not a choice.

Fifty-four years ago, on 20 July 1969, Neil Armstrong set the first human foot on the moon and uttered these immortal words, 'That's one small step for man; one giant leap for mankind.'

Chandrayaan-3 may, in comparison, seem a modest step but it abounds with the energy, vision and aspiration that firmly puts India on a path of a fascinating and promising future in the realm of space diplomacy.

**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.*

LOKMANYA BAL GANGADHAR TILAK'S BIRTH ANNIVERSARY

Lokmanya Tilak's Vital Scientific Insight for Freedom Struggle

Editor's Note: On the occasion of the 166th birth anniversary of Lokmanya Bal Gangadhar Tilak, Shri Jayant Sahasrabudhe, Mentor and Chief Editorial Advisor of *Science India*, delivered a speech at Thiruvananthapuram in Kerala on 21 July 2022. The central theme of his speech was the scientific vision of Lokmanya Tilak. We present an excerpt of his speech.

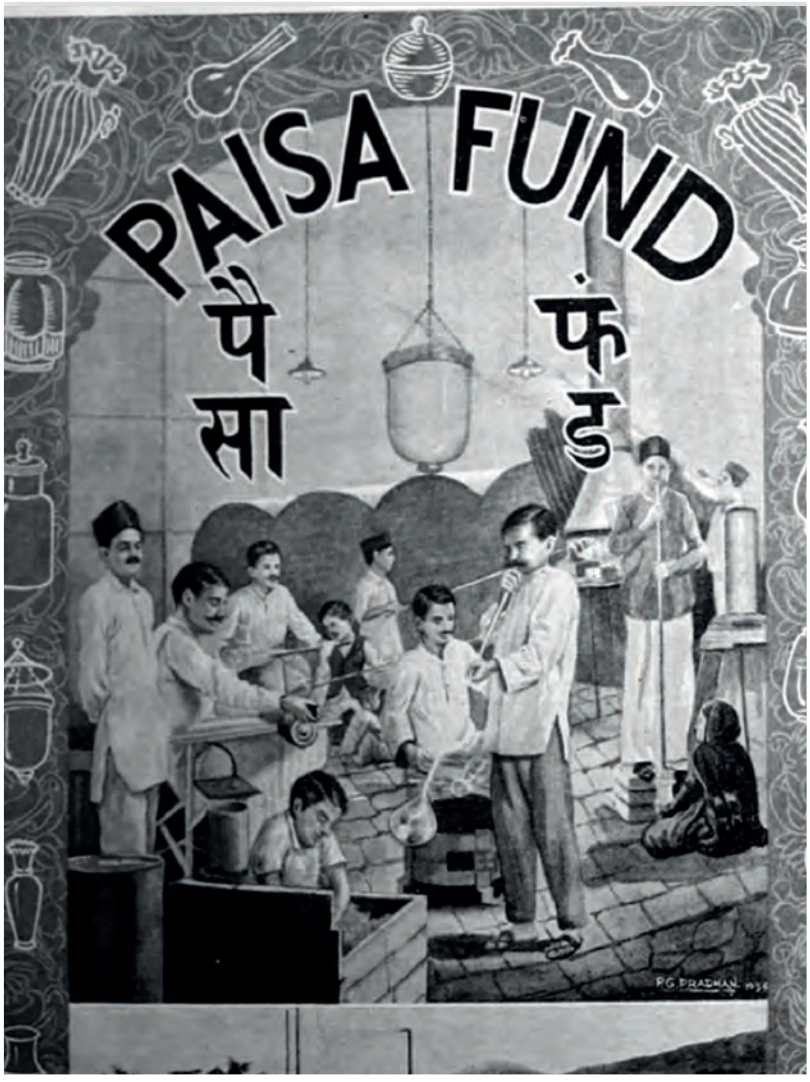
■ **Jayant Sahasrabudhe**

Bal Gangadhar Tilak was born on this day (21 July) in Ratnagiri in the coastal belt of Maharashtra. He was popularly called the 'Father of Indian Unrest', because the British called him so, as he successfully created unrest those days against the British government. He was a great force of India's freedom struggle.

The prefix 'Lokmanya' was used before his name because his leadership was readily and widely accepted by the people, not only of Maharashtra, but of the entire country.

Today, in our History text books, we read about three people — the trio— Lal, Bal, Pal and they were Lala Lajpat Rai from Punjab, Bal Gangadhar Tilak from Maharashtra and Bipin Chandra Pal from Bengal. They were very popular as they could create unrest against the British hegemony during British imperialistic rule in India, and it's due to these people that we could see this Independence.

It's our sacred duty to pay tribute to all our freedoms fighters, who sac-



The first factory set up by Indians with capital collected through crowd funding was the Paisa Fund Glass Factory in Talegaon

Image Courtesy: Paisa Fund, Talegaon

rificed everything for the Motherland. And, Tilak was a leading light among the freedom fighters. He was a versatile and multifaceted genius.

SCIENCE AS A TOOL OF EXPLOITATION

Today Vijnana Bharati (Vibha) has come forward to pay tribute to Lokmanya Tilak not only as a great freedom fighter but for one big thing, which he had identified. He identified that the British invaded India by using science as a tool. Vibha is looking at this freedom struggle in a different manner by revisiting Swatantrata Andolan and re-studying the struggle.

A number of invaders attacked India, with the goal to demolish the identity of this country by using ideas, strategy and tools. In the medieval period, Bakhtiyar Khilji attacked the seat of our learning — Nalanda and demolished the entire university. His intention was to destroy the identity of India, so that the people would forget their own identity, lose self-esteem and become his slaves. But the Britishers were different from all the previous invaders, in terms of methods and tools.

The tool the British used against us was science. Dr Rajesh Kochar, a scientist and astrophysicist (unfortunately, he died six months ago), did a lot of studies on science in recent times, which was related to British advent in India till today. His research article titled — 'Science utilised as a tool to consolidate colonial power in India'— tells us the real story of British invasion. Another author, Dr Asish Nandy in his article mentioned how British colonisers used a kind of 'black magic' that was developed on the theories and discussions of modern science to impress the minds of the natives. And, this is how the British used science as a weapon to subjugate India, to demolish our identity and jeopardise our uniqueness. Tilak could identify this design of British attack.

HOW BRITISH DEMEANED INDIA

Despite gaining independence and our people ruling the country, the dominion of Western Science still exists in this country. Even when we are completing

Image Courtesy: Wikimedia Commons

The British called Lokmanya Bal Gangadhar Tilak the 'Father of Indian Unrest' as he successfully created unrest against the colonial government

The British used science as a weapon to subjugate India, to demolish our identity and jeopardise our uniqueness. Lokmanya Tilak could identify this design of British attack

75 years of Swatantrata, we are not in a position to come out of that influence. We need to understand this fact.

Lokmanya Tilak was a great visionary who understood this. He was the one who put forward through his own life the example to counter scientific challenge of British people through science.

We all know several things about Tilak as a freedom fighter in many fields, different walks of life, but we really are not aware about his scientific endeavour to challenge British intellectual hegemony.

The British wanted to claim their superiority and they were abusing Indians

as most inferior people on this planet. They said Indian knowledge is most regressive in nature. We all know how Britishers used to abuse and demean India — as snake charmers, and what not. They said that though Indians livedfor long for eons together, they were immersed in all kinds of blind faith.

They claimed that Indians and India had no connection with reason-based knowledge creation and wasn't based on rational thinking. For claiming their superiority they used to say, "You are a dwarf in front of us. Your knowledge is so little compared to European knowledge, especially British knowledge." They wanted to prove that with many examples.

One particular thing we should know: They said the Aryans invaded this country and they pushed back original Indians, and they became sole rulers of this country. So as Aryans came from outside, we (British) are also outsiders.

The British wanted to legitimise their rule over Indians by saying that we're giving you great gifts, which are science and technology — a new and most useful knowledge for people.

To demean Indian knowledge, Macaulay made a statement that existing Sanskrit and Persian texts were of little use for 'useful learning'. And useful knowledge is science … science is useful for life and that's totally absent in India's knowledge system. They made such statements to legitimise their stay and their rule in India. They wanted to give the message to Indians that they were here to uplift Indians and take them to new heights, so that Indians could progress further.

Western thought claims that this entire creation of universe took place 4004 years before the birth of Jesus Christ . It is clearly mentioned in all the texts of Western theology. That's their claim. All of you are aware that modern science claims that Big Bang took place 13.8 billion years ago but despite that they continue to claim that creation of universe took place hardly 6000 years ago!

The Paisa Fund Glass Factory in Talegaon was a weapon of common Indians against the British rule

Image Courtesy: Paisa Fund, Talegaon

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HOW TILAK ORGANISED INDIAN SCIENCE

Tilak was a great mathematician and he wrote a book on Arithmetic, which is used in Maharashtra. He took up the challenge to prove that India was much ahead of European idea of creation. He wanted to prove the superiority of India and Indians against the British claim by using science. He was not just a Mathematician; he was a great astronomer too. He could reform almanacs those were present in those days in Maharashtra. In those days there were 60 almanacs. Tilak brought astrologers together and made a Parishad of Jyotishis (a council of astrologers). Thereafter he came out with a reformed new almanac by using science called Tilak Panchang.

As he was also a Sanskrit scholar, he studied Vedas focussing on position of astral bodies mentioned in Vedas; and based on those descriptions he endeavoured to calculate time at that particular time. On the basis of his calculations, he could actually calculate and prove through astronomy and mathematics — that this particular part of *Rigveda* was written 4,500 years before the birth of Christ. So, it was 5,000 years before the birth of Christ. He claimed that it was not a sudden outbreak of knowledge; there has to be some tradition of knowledge for that. He kept on investigating using science and mathematics as a tool and he could

Image Courtesy: Wikimedia Commons

Lokmanya Tilak (above) was a great friend of Swami Vivekananda (right), and while paying tribute to the latter, Tilak said, "Swami Vivekananda was a son of India. He represented India, the mother of spiritual sciences, on the world platform."

Image Courtesy: Wikimedia Commons

The most famous article about Tilak's book *The Orion*, has been written by one of the greatest living scientists of India, Prof Jayant Vishnu Narlikar, and it is available on Internet. Everyone should read this article to know how with great respect Narlikar described the efforts of Tilak

date the origin of our Vedas to 8000 years.

Tilak's first book on science was published in 1892, titled *The Orion (Murga Nakshatra)*. He could relate that vernal equinox was there when this particular constellation was there in the sky in that period. Consequently, he literally proved with all evidences that the particular verse in Rigveda was scripted in 4500 BC.

Even today, people are learning or trying to know many things by referring to that book.

The most famous article about this book *The Orion*, has been written by one of the greatest living scientists of India, Prof Jayant Vishnu Narlikar, and it is available on Internet. Everyone should read this article to know how with great respect Narlikar described the efforts of Tilak.

Through another book with the same idea, *Artic Home in Vedas*, Tilak tried to prove, based on scientific evidences, that the Aryan race didn't come from the western side and at that point of time the home of the Aryans was at the Artic region. The Aryans travelled to three different parts of the

world from there — India, Persia and Greece. Tilak wanted to claim the superiority of Indians over the British. He was the first one to date many historical events on the basis of science and by using astronomical methods in the history of modern era. This great contribution was to prove the superiority of India over the British; to challenge the British hegemonic attitude.

Image Courtesy: Bookspace.in

Tilak brought astrologers together and made a Parishad of Jyotishis (a council of astrologers). Thereafter, he came out with a reformed new almanac by using science called Tilak Panchang.

BRITISH LOOT OF INDIAN ECONOMY

Most versatile and multifaceted genius, Lokmanya Tilak proved how the British looted us. It has been scientifically proved that while the British ruled this country for 190 years, they looted our country of $45 trillion. Government estimates that size of our economy by 2030 should be $5 trillion, which shows the British looted nine times to our national aspiration today.

By studying all these facts, Tilak opined that we should industrialise our country and he promoted the concept of Swadeshi. As one of the proponents of this concept, which was conceptualised by Lal-Bal-Pal, he said that we should achieve self-reliance in every walk of life, and economic domain of our country should be strengthened based on modern industry.

A big example is that of a glass factory, which we have before us at Talegaon near Pune. Incidentally, the UN has declared this year (2022) as the International Year of Glass and Ceramics.

Tilak envisaged how we can use science to make glass in our industry and encouraged people to go to Japan to learn how the Japanese, without taking any European help, developed their industry with their own science and technology.

The India House in Japan was under Govind Poddar from Maharashtra. He connected Indian youngsters who visited Japan those days, to learn from or work with different Japanese industries.

A fund was created in India those days — a crowd sourcing kind of idea. The objective was that people would contribute paisa in that fund to free India from the clutches of British rule.

That Paisa Fund, which a kind of weapon against the British rule, was utilised in building industries so that we could prevent import of goods from Britain. The first factory that was built from the capital of this Paisa Fund was the Paisa Fund Glass Factory, which exists even today at Talegaon. The aim was to make Indians self-reliant, with international links.

SCIENTIST-FREEDOM FIGHTERS

A great proponent of the *Bhagavad Gita*, Tilak wrote treatises on *Gita* called *Gita Rahasya* while he was in Mandalay jail for six years. It has been translated in 70 languages. He insisted on the theory of Karma in the *Gita*. His stress was on Karma Yoga in his treatises on Gita.

In the prelude to commentary on *Gita*, Tilak wrote extensively on science.

What is 'field' according Indian knowledge system? Lokmanya Tilak wrote extensively about field; how science evolved in India; what are the basis of science, what's Panchamahabhuta, Sankhya Darshan (theory of evolution), etc. He made us understand how we should know *Gita*.

Freedom struggle was not just a political struggle or about politics alone; Tilak and other stalwarts like him used Indian knowledge system and science to claim India's superiority against the British intellectual hegemony.

Vijnana Bharati has come forward and is trying to highlight and shed light on these aspects of great people like Lokmanya Tilak, who were patriots and visionaries as well for Swatantra Bharat.

We are still under the influence of western science and unless we come out of it, we won't be able to progress in the right direction. The need of the hour is to regain the lost glory of our Indian science and this celebration of the 75th year of Swatantrata has given us an opportunity to revisit our freedom struggle, revisit great lives of our patriots and understand their great ideas about Independent India.

Generally, people don't look up to these great leaders of freedom struggle like Lokmanya Tilak as scientists. They were scientists. So, let's look at them with a different eye.

The British ruled this country for 190 years, during which they looted our country of $45 trillion. The government estimates that the size of our economy by 2030 should be $5 trillion, which shows the British looted nine times our national aspiration today

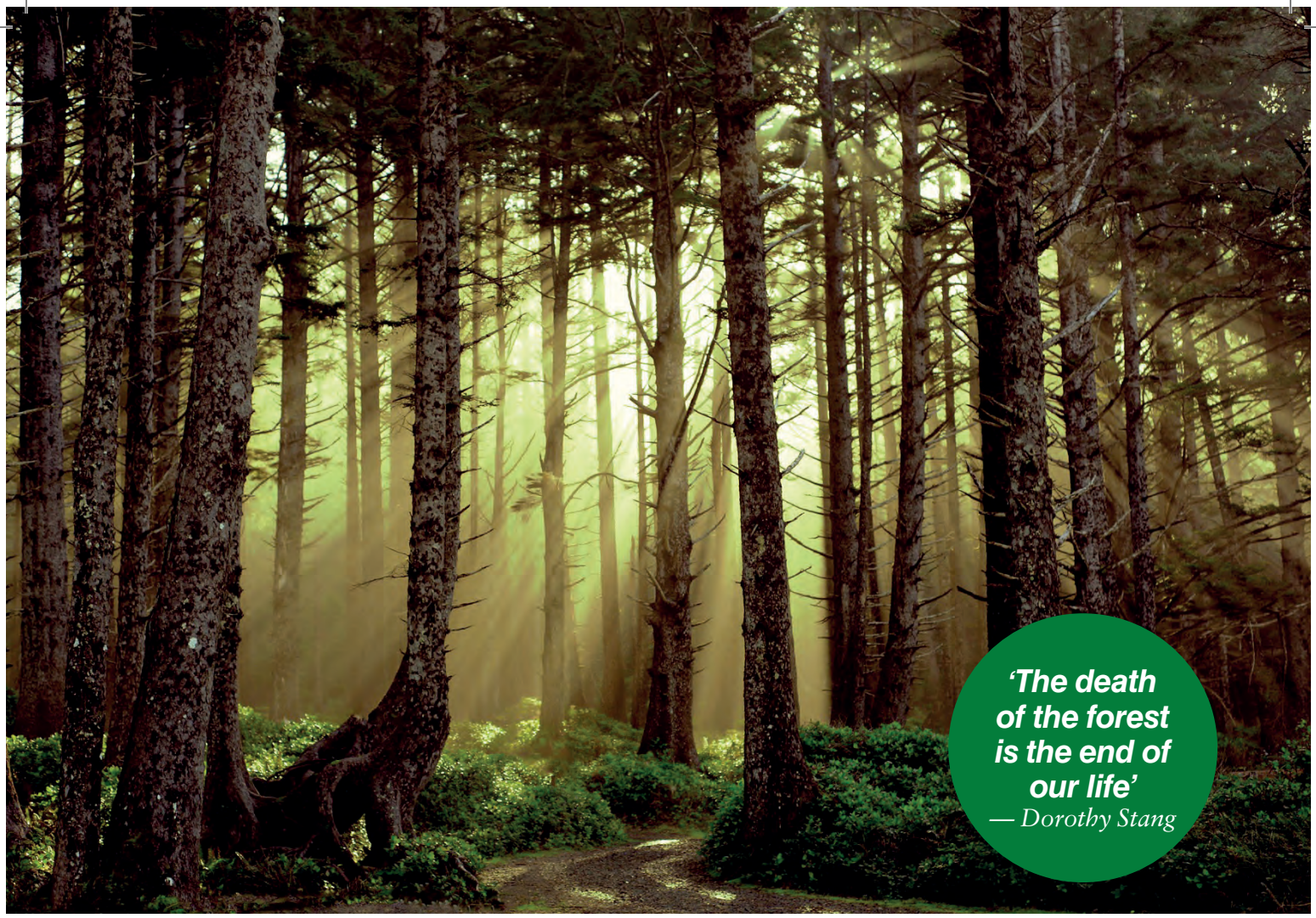

Image Courtesy: Pixabay

Switching to Roots to Restore Our Jungles


■ **Nandini Killa and Dr Monika Koul**

India's forest cover has become alarmingly low and the attempts to restore it will have to incorporate traditional knowledge whose accuracy has been perfected over centuries

One of the most pressing concerns worrying the policy makers and the environment conservationists in India is the meteoric loss of forest cover. As per a study conducted in 2020 by UK-based Utility Bidder, India is placed second highest in the rate of deforestation with 668,400 hectares of forest converging into disappearance alone in the period between 1990 to 2020.

The prime reason discovered was the upsurge in the population of the country, owing to which the human settlements are continually expanding at the cost of the green cover. Initially, for meeting the need of food, forest paved way for agriculture and now agricultural land is converted into concrete jungles (tall buildings) all over. The current area under forest cover amounts to around 21.71%, comprising 3.04% very dense forest, 9.33% moderately dense forest and 9.34% open forest. These numbers are exceptionally low when compared to the recommended area under forest cover of 33% (1/3rd of the total land area of the country) suggested by the National Forest Policy 1988.

As you take a glance at these statistics, you are probably wondering to yourself if they can even be attributed as a reflection of the present reality. We do see greenery and are accustomed to seeing plants on the side on our way to work and we experience the pleasure of

nature's sweet caress by merely taking a stroll in a park. These plants that you see growing in the parks, gardens and common community lands do cleanse the air and impart a fulfilling sentiment, but the tree stand cannot remotely be equated to the magnanimity of a forest. Thus, such green cover can only be defined as a forest in the infancy stage at its best for it requires a paradigm shift in aspects such as the extent of stratification, density, girth and breadth of trees, as well as the number of species inhabiting it for it to come closer to the denotation as a forest. The forest in terms of ecology is a terrestrial ecosystem where dominant vegetation component is the trees with a lot of diversity and these ecosystems are safe havens for fauna, microbes, and other life form too. It is also important to understand what a tree means, not all plants that are tall are trees. A tree, as ecologists defined them, are plants with woody stems, and a tree can be single stemmed or multi-stemmed too. The trees are mostly perennials and once grown can stay their ground for years with a beautiful canopy and crown, up to 10 feet or taller than that and the most important is that the diameter at breast height should be more than three inches. In these ecosystems, organisms irrespective of their taxonomic affinity interact with each other for food, survival and for producing fertile offsprings.

COMPLEX ECOSYSTEMS

Forests are convoluted ecosystems that act in their capacity as a repository of earth's biodiversity and genetic resources. They house a myriad of species ranging from plants and animals to microorganisms, like the Royal Bengal tiger found in the Sundarbans mangrove forest in the Bay of Bengal, which not only holds great cultural and ecological significance, but is also a symbol of India's rich biodiversity. Similarly, sandalwood, a fragrant tree species found in the forested regions of India has great economic value for its aromatic wood which is used commercially in the production of perfumes and incense. Furthermore, forests play an integral role in maintaining the global carbon cycle by sequestering and storing carbon.

Healthy forests are also entitled with the capability of averting natural disasters such as droughts, floods, and landslides by preventing soil erosion and water run-offs, as well as stabilising the stream flows. Additionally, they are a treasure trove of natural resources like foods, such as honey, nuts, fruits, and mushrooms; timber; cork and wood biomass, which have an enormous commercial value and serve as a means of earning livelihood for the local communities. Some of the plant species also have medicinal properties and thus, have great untapped potential for curing/curbing a lot of medical conditions that humanity is faced with today. The plants also have products that can help maintain agility, increase longevity, and provide antidotes to poisons. The mention of Sanjeevani and many other plants that were considered treasures also supports the fact that Indian civilization always upheld forests in great reverence. Undoubtedly, forests are also impeccable sites for undertaking a plethora of recreational activities like walking, cycling, running, tree-climbing and even meditation. Ergo, they aid in boasting the general sense of human well-being by delivering them solace and tranquillity alike.

RESTORING OUR FORESTS

Considering the current rate of deforestation and the absence of substitutes of the services that a forest translates, it is no surprise that India is planning to restore 20 million hectares of its forest cover by the year 2030. For achieving the same, the government is engaging in supportive policies and funding. For example, the National Afforestation Program (NAP), 2000, which had an initial allocation of Rs 17.14 billion for a period of five years, was aimed at boosting tree cover in India by promoting afforestation, reforestation, and sustainable forest management.

Additionally, the Compensatory Afforestation Fund Management and Planning Authority (CAMPA) was established in 2016 to manage funds collected for compensatory afforestation and wildlife conservation activities. Organisational bodies like the Ministry of Environment, Forest and Climate Change (MoEFCC) and Indian Council of Forestry Research and Education (ICFRE) are shouldered with the responsibility of formulating and implementing the policies that relate to forest and environmental conservation in India. They also oversee the implementation of various initiatives and programs focused on sustainable forest management and

Image Courtesy: Pixabay

Green cover can only be defined as a forest in its infancy. It requires a paradigm shift in aspects such as the extent of stratification, density, girth and breadth of trees, and the number of species inhabiting it for it to be denoted a forest

disseminate knowledge to forest professionals. Another government entity, Forest Survey of India (FSI) oversees conducting regular forest assessments, mapping, and monitoring activities in the country. Social forestry that is forestry of the people, by the people and of the people, includes practices where one can grow some trees in public places and harvest fuel wood and fodder besides selling minor produce from these trees. The onus of management lies with the people.

OUR SACRED FORESTS

The contemporary funding, policies and campaigns can help in easing out the path to restoration of the green cover; but switching to our roots by turning to the traditional conventions and practices which were once ingrained in our culture would aid in accelerating this process to an astronomical degree and inculcate a sense of ownership and responsibility in every individual. As mentioned, Indian history is impregnated with such traditions that foster forest, environment, and wildlife conservation. They first emanated as an effort by our ancestors and tribal communities to express their gratitude towards mother nature for her endless bounty and has been passed down the generations ever since. These customs date back to the days in which Vedas were written, which emphasised on the sacredness of forests and its interconnection with all the living beings. In *Ramayana*, the exile of Lord Rama is set in the backdrop of forest where his character ignites reverence for the fellow animals and their habitats. *Arthashastra*, an ancient treatise on statecraft advocates for sustainable practices, regulated hunting, and protection of forest to ascertain prosperity and stability in a kingdom. Additionally, innumerable tales of *Panchatantra* and *Hitopadesha* explore the relevance of harmonic balance with wildlife and the consequences of perturbed environmental balance through their animal characters.

Forests have been revered in India, as they have been considered as safe havens for meditation, self-reflection, and introspection and that is why our ancient texts have references of *gurukul*s (schools and training grounds) and homes of recluse and sacred grooves for saints and *rishi*s. The mention of dancing peacocks, hopping deers, the majestic elephants, the big bold cats, and beautiful birds mesmerize us all when we go through the ancient Indian texts. The importance of forests in Indian ethos is intertwined and so the trees are considered deities and are held in great esteem. Ancient Indians knew that these forests provide economic functions (by providing food, shelter) and ecological functions by providing clean air and maintaining the serene environment.

The establishment of local governance entities like Van Panchayats found in Uttarakhand can assist in conserving forests through a cooperative and participatory approach

The present hour calls for jogging this memory of history to preserve and conserve the future. For example, the concept of Sacred Groves, which are areas of biodiversity hotspots that render habitat for a variety of plant and animal species and are considered as sacred by the local communities, thus revered, and protected. One of the famous examples is that of Khecheopalri Lake and its surrounding forest in Sikkim which is believed to be an abode of a protective deity by the local Lepcha community. Transfer of ownership of a forest to indigenous and local communities can also prove beneficial as they adopt sustainable use of forest resources, customary rules, and community participation in decision-making processes for its management. The establishment of local governance entities like Van Panchayats found in Uttarakhand can assist a great deal in conserving the resources of forests through a cooperative and participatory approach.

Apart from this, there are a wide range of rituals and festivals across the country that are dedicated to celebrating and conserving biodiversity. Nag Panchami is a festival committed to revere the snakes for protecting the agricultural fields and it kindles awareness for reptiles, thus promoting their protection. Similarly, Ganga Aarti is a daily ceremonial ritual performed at multiple riverbanks (*ghats*) along the river Ganga involving chanting, singing, and offering of lamps to the river which symbolises the respect for the sacred river and the biodiversity it supports.

TRADITIONAL KNOWLEDGE

Besides this, the indigenous communities in India retain a gold mine of traditional knowledge which has emerged and been refined over a span of centuries. It circumscribes around understanding of local ecosystems, identification of medicinal plants and sustainable harvesting practices of deriving resources from the forest for their economic merit without incurring any harm or practicing over exploitation. Lastly, reintroduction of the age-old traditional methods of water harvesting and irrigation like stepwells, ponds and check dams can play a significant role in conserving water, retaining soil moisture, and creating microhabitats that further the biodiversity within and around the forests.

These are a few approaches that embody the spirit of the many traditional practices that lie buried in our culture, which resonate with the serene relationship and interdependence between the indigenous communities and their surrounding environment. Integration of this knowledge with the modern conservation practices can go a long way in not only realising the goal of 33% of national area under forest cover, but also imbibing a sense of intimacy with the forests and mother nature, which form the stepping stone in the journey to attainment of sustainability.

**Nandini Killa is pursuing master's in Plant Molecular Biology and Biotechnology at University of Delhi while Dr Monika Koul is a Professor at the Department of Botany, Hansraj College, and a Fellow IoE, University of Delhi.*

PROFILE OF THE MONTH: DR DS KOTHARI (6 JULY 1906 – 4 FEBRUARY 1993)

Dr Daulat Singh Kothari: An Asset of India

A scientist-teacher in the unique tradition of pre-Independence scholars of India, Dr Kothari's contribution to science, teaching, and institutions remains a beacon of light for contemporary generation

■ **Dr Jayanti Dutta**

Image Courtesy: Wikimedia Commons

Daulat is an Urdu word, meaning wealth. When Dr Kothari was named, 'Daulat' it seems he was named with a foresight as he was to prove a great asset for his nation. Daulat Singh Kothari is one of those illustrious scientists of the pre-independence era, who, by the dint of brilliance, hard work and exceptional capabilities, served the cause of the nation both before and after independence. Born on July 6, 1906, at Udaipur in Rajasthan, he lost his father — a school teacher, to the plague epidemic at the tender age of twelve. He was brought up by his mother Lahar Bai, along with his three brothers amidst great hardships but also in a highly principled manner.

Finding young Daulat Singh to be a promising lad, Sir Siremal Bapna, the Chief Minister of Indore State and a friend of Daulat Singh's father, invited him to continue his studies in Indore. Thus began his very successful academic career where Daulat Singh would never score less than the top position and would earn scholarships and study awards to continue his higher studies. After matriculating in 1922 from Maharaja Shivajirao High School, Daulat Singh passed the Intermediate examination from the Intermediate College at Udaipur in 1924. Due to his meritorious standing in the Rajputana Board with distinctions in Physics, Chemistry and Mathematics, the Maharana of Mewar granted him

a handsome scholarship of Rs. 50/- per month for higher studies. He joined Allahabad University for his BSc in 1926 and MSc in Physics in 1928.

At Allahabad University, Kothari came across Professor MN Saha, who was the head of the Physics Department. This meeting of the student Kothari and teacher, Prof Saha, was to last a lifetime and transform Kothari from a good student to an arduous researcher, science writer and teacher. He was appointed demonstrator in the Department of Physics of Allahabad University. Kothari wished to pursue his PhD with Lord Rutherford at Cambridge and arrived in England in 1930 availing a UP Government scholarship. His PhD research work was profusely appreciated by the examiners of his thesis who, it is recorded, 'spoke very warmly indeed of the excellent quality and character of his thesis.'

After earning the PhD degree, in 1933, Dr Kothari rejoined Allahabad University. In keeping with the imperialist traditions of not giving the rightful due to its Indian employees, the British bureaucrats refused to grant him increments for the period he was away.

Dr Kothari joined Delhi University in 1934 which was the same year in which post graduate classes were initiated in the University. In his life, Dr Kothari was now entering into a phase where his identities of an inspiring teacher, an intelligent researcher, a competent administrator were to emerge in a significant way which helped him to become the great visionary that the nation needed for its higher education sector at that period.

Unlike most of the teachers who preferred to teach higher classes, Dr Kothari would teach undergraduate or even intermediate classes and would also invite eminent scientists like Professor MN Saha to be practical examiner for lower classes

His pedagogic style was very unique as he did not follow the traditional delivery method of text book material but used demonstration and experimentation in his classrooms. Unlike most of the teachers who preferred to teach higher classes, Dr Kothari would teach undergraduate or even intermediate classes and would also invite eminent scientists like Professor Saha to be practical examiner for lower classes. He established the Physics department of the University with building, books and equipment. He did not stop at creating quality infrastructure only, but revamped the curricula, introduced several novel courses such as 'History and Philosophy of Science' and brought world renowned teachers to the campus. This was to be his roadmap for all institutions which he headed.

Dr Kothari was instrumental in developing the University library as a modern space with the best of academic facilities. His infectious, enthusiastic and genuine interest in the University's academic affairs made his department a vibrant space charged with productive energy. Students, researchers and teachers were always arguing, debating or discussing the updates in the field of physics.

Dr Kothari published his first research paper with his teacher Dr GB Deodhar on 'Further Study of Elastic Behaviour of India Rubber' in the *Indian Journal of Physics* — a journal established by CV Raman. His next paper on the measurement of the ratio of charge to mass of electron received appreciation from none other than Professor Saha. A well-known anecdote says that Lord Rutherford was reading Kothari's paper when he met the former for the first time for getting admission to the Cavendish laboratory. His research focused on a variety of areas including quantum statistics, properties of degenerate matter, pressure ionization, internal constitution of stars, hole theory of the liquid state, bounded harmonic oscillator, Fermi's theory of particle production, Riesz potential, colour centres in solids, armour penetration, radiation and sensation of pain, etc. The list is not exhaustive.

His pressure ionization theory helped to deduce important conclusions about white dwarf stars to planets and it was acknowledged by the international scientific community, that his work was the first to state the result explicitly. Professor A Sommerfeld's statements in this context are really interesting. He said, '.... It is noteworthy that the Indian DS Kothari has developed an audacious relationship between the old fashioned planets and the now discovered newest heavenly bodies, the white dwarfs.'

While pursuing core Science prob-

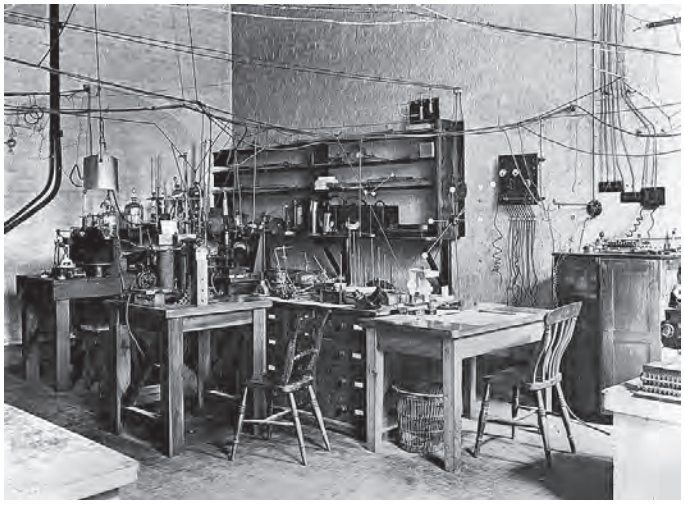

Image Courtesy: Neel Sarovar Bhavesh

A photograph of Sir Ernest Rutherford's lab at Cavendish Laboratory, University of Cambridge, where Dr DS Kothari pursued his PhD

lems, Dr Kothari never forgot the salience of the human angle which is the most crucial for any successful venture. He established an active research group at Delhi University. Wherever he worked, he was wont to create an informal but seriously academic atmosphere which spurred the creativity of his coworkers and he could create vibrant, dynamic teams.

As a teacher interested in the practice of teaching, he also wrote many papers on teaching-learning-understanding the understood; 'How big is the moon and how far is the sky?'' Why Add Marks in Examinations?' are the titles of some of his pedagogic papers, which indicate his insights and original thinking in the field of pedagogy which teachers of Science hardly touch.

It was clear that a teacher-scientist who has done a great service to his institution within the straitjacketed constraints of dictates of a foreign rule, will surely play a very significant role in the free nation when education was the domain of priority for the government. He was appointed Scientific Advisor to the Ministry of Defence in 1948 and was at the helm of affairs to establish Defence Science Organization in 1949. Dr Kothari, through his clear vision and foresight, could chart a roadmap of the organization well into the future. Today the different defence labs established across the country have their origins in the prudent execution of Dr Kothari. Institute of Armament Studies and Naval Chemical and Metallurgical Laboratory at Mumbai, Indian Naval Physical Laboratory at Kochi, Defence Science Laboratory at Jodhpur Defence, Food Research Laboratory at Mysore, Defence Institute of Physiology and Allied Sciences at Chennai, Defence Electronics and Research Laboratory at Hyderabad, Technical Ballistic Research Laboratory at Chandigarh, and Centre for Fire Research, Solid State Physics Laboratory, Directorate of Psychological Research and Scientific Evaluation Group at Delhi are the prominent institutes which have created a research and development network for defence requirements of the country.

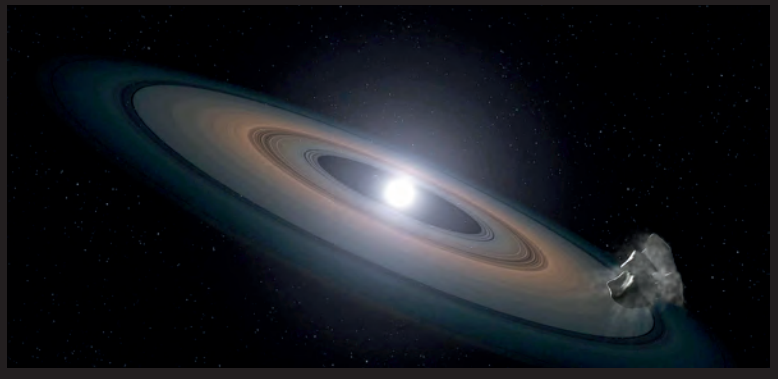

Image Courtesy: Nasa.gov

Dr Kothari published a historic paper related to the fundamental properties of white dwarf stars

In 1964, Dr Kothari was appointed the chairman of the first Indian Education Commission. Today, while reading the recommendations of the commission titled, 'Education and National development', one is awed by the farsightedness reflected in it

However, these administrative functioning could not deter Dr Kothari from pursuing his academic ventures and he even took out time to teach classes during his tenure as scientific advisor. Dr Kothari also wrote a very comprehensive book on the theme 'Nuclear Explosions and Their Effects' which was published in 1956. It was translated into Russian, German and Japanese and was hailed as a 'history-making book conveying decisive knowledge at the right moment in an authentic form — unobjectionable and incorruptible, objective, consolidated and total'.

It was quite appropriate that the next assignment Dr Kothari was given was even more significant and his decisions would have far reaching consequences. In 1961, he was appointed the Chairman of the University Grants Commission (UGC). He had a tenure of 13 long years on the post and nurtured UGC with his eloquent ideas, acumen for creating value, thereby laying the foundation of a strong higher education system in the newly independent India.

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The life and works of Dr Kothari are a continuation of the legacy of the great Indian teacher-scientists of pre-independent India who lit the fire of nationalism through the lens of Science and handed over the baton to the next generation of their equally illustrious students who then went ahead and worked for the reconstruction of the newly independent nation.

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An aerial view of the main campus of Rajiv Gandhi Centre for Biotechnology, Thiruvananthapuram

IN FOCUS: RGCB, THIRUVANANTHAPURAM

Leading the March to Free the World of Diseases

Beginning as a small charitable society in 1990, the RGCB has quickly and successfully engaged with biotechnology in pushing the envelope for better human health

All Images Courtesy: RGCB, Thiruvananthapuram

■ **Prof Chandrabhas Narayana**

India's engagement with biotechnology has been remarkably fruitful, driving scientific advancements that significantly affect human health and technological development. The Rajiv Gandhi Centre for Biotechnology (RGCB) in Thiruvananthapuram, an Autonomous National Institute under the Department of Biotechnology, has remained at the forefront of this biotech advancement. In just over three decades, it has evolved into a unique organisation dedicated to biotechnology research and development in the niche area of disease biology.

OBJECTIVES

RGCB has four important mandates: discovery research in disease biology, translational sciences, technology development, and training and education. Its primary mission, however, is to understand the biology of human, animal, and plant diseases and develop practical solutions through collaborative efforts among scientists, medical professionals, veterinarians, and agriculturists.

The centre is deeply committed to multi-disciplinary investigations and the quick translation of scientific discoveries and technology to improve lives. Its research programmes are tailored to aid the national initiatives for skill development, job creation, and self-reliance launched by the Prime Minister Narendra Modi.

Over the past decade, RGCB has witnessed a considerable expansion of its core facilities with substantial support from the Department of Biotechnology, Government of India, and consequent progress in research outcomes.

LEADERSHIP AND HISTORY

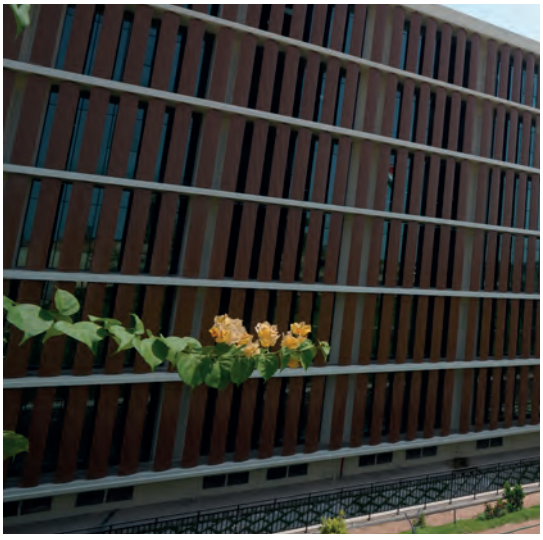
From its start, RGCB has been guided by visionary leaders and distinguished scientists who have played a pivotal role in shaping the institute's growth and reputation. The leadership has included eminent scientists, academicians, and administrators, all united by a shared goal of achieving scientific excellence and creating a positive societal impact.

RGCB, which began as a small charitable society in 1990, grew into a modest biotechnology centre under the Kerala State Council for Science, Technology, and Environment in 2004. The Government of India adopted RGCB in April 2007. The same year, it became an Autonomous National Institute by an Act of Parliament under the Department of Biotechnology, Ministry of Science and Technology. From then on, RGCB has witnessed remarkable growth and garnered a reputation for its contributions to basic science, translational and applied research, and public health outreach. It also gained attention for its academic programmes and activities promoting entrepreneurship.

RESEARCH FOCUS AND THRUST AREAS

RGCB has focused its research activities on six areas of critical relevance to human health, agriculture, and the environment.

The Cancer Biology programme is



for understanding the molecular mechanisms behind cancer development and harnessing the emerging knowledge for designing effective strategies for cancer management.

The Cardiovascular Disease & Diabetes Biology programme focuses on the molecular mechanisms involved in cardiovascular diseases and diabetes to translate bench side findings to diagnosis and therapy.

The Pathogen Biology group studies infectious diseases, including the development of antimicrobial agents, multi-

Clockwise from above: Students at RGCB library; the RGCB building at Akkulam; students at cafetaria

drug resistance evolution, disease epidemiology, and vaccine responsiveness.

Plant Biotechnology & Disease Biology group designs genomics-based strategies, develops elicitors for disease protection in spice crops and characterizes therapeutic phytochemicals.

The Transdisciplinary Biology group complements the work in different research domains and is currently engaged in chemical synthesis, protein engineering, and biophysical computations.

Neurobiology, Regenerative Biology, and Reproduction Biology programmes cover the development of cell replacement therapies for neurodegenerative disorders, the identification of potential epigenetic modifiers in the generation of induced pluripotent stem cells and hematopoietic differentiation, and the elucidation of factors associated with successful pregnancy.

RGCB actively contributes to disease management and public health improvement by addressing critical challenges in all these domains.

RGCB CAMPUSES

RGCB operates from three campuses, each with a unique research focus and purpose.

1] Centre for Discovery Research:
The Main Campus, a centre for Discovery Research located at the heart of Kerala's capital city Thiruvananthapuram, is the hub of discovery research and focusses on innovative studies in cellular and molecular mechanisms of a wide range of human, animal, and plant diseases — from cancer to neurological disorders.

2] Shri Guruji Madhav Sadashiv Golwalkar National Centre for Complex Disease in Cancer & Viral Infection:
Situated on the outskirts of Thiruvananthapuram, this innovation-focused research facility specializes in research on vaccines, immune therapeutics, molecular diagnostics, biomarkers, and tropical disease biology and is still undergoing expansion.

3] BioNest:
The third facility, BioNest, is operated by RGCB in collaboration with Kerala Start-up Mission at the KINFRA Hi-Tech Park, Kochi. It is an incubation centre for start-ups, Small and Medium-scale industries (SMEs), academic institutions, and hospitals. It also provides cutting-edge biotechnology instrumentation platforms and training courses for students. Currently, 25 start-ups are run there by entrepreneurs from different industrial sectors.

ACADEMIC PROGRAMMES

RGCB offers an exceptional educational experience for scholars aspiring to pursue careers in scientific research, innovation, and discovery. The centre provides PhD and post-doctoral programmes in basic, interdisciplinary, and translational science. Its rigorous academic curriculum equips graduates with the knowledge and skills necessary to lead scientific research and contributes to India's development in the biotechnology sector; current research publications from the RGCB number over 1,000, with over 21,000 citations.

RGCB also launched a master's degree program recently, a course usually run by universities. Its MSc Biotechnology programme, affiliated with the Regional Centre for Biotechnology, Faridabad, has attracted much prestige and attention.

The centre also conducts an exclusive Biotechnology Skills Development Programme for engineering and science graduates to make them acquire skills in molecular diagnostics, instrumentation engineering, analytical sciences, and bio-imaging.

PUBLIC SERVICES AND TECHNOLOGICAL BREAKTHROUGHS

RGCB is committed to the application

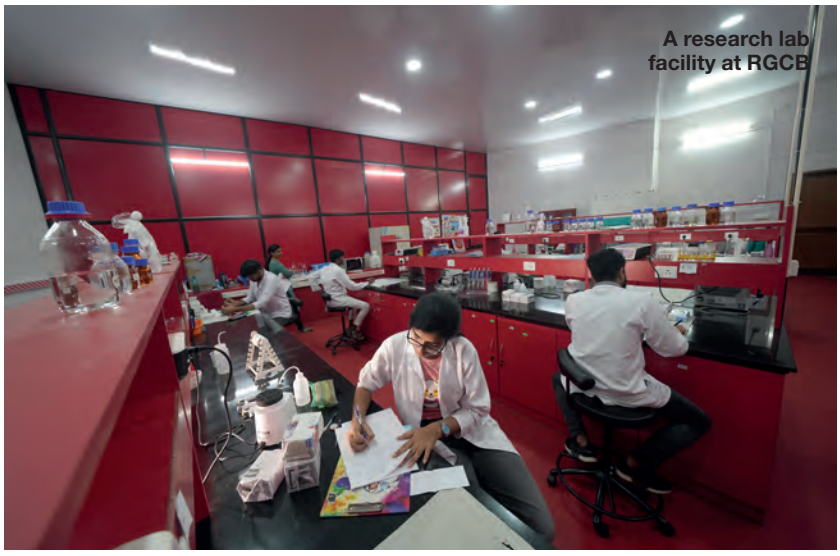
of science for public service. The Medical Laboratory Services (MLS) unit, with eight laboratories and 202 collection centres across southern Kerala, can analyse 408 diagnostic parameters and provide yeoman service to the public and health care providers.

RGCB's Laboratory Medicine & Molecular Diagnostics (LMMD) services, a NABL, NABH, and ILAC-accredited laboratory system, has been developing diagnostic tools and providing diagnostic services in 210 domains, including molecular diagnosis of viral, bacterial, and genetic diseases and cancer. It is among India's highly rated labs and immensely supported the government during the COVID-19 crisis. A dedicated BSL3 PLUS facility for handling live viruses for advanced research and product validation is nearing completion at Campus II. LMMD is also a centre for contributing genome sequences of viruses from the southern region to the 'Indian SARS-CoV-2 Genetics Consortium' (INSACOG). It has contributed over 18,000 sequences.

The Molecular Forensics & DNA Technology unit provides paternity testing and identification services to the judiciary and law enforcement agencies through DNA fingerprinting and barcoding.

RGCB's 'Centre for Excellence in Inclusive Technology Interventions for Tribal Heritage Resilience of Kerala' has many research activities and programmes for documenting traditional knowledge, developing value-added products based on tribal knowledge in ethno-veterinary medicine, and for the social empowerment of the tribal community. As part of the Azadi Ka Amrit Mahotsav initiative of the Government of India, RGCB has established one of the best science museums in the country in Wayanad, an Aspirational District with poor socio-economic indicators identified by the government for promoting the culture of science among school children and the public.

RGCB has made several significant breakthrough discoveries in disease prevention and treatment, and several promising therapeutic molecules and diagnostic devices are under development.


A research lab facility at RGCB

For instance, recent studies by RGCB researchers led to the WHO recommendation for a single dose of HPV vaccine for girls against cervical cancer. Consequently, India launched the first generic cancer vaccine against cervical cancer (Cerevac), which the Serum Institute of India now manufactures.

Uttroside B, a molecule isolated by RGCB scientists from the plant Solanum nigrum, is found to have therapeutic value against liver cancer

Uttroside B, a molecule isolated by RGCB scientists from the leaves of the medicinal plant Solanum nigrum, based on traditional knowledge, was found to have therapeutic value against hepatoma (liver cancer) and is currently in clinical trials against liver cancer.

RGCB scientists also identified Cyclophilin A, a protein that is a known player in several human diseases, as a potential drug target for reducing the risk of heart disease in patients with diabetes — a discovery that will help in risk reduction and development of novel pharmacological therapies.

Researchers also developed a lateral flow point-of-care device capable of identifying four known venomous snakes in Kerala and the approximate venom payload delivered by the snake.

Another critical study has provided molecular evidence that 'defense priming,' a system of protection of crops by strengthening their immune system in a natural way without using hazardous chemicals and pesticides, has enormous potential for safety and better yield of pepper, an important commercial crop in Kerala.

As India's engagement with biotechnology continues to evolve, the Rajiv Gandhi Centre for Biotechnology remains at the forefront of driving scientific excellence and contributing to societal well-being. With its collaborative research efforts and commitment to translational research, RGCB serves as a beacon of innovation in biotechnology, addressing critical challenges in disease biology and significantly impacting human life and technology.

**The writer is the Director of RGCB. A highly accomplished scientist, and interdisciplinary research leader, he was earlier Dean (Research and Development) at Jawaharlal Nehru Centre for Advanced Scientific Research (JNCASR), Bengaluru. He has also served as the Professor of Chemistry and Physics, Materials Unit, and as the Dean, Fellowships and Extension Programmes at JNCASR.*

YOUNG SCIENTIST: INSA MEDAL FOR YOUNG SCIENTISTS

A Prestigious Honour for Emerging Scientists

Every three years, INSA honours scientists for the finest research papers published in a reputed journal

■ **Science India Bureau**

FOR the prestigious INSA Young Scientists Award, 42 scientists have been chosen. The Indian National Science Academy (INSA) launched the INSA Medal for Young Scientists 2022 project for the young scientists to support and honour them for their work and contributions to India's science and technology industry. The 42 recipients received a prize of Rs 1 lakh, a plaque, and a certificate.

INSA, an organisation of Indian scientists, was established in 1935 with the goal of advancing science in India. According to INSA's official website, the Young Scientist Medal is a prestigious and highly competitive award presented to Indian scientists under the age of 35. It is regarded as 'the highest recognition of promise, creativity, and excellence in a young scientist'. It is given each year to those who stand out for these qualities, as shown by the research they conducted in India.

One of the scientists to receive the INSA Medal for Young Scientists is Dr Hrishikesh Tavanandi. He is currently working as a temporary training coordinator for the PMFME project at the CSIR-CFTRI (Central Food Technological Research Institute) in Mysuru.

INSA president Prof Chandrima Shaha stated in her letter of selection for Dr Hrishikesh Tavanandi: "You have demonstrated significant potential to be a pioneer in research. I genuinely hope you will keep working hard in the upcoming years to realise your potential and demonstrate your leadership."

Dr Tavanandi conducted his research under the direction of Prof KSMS Raghavarao (Professor at IIT Tirupathi, Former Director, CSIR-CFTRI). Dr Tavanandi has created novel, adaptable hybrid and integrated separation techniques to increase the yield and quality of economically valuable phytochemicals that may be extracted from biomass. His strategies for producing high-quality bioactives from spirulina and high-quality drying of microorganisms and biomolecules using techniques other than freeze drying are remarkable.

Dr Hrishikesh Tavanandi receiving the INSA Medal for Young Scientists

Image Courtesy: Twitter

The Indian National Science Academy Medal for Young Scientists has also been awarded to four Indian Institute of Science (IISc) professors. These are Dr Srimonta Gayen, Dr Subhojoy Gupta, Dr Mohit Kumar Jolly, and Dr Venkatesh Rajendran.

Dr Tavanandi has created novel separation techniques to increase the yield and quality of economically valuable phytochemicals extracted from biomass

Dr Gayen is an assistant professor at the department of Molecular Reproduction, Development, and Genetics (MRDG) at IISc. INSA stated that his findings might improve the success rates of in-vitro fertilisation (IVF) and offer a clinical approach to assist reduce the pervasiveness of bias against babies born through IVF.

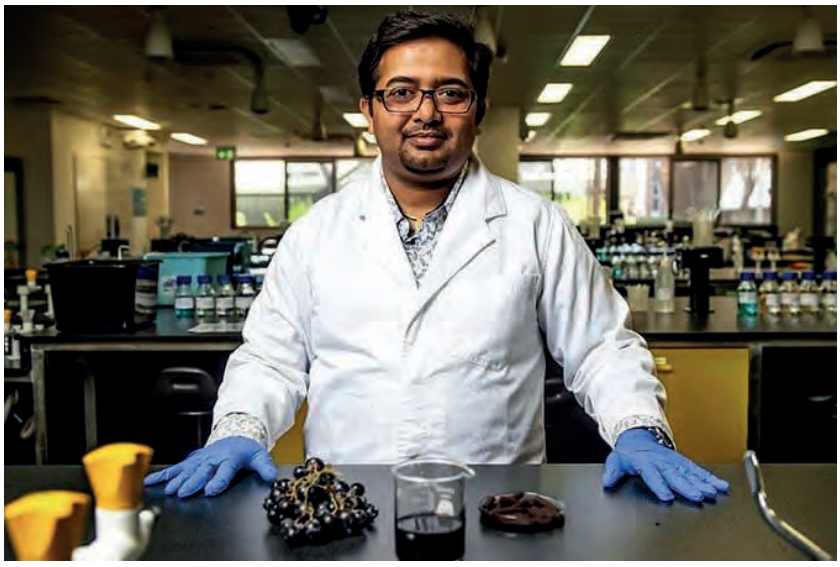
Dr Gupta, an assistant professor in the Department of Mathematics at IISc, has received recognition for his work on Riemann surfaces. At the Centre for Bio-Systems Science and Engineering (BSSE), Dr Jolly, an assistant professor, is focused on reducing cancer metastasis and preventing drug and therapy resistance in cancer cells. Kac-Moody algebras and their representations are Dr Rajendran's area of expertise at the Department of Mathematics.

Every three years, INSA honours scientists for the finest research paper they have published in a reputed journal.

Fuel Out of Waste Food

This low-cost, environmentally responsible alternative to fossil fuels may help in solving the world's fuel shortages

■ **Science India Bureau**



Dr Kiran Mahale is garnering acclaim for turning food waste into fuel

Indeed, food waste is a global issue and according to the UN, one-third of all food produced is lost or squandered while millions of people die hungry. However, we are still very far from being the excellent, responsible civilization that we should have been. India is home to many traditions that protect the environment but we still abuse and harm nature in many ways. A group of scientists in Australia, led by an Indian-origin researcher are working to turn food waste into useful compounds.

Dr Kiran Mahale, a 38-year-old research scientist and passionate biotechnologist at the University of Southern Queensland, Australia, is gaining attention for turning food waste into fuel. He is currently in the news after learning that the abandoned grape solid wastes could be used to make beneficial chemicals.

About 5% of the anthocyanin that was once present in winery garbage served as his inspiration. He made investments and developed new techniques to utilise the anthocyanins found in winemaking trash. According to Dr Mahale, these chemicals can be processed and sold for 850 Australian dollars for 10 mg.

After removing the anthocyanins, Dr Mahale extracted the fermentable sugars using only winery waste. Then, through the process of fermentation, he would transform it into ethanol, butanol, methanol, or propanol. Enzymes are used in this metabolic process to change the chemical energy substrates. These alcohols can be combined with petrol to provide an inexpensive, sustainable alternate fuel. The catch is that he produces inexpensive, environmentally beneficial gasoline using food waste.

Dr Kiran Mahale

Dr Mahale hails from the Maharashtra district of Nandurbar. As a child, he witnessed the miseries of food waste. He learned the value of food from his father, a farmer. His parents instilled in him the belief that food is God and is therefore sacred, and deserving of respect (his parents called it 'Anna Bhagwan').

Dr Mahale discovered how blood at a blood bank was divided into unique components and used in various places. This kindled his interest in biotechnology and inspired him to enrol at North Maharashtra University to earn a Bachelor of Science in Microbiology. Dr Mahale is confident in his research, even if his idea still needs a lot of distilling and investigation.

The first thing he tried was working with orange trash, which included both orange peels and pulp seeds. He discovered the flavonoid naringenin, which holds great promise for the pharmaceutical industry. It needs to be extracted and purified for 16 to 18 hours. He came up with a brand-new extraction technique that takes three hours to finish. He carried out the same procedure with pineapple and vineyard waste for his PhD.

Because English was his third language, Dr Mahale had to adjust to learn it. Despite this, his language abilities were enough for him to pass the IELTS. He was able to hone his language skills thanks to an expansive network of English-speaking clubs and foreign student friends.

Dr Mahale, like the majority of Indian students, had a tough time adjusting to a new country right away because he was unaware of its culture. People felt unfamiliar and uncomfortable because they had never celebrated Christmas before migrating to Australia. Football and football were quite unfamiliar to him, as per an article published in the in-house newsletter of the University of Southern Queensland.

Dr Mahale believes that all of India's upcoming scientists have a solid grounding in their specialities and a thorough understanding of fundamental scientific concepts.

Screening Device for Reliable Assessment of Blood Vessel Health

Researchers at IIT Madras have created a cutting-edge, non-invasive tool to evaluate the condition and age of blood vessels

■ **Science India Bureau**

Blood vessel stiffness has been proven to be a highly powerful indicator of cardiovascular issues and ageing of the heart. Accurate measurements of changes in arterial dimensions and blood pressure are necessary for determining arterial stiffness. Modern techniques carry out this measurement using specialised ultrasound imaging apparatus. Widespread application of image-based arterial stiffness monitoring is constrained by the need for expensive equipment and high levels of technical skill to operate it. A low-cost, simple-to-use technology that can be widely used with little training is required.

The ARTerial Stiffness Evaluation for Non-invasive Screening (ARTSENS) test, created by HTIC (Healthcare Technology Innovation Centre, an R&D centre of IIT Madras and Department of Biotechnology, GoI), uses an ultrasonic probe with patented intelligent signal processing to analyse artery anatomy, record vessel wall dynamics, and determine clinically recognised stiffness parameters non-invasively. Within 30 seconds of placing the probe on the neck, the device directly produces the stiffness measurement. Based on ARTSENS technology, a portable cardiovascular screening tool is currently being created.

The in-vivo measurements made using ARTSENS in comparison to a traditional ultrasound imaging system were validated in a pilot study on over 100 participants carried out in partnership with MediScan Systems, Chennai. The Thambiran Heart and Vascular Institute in Chennai used the ARTSENS device to evaluate the arterial stiffness of about 50 patients over the course of around 4 hours during a vascular screening camp.

Images Courtesy: IIT Madras

In the US, the EU, and India, the technology has already been granted five utility patents, ten design patents, and 28 patents are pending in other jurisdictions.

After comprehensive testing, the product is prepared for technology transfer and commercialization. This will be used by the IIT Madras team to do more than a million vascular screenings annually.

Dr Jayaraj Joseph, assistant professor in the department of electrical engineering at IIT Madras, oversaw the study. Dr PM Nabeel, Lead Research Scientist, HTIC-IIT Madras, V Raj Kiran, PhD scholar, Department of Electrical Engineering, IIT Madras, and Dr Joseph co-authored the article in the Journal of Hypertension.

The leading cause of death worldwide remains heart and blood vessel-related disorders. According to Dr Joseph, "Reliable assessment of vascular health requires a measurement to be made directly on the blood vessel walls and not on the skin surface. Our ARTSENS technology measures the material property in a fully non-invasive and precise manner, allowing us to evaluate the impact of molecular and protein level changes in the vessel wall brought on by illness and ageing."

At AIIMS New Delhi, a comprehensive clinical investigation is in progress, where researchers are trying to comprehend the physiological underpinnings of arterial ageing in various disease conditions. Researchers at Radboud University Medical Centre in the Netherlands are using it to investigate the relationship between arterial age, physical inactivity, and cardiovascular events.

Prof Dick Thijssen of Radboud UMC, who also worked on this experiment, said: "We have employed the most recent ARTSENS gadget in our recent clinical investigations on more than 600 participants. Large-scale research projects using portable, simple-to-use equipment make it possible to fully comprehend vascular ageing." The likelihood of cardiovascular problems rises when the artery stiffens and matures prematurely.

Dr Dinu S Chandran, Department of Physiology, AIIMS New Delhi, a different collaborator on ARTSENS, stated: "The ability of ARTSENS to assess both local and arterial stiffness along with central blood pressure, all in a single test, makes it extremely useful in estimating vascular health status as an early marker in multiple disease conditions."

Arterial stiffness and central blood pressure are both simultaneously monitored by ARTSENS. A probe is placed on the surface of the neck to locate the carotid artery, and pressure cuffs are attached at the upper arm and thighs.

The IIT Madras team carried out basic scientific research as well as engineering and technological development for prototypes that had undergone clinical validation. Simulation studies and randomised experiments were carried out on both human and animal subjects.

ISRO launches Chandrayaan-3 mission on LVM3

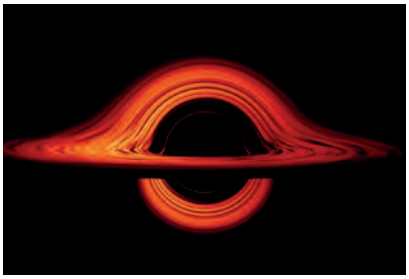
The eagerly anticipated Chandrayaan-3 mission to the Moon was launched by the Indian Space Research Organisation. On board the Launch Vehicle Mark-III at the Satish

Chandrayaan-3 is expected to have cost Rs 615 crore

Dhawan Space Centre in Sriharikota, the spacecraft launched flawlessly. India's second attempt to set foot on the moon's surface was made with Chandrayaan-3, the third mission in the Chandrayaan series. The mission, which is expected to have cost Rs 615 crore, aspires to make India a moon faring country and join the privileged club. By placing the Chandrayaan-3 mission in a precise orbit, the LVM3 was able to complete the mission successfully, demonstrating its capability once more. Following the launch from Sriharikota, the spacecraft detached from LVM3 after more than 900 seconds. All three stages operated as expected.

IIT-Hyderabad scientists listen in to the universe's buzzing

The Indian Institute of Technology Hyderabad (IITH) researchers have discovered proof of the universe's buzzing. The scientists were a part of a multinational team that kept track of pulsars, which are among nature's most accurate clocks. The team from India, Japan, and Europe tuned in to the vibrations coming from outer space using six of the most sensitive radio telescopes in the world, including India's largest observatory, uGMRT. According to a press statement from



The universe is buzzing and IITH scientists have its proof

IIT Hyderabad, 'These results provide a hint of evidence for the relentless vibrations of the fabric of the universe, caused by ultra-low-frequency gravitational waves.'

India's Skyroot signs agreement with French firm to launch satellite constellation

Skyroot Aerospace, a private space firm based in India, has signed a contract to launch a constellation of satellites into orbit with Promethee, a French new-space operator. The agreement was reached on the eve of Prime Minister Narendra Modi's trip to France this month. As Skyroot continues to refine its Vikram-I launch vehicle, the launch might take place as

Skyroot Aerospace has signed a contract with French firm Promethee

early as December this year. The two French and Indian businesses have decided to research on how to deploy the JAPETUS earth observation constellation using Skyroot's Vikram launcher.

New study holds promise for green hydrogen

India can progress towards achieving Net Zero by 2070 with the use of green hydrogen. A parent oxoborane with the molecular formula H-B=O has been created in the lab by researchers from the CSIR-National Chemical Laboratory (NCL), Pune, and the CSIR-Central Salt and Marine Chemicals Research Institute (CSMCRI), Bhavnagar. This compound may be used for a variety of purposes, including the production of hydrogen in standalone systems. The creation of novel compounds is a fascinating

All Images Courtesy: Internet

A newly created compound will help in the production of green hydrogen

and ongoing area of chemical science study. These newly created materials frequently have numerous practical or industrial applications, or the process optimisation results in cost and resource savings.

Researchers develop green alternative to synthetic pesticides

Asia produces and consumes a lot of aubergine, also known as brinjal. It is prone to vicious pest infestations throughout the growing season, which results in significant output loss. The intrinsic defence mechanism and biopesticide of aubergine have been demonstrated by an Indian research team to be effective in fending off the insect Shoot and Fruit Borer (SFB). The research team, which included individuals from the Indian Institute of Science Education and Research (IISER), Pune, and the Indian Council for Agricultural Research (ICAR) Complex for North East Hill (NEH) Region, Umiam, Meghalaya, was attempting to determine whether or not the chemical ecology of the interaction between the SFB and eggplant could be used to address the issue.

Webb Telescope celebrates first anniversary with incredible images

On the first anniversary of the telescope's science operations, the James Webb Space Telescope has taken a magnificent image illustrating the birth of new suns. At least 50 young

All Images Courtesy: Internet

On its first anniversary, the James Webb telescope has taken images illustrating the birth of new suns

stars with masses equal to or less than the Sun are visible in the photograph. The star-forming zone that is closest to us, at a distance of about 390 light years, is shown in the image published recently. The spacecraft provides a close-up view of the formation of these new suns that is extremely detailed and devoid of background stars.

China launches first methane-powered rocket to space

The first methane-liquid oxygen rocket has been launched by a private business in China, which might revolutionise space exploration. With this initiative, China is better able to create the next-generation launch vehicle that might put payloads into Earth orbit than rivals like the US, India, and Europe. In northwest China, the Jiuquan Satellite Launch Centre saw the launch

China launched Zhuque-2, its first methane-powered rocket

of the Zhuque-2 carrier rocket. This was Zhuque-2's second attempt to be launched by Beijing-based LandSpace, one of the earliest companies in China's commercial launch business. The December attempt was the first to fail.

Bizarre chemistry turns planet into giant shiny mirror

The most reflective exoplanet ever seen is revealed by data from the European Space Agency's (ESA) exoplanet spacecraft Cheops. It is an extremely hot planet covered in reflective clouds

ESA's exoplanet spacecraft Cheops has released data on most reflective exoplanet ever seen

of metal. The brightness of the planet, known as LTT9779 b, is comparable to that of Venus, which is the second-brightest celestial body in our night sky after the Moon. Following the initial identification and characterisation of LTT9779 b by NASA's TESS mission and ground-based equipment such the ESO HARPS instrument in Chile in 2020, follow-up observations led to Cheops' high-precision results.

Dead whale becomes home to thriving marine life on ocean floor

Researchers have now documented the size of this expanding community living beneath the North Pacific waters in a dead whale that has evolved into a thriving marine environment. The benthic zone, often known as the ocean floor, has been transformed by the carcass of the dead whale. The whale fall carcass provides fresh perspectives on how these remains support healthy ecosystems. The body was found in 2009 at a depth of 1,250 metres off the coast of British Columbia, and since then, experts have been monitoring its

Body of a dead whale, found off the coast of British Columbia, is now home to a thriving marine life

disintegration and how it has served as a life-supporting environment.

Japan to dump Fukushima radioactive water into the Pacific

The Fukushima Nuclear Plant's radioactive water can now be released into the Pacific Ocean, according to nuclear regulator decision maker in Japan. The decision would allow Tokyo Electric Power Co (Tepco), which managed the defunct Fukushima Daiichi nuclear power plant, to discharge more than a million tonnes of radioactive

Fukushima nuclear plant's radioactive water has been cleared for release into the Pacific Ocean

water into the ocean. According to a two-year evaluation by the International Atomic Energy Agency (IAEA), Japan's proposal for the release would have a minimal environmental impact. The last step the utility needed to take to start the procedure was the regulator's certificate from Japan.

QUIZ: Kothari Commission

1.What was Kothari Commission constituted for?
A.To provide guidelines for the energy sector in India
B. To provide guidelines for medical education in India
C.To provide guidelines for education sector in India
D.To provide guidelines for legal education in India

2.When was the Kothari Commission appointed?
A.August 15, 1964
B.July 14, 1964
C.June 14, 1964
D.None of the above

3.Which studies were excluded from the purview of the Kothari commission?
A.Legal
B.Medical
C.Both the above
D.None of the above

4.When did the Kothari Commission submit its report?
A.29 July 1966
B.29 June 1966
C.29 July 1964
D.None of the above

5.What was the Commission's recommendation regarding languages at the state level?
A.Impart teaching in mother tongue
B.Impart teaching in Hindi
C.Adopt the three-language formula
D.None of the above

6.Kothari Commission is also known as
A.Education Commission 1966
B.Indian Education Commission 1882
C.National Policy on Education 1986
D.None of the above

7.Kothari Commission was headed by a scientist and an educationist. Who was he?
A.Dr DP Kothari
B.Dr DS Kothari
C.Dr SP Kothari
D.None of the above

8.The pattern of education recommended by Kothari Commission was
A.10+1+2
B.10+2+3
C.10+3+2
D.None of the above

9.As per the recommendations of the Kothari Commission, the National Education Policy was formulated in?
A.1966
B.1967
C.1968
D.1969

10.Dr Daulat Singh Kothari, the head of the Kothari Commission, was the chairman of which national body when the commission was constituted?
A.CSIR
B.CBSE
C.NCERT
D.UGC

Enrich Yourself With Facts On Rohini Satellite

■ The Indian Space Research Organisation (ISRO) has launched a number of satellites under the name Rohini. Three of the four satellites in the Rohini series successfully entered orbit after being launched by a satellite launch vehicle (SLV). The majority of the series were satellite experiments.

■ On July 18, 1980, the Satish Dhawan Space Centre successfully launched RS-1, an experimental spin-stabilized satellite weighing 35 kg (77 lb) into an orbit with an inclination of 44.7° and a range of 305 km (919 miles). It was the first satellite that the homegrown SLV launch vehicle had successfully launched. It offered information about the fourth SLV stage. The satellite had a 1.2-year mission and a 20-month orbital life.

■ On May 31, 1981, RS-D1, an experimental spin-stabilized satellite weighing 38 kg (84 lb), was launched using 16W of electricity. The SLV's launch was only partially successful because the satellite did not reach the desired altitude and only remained in orbit for nine days. It achieved an orbit with an inclination of 46° and a diameter of 186 km by 418 km (116 mi by 260 mi). The Landmark Tracker, a solid state camera for remote sensing applications, was carried by the satellite and operated as intended.

■ On April 17, 1983, RD-D2, an experimental spin-stabilized satellite weighing 41.5 kg (91 lb), successfully launched into an orbit with a diameter of 371 km (232 mi) by an altitude of 861 km (231 mi) and an inclination of 46°. The satellite's main payload, a smart sensor camera, took around 2500 photos throughout its 17-month operational period (mission life). The camera could capture images in both the visible and infrared spectrums. On April 19, 1990, the spacecraft returned to Earth's atmosphere after an orbital lifetime of 7 years.

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

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02	1 Year	School Students	300	$80	300
		School Library	600		
		Colleges/Other Institutions/ Individuals	1,000		
03	2 Years	School Students	550	$150	550
		School Library	1,000		
		Colleges/Other Institutions/ Individuals	1,750		
04	3 Years	School Students	800	$210	800
		School Library	1,500		
		Colleges/Other Institutions/ Individuals	2,500		

Dr Daulat Singh Kothari (July 6, 1906 – February 4, 1993)

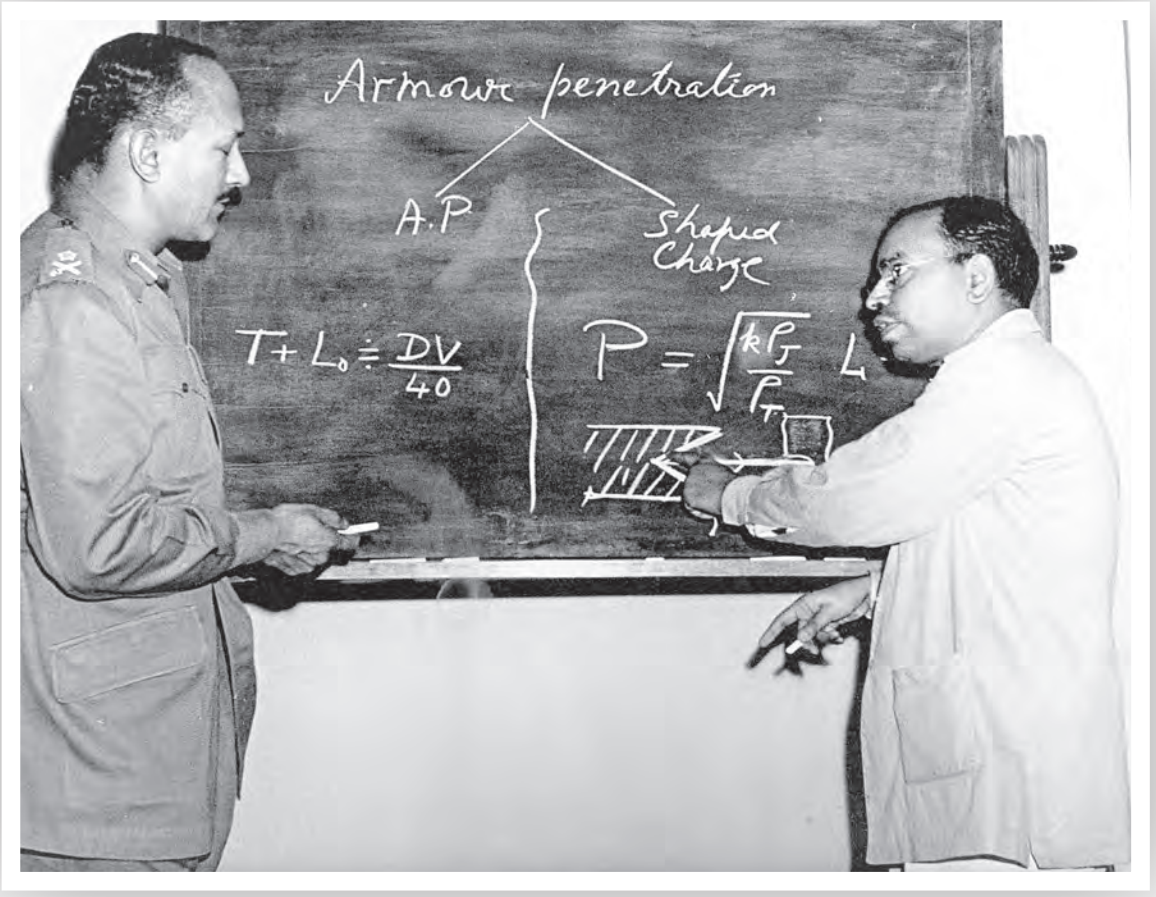

Image Courtesy: Wikipedia

Indian scientist Dr DS Kothari was born in the Rajputana princely kingdom of Udaipur. His mother raised him after his father perished in the 1918 plague epidemic. Renowned scientist Prof Meghnad Saha helped him earn a master's degree in physics from Allahabad University in 1928. Prof Saha recommended Kothari to Ernest Rutherford, who oversaw his work at the Cavendish Laboratory, University of Cambridge, where Kothari completed his PhD.

July
2023

Celebrating Science This Month

JULY 1
National Doctors' Day.

IRNSS-1A, first satellite in the Indian Regional Navigation Satellite System, was launched in 2013 by PSLV-C22 from SDSC-SHAR Centre, Sriharikota.

JULY 4
Swami Vivekananda, the great scientific visionary, passed away in 1902. The establishment of the prestigious Indian Institute of Science in Bengaluru was a result of an interaction between Swamiji and the industrialist Jamsetji Tata.

JULY 6
Daulat Singh Kothari was born in 1906. He was elected as the General President of the Indian Science Congress in 1963 and President of the Indian National Science Academy in 1973. His research on Statistical Thermodynamics and Theory of White Dwarf Stars gave him global recognition.

JULY 10
INSAT-4C was launched from SDSC-SHAR, Sriharikota, in 2006.

JULY 11
World Population Day is observed.

Cotton scientist, Chandrakant T Patel, was born in 1917. He developed the first commercial cotton hybrid, known as Hybrid-4 (Sankar-4) in 1970.

JULY 12
CARTOSAT-2B was launched in 2010 by PSLV-C15 from Sriharikota.

JULY 13
SROSS-2 was launched in 1988 by ASLV-D2 from SHAR Centre, Sriharikota.

JULY 14
Padma Shri TS Chandrasekar, an internationally renowned Interventional Gastroenterologist and the Founder & Chairman of MedIndia Hospitals, Chennai, was born in 1956.

JULY 15
GSAT-12 was launched in 2011 by PSLV-C17 from SHAR, Sriharikota, India.

JULY 16
Indian Council of Agricultural Research (ICAR), formerly known as the Imperial Council of Agricultural Research, was established in 1929 as a registered society under the Societies Registration Act, 1860 in pursuance of the report of the Royal Commission on Agriculture.

JULY 18
University of Mumbai, was founded in 1857.

Kadambini Ganguly, first Indian female doctor who practiced with a degree in western medicine was born in 1861. Her lectures made Calcutta Medical College finally open its doors to women. Ganguly was also the first female speaker at the Indian National Congress.

Rohini Satellite RS-1 was successfully launched onboard SLV-3 from SHAR Centre in 1980.

JULY 22
Indian American mathematician, Shreeram Shankar Abhyankar, was born in 1930 in Ujjain. He is known for his contributions to algebraic geometry.

Chandrayaan-2 was launched in 2019 by GSLV-Mk III - M1. It reached lunar orbit in August 2019. Pi Approximation Day is observed as the fraction 22/7 (22nd July) is the common approximation of the mathematical constant pi.

JULY 25
Central Electro Chemical Research Institute (CECRI) was established in 1948 in Karaikudi, Tamil Nadu.

Indian space scientist, Nilamber Pant was born in 1930 in Almora, Uttarakhand. He was a pioneer of satellite-based communication and broadcasting in India.

JULY 27
Indian aerospace engineer and former President of India, Dr APJ Abdul Kalam, passed away in 2015. He spent his life as a scientist and science administrator, mainly at DRDO and ISRO, and was involved in India's civilian space programme and missile development efforts. He also played a pivotal role in India's Pokhran-II nuclear tests in 1998. While delivering a lecture at the Indian Institute of Management Shillong, the great scientist of India collapsed and died from cardiac arrest.

JULY 28
World Nature Conservation Day is observed.

JULY 29
Indian Association for the Cultivation of Science was founded in 1876 by Mahendra Lal Sircar. It focuses on fundamental research in basic sciences.

JULY 31
Indian polymath, Damodar Dharmananda Kosambi, was born in 1907. He contributed to genetics by introducing the Kosambi map function. In statistics, he was the first person to develop orthogonal infinite series expressions for stochastic processes via the Kosambi–Karhunen–Loève theorem.

The Indian Academy of Science, Bangalore, founded by CV Raman, was inaugurated in 1934.

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