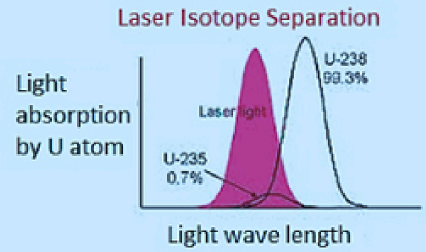
JANUARY - MARCH 2026
VOL. 27 ISSUE 3

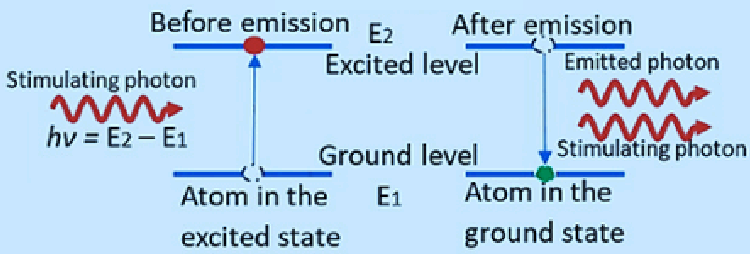
# INDIAN NUCLEAR SOCIETY

## NEWSLETTER




Dr. Asima Chatterjee
The first women recipient of Shanti Swarup Bhatnager Award

Simulated emission

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# President's Message

Dear INS Members,

It is my privilege to greet you on behalf of EC, in the first quarter of 2026 and update you on the activities of the Society during this period. I must say that the present EC has been immensely fortunate to receive the overwhelming support of members and blessings of veterans who have dedicated golden years of their professional life to nuclear science and technology. I would like to commend the Editor and Editorial board members for regular publication of quarterly INS Newsletter and facilitating communication with all of you.

President, Mrs Droupadi Murmu assented to the Sustainable Harnessing and Advancement of Nuclear Energy for Transforming India (SHANTI) Bill in December 2025. It is a landmark legislation which fundamentally restructures India's nuclear power framework by allowing private participation in building and operating nuclear power plants without compromising on the safety and security of nuclear facilities on one hand and safeguards of nuclear materials on the other hand. Due to it's far reaching consequences, INS organised a webinar on "The Legislative framework for nuclear energy in India" by Dr. R.B. Grover, Member Atomic Energy Commission and Distinguished Professor Emeritus, HBNI. In view of the keen interest of private sector in national nuclear mission of 100 GWe by 2047, a theme meeting was organised to address to their aspirations, expectations and concerns. About 35 representatives of private companies as well as public undertakings participated in the program, INS is grateful to Shri B.C. Pathak CMD, NPCIL and distinguished panel of speakers for sharing their wide experience of nuclear industry with the participants.

INS hosted a seminar on "An Overview of Canadian Nuclear Program" by Prof. Sriram Suryanarayan, Director Innovation, Kinectrics Inc. Toronto and Adjunct Professor, University of Toronto, Canada. It was very informative presentation which included the journey in memory lane considering the historic support of AECL towards reactor technology in the early years of Indian Atomic Energy Program.

An Outreach program conducted at Central University Punjab at Bathinda
(CUPB) was a grand success considering the active participation of post graduate students, Ph.D. scholars and faculty of CUPB and adjoining universities. Highlight of the program was a Walkathon where more than 300 students participated displaying placards with paintings on theme of the rally " नाभकीय ऊर्जा और नाभकीय विकिरण : उज्जवल भविष्य के लिए वरदान" INS has signed an MOU with Nuclear Institute, U.K., in Jan. 2026, which provides range of opportunities for the interaction of two societies like
a) Participation in scientific conference of international significance,
b) Co-sponsorship of joints meetings/workshops,
c) Exchange of publications and
d) Reciprocal company membership etc.
Members are urged to visit website to peruse details of all the INS activities which include the full coverage of 2 day theme meeting seminar/webinar/outreach programs. Friends, there has been wide coverage of national nuclear mission and SHANTI acts in print media during this quarter. On one hand merits of nuclear energy like 24x7 uninterrupted supply with low carbon emission were highlighted, on the other hand apprehensions like long gestation period, large exclusion zone, large CAPEX and dependence on foreign suppliers for nuclear fuel were expressed.

To meet some of these challenges, SMRs and microreactors have been proposed by their proponents which are particularly suitable as captive power stations in remote areas. INS contemplates that there is a need to carryout in depth study of the role of SMRs and microreactors in achieving the target of 100 GWe by 2047.

There is also intense discussion in media about the merits of early introduction of thorium in the 1 st stage of India Nuclear Power Program itself. There is a proposal to use Th along with high assay low enriched uranium (HALEU) in PHWRs to overcome the limited global supply of natural uranium rather than waiting for the build up of sufficient U-233 inventory through Fast Breeder Reactors. INS contends that there is a need to carryout in depth multidisciplinary study of challenges of Th utilization at different stages. I would like to invite our members who have passion to contribute in the above areas to be a part of the INS Study group.

INS has been receiving requests from academic institutes and industries for short term courses / training programs in nuclear science and technology. We are committed to support such initiatives as part of our mandate. However, we depend largely on (our core strength of) experienced members who have been associated with such assignments during their service years. I would like to invite our members who have passion to contribute in this area to be a part of INS Training group.

Our outreach programs are immensely popular and many reputed organisations have expressed their interest to co-organise such events. Only last week a proposal has been received from the director Nehru Science Centre for a collaborative outreach program. INS considers it as a very good opportunity to interact with visitors of Nuclear Gallery at NSC and spread the message that Nuclear Energy and Nuclear Radiations are Boon for the mankind. Finally I urge upon members to not only actively participate in the INS activities but also visit website ***www.ins-india.org*** and send their valuable suggestions regularly to ***indiannuclearsociety@gmail.com***. We will try our best to live up to their expectations.


**Bhavini made PFBR critical on 6th April 2026 at 8:25 pm**
**INS joins Prime Minister in congratulating the entire DAE community for this achievement**

**Jai Hind**
**Dr. Vijay Manchanda**
**President, INS**

# From Editor’s Desk

Dear Members, greeting from INS

It was yet another exciting quarter in INS with activities planned and executed in collaboration with academic institutions and private and public industries. The editorial team as always has tried to bring in newer scientific articles contributed by domain experts for information of our members. The reports of the activities brought out in this quarter indicates the single minded effort by INS to remain in tune with the current development largely connected with nuclear science and technology and in planning outreach programs as mandated for the society.

This quarter we have lost one of eminent physicists, Dr. B. Anantha Dasannacharya on 15 th Feb 2026. He has made extraordinary contributions to condensed matter physics, nuclear instrumentations, and nation-building in research and developments that continue to inspire and guide the younger generation. We in INS pray for his eternal peace and wish the family members strength to bear his absence. All the INS members are requested to bring to the notice of INS about sad demise of any member from DAE community. INS newsletter will cover homage to the departed soul appropriately.

INS organized the following important events-

1.Webinar on “The legislative framework for nuclear energy in India”. By Prof R B Grover.

2.Seminar on “Overview of the Canadian Nuclear Program” By Prof Sriram Suryanarayan of University of Toronta, Canada.

3.Theme meeting on “National Target of 100 GWe Nuclear Energy by 2047” for professionals from private and public sector industries.

4.Conference on “Nuclear Energy and Critical Minerals: Exploration, Myths, and Societal Impact” (NE&CM-2026) in University of Punjab, Batinda.

To rekindle interest in members in technologies which are silently working in the background for making our daily lives easy, the editorial team has selected topic on LASER. In the current and next newsletter, we intend to cover the historical development of LASER and its range of applications in two parts. In this quarter we celebrated the International Women`s day on 3rd March 2026. Commemorating the day, we have one interesting article on contribution of women in science. The article on women in quantum science narrates about how Satyendra Nath Bose not only made huge contributions to quantum science; but also welcomed women into what was at the time a male-dominated field. In 1951 he welcomed a Ph.D. student Purnima Sinha to his group at the University of Calcutta. In 1956 Sinha was awarded her Doctorate in Physics. There is also one article on LASER based isotope separation in BARC. One can look forward to cheaper and abundant supply of Radiopharmaceutical for use by oncologists and other medical professionals.

You will all agree that we are passing through the best phase wherein the country is looking forward for concrete developments to accomplish the nuclear mission. Today collaboration is the mantra for success. Be it large or small plants, it is important that industry has to grab the opportunity to be part of the mission and we in INS are willing to be a bridge between DAE and the industry.

The editorial team once again requests all the INS members to contribute interesting articles. I acknowledge the individual contribution of the entire editorial team in bringing out the third newsletter. Our special thanks to Smt. Shweta INS Staff who volunteered to design and compile the contents of the newsletter provided to her time to time.

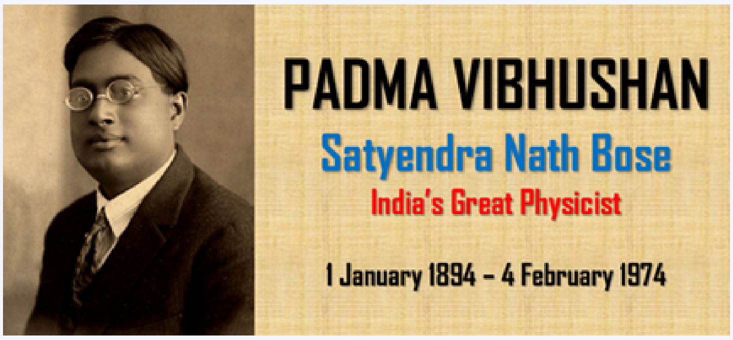
**Jai Hind**
**Dr. A Rama Rao**
**INS Member**


***JRD Tata and Dr Homi Bhabha's shared vision of advancing India's modern scientific capabilities***

# The Rise of Women in Quantum Science in India and the Legacy of Satyendra Nath Bose

By Tanusri Saha-Dasgupta, Director S.N.Bose National Centre for Basic Science, Kolkata and Rupamanjari Ghosh Former Prof. JNU

Satyendra Nath Bose didn't just make huge contributions to quantum science ; he also welcomed women into what was at the time a male-dominated field . The 1920s was an era of transformation. In the US, the "Roaring Twenties" saw industrial growth, the rise of consumerism, and huge social change, marked by jazz music, prohibition and flapper fashion. Europe , meanwhile, was recovering from the devastating First World War and experiencing political and economic instability alongside flourishing artistic and intellectual movements. And India – which was still under British rule at the time – was embracing Mahatma Gandhi's policy of non-violence and civil disobedience , accelerating its nationalistic movement towards independence . Amid worldwide cultural and socio-political change , another revolution was unfolding in science, particularly in our understanding of physical phenomena that cannot be explained by the classical laws of physics. Intense efforts were being made by European scientists to reconcile puzzling observations, and ground-breaking ideas were being introduced, such as Max Planck's hypothesis of "quanta" and Albert Einstein's quantization of electromagnetism. The first quantum revolution was flourishing.




In the midst of this excitement, a modest man from Bengal in undivided India, Satyendra Nath Bose, was teaching physics at Dacca (now Dhaka) University.

He was greatly inspired by the new ideas in physics, and set about trying to solve the big inconsistency with the Plank distribution of black body radiation – the fact that it mixed classical and quantum concepts. Bose introduced the ground breaking notion of indistinguishability of particles into the evolving quantum theory to rectify the problem, culminating in an equation describing the distribution of energy in the radiation from a black body purely based on quantum physics.

Bose's derivation of Planck's law impressed Einstein, who had also been trying to solve the problem. He translated the work and submitted it to Zeitschrift für Physik journal on Bose's behalf. Bose's novel quantum statistical approach later became known as Bose Einstein statistics. Einstein followed up with its extension to atoms and the prediction of Bose – Einstein condensates. Bose's work was a break-through for quantum mechanics, and there have since been many discoveries and multiple Nobel prizes awarded for work related to his research. He also laid the foundation for novel technologies that are central to today's "second quantum revolution" . This exciting era encompasses themes such as quantum computing, communications, sensing and metrology and materials and devices. Bose's scientific breakthroughs were not his only contributions to physics at the time.

## Competent and capable

Bose lived in an era when women were not welcome in the scientific community in India, as was the case in much of the rest of the world.

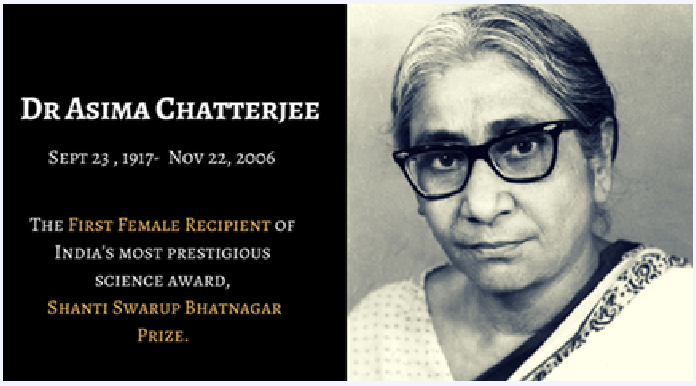
Infamously, in 1933 biochemist Kamala Sohonie , who went on to be the first Indian woman to get a PhD in a scientific discipline , was denied admission to the Indian Institute of Science by the then director Chandrasekhara Venkata Raman. Best known for his work on light scattering, Raman believed that women were not competent enough to do scientific research.

While Sohonie eventually did get a place, she had to fight hard for it, and Raman enforced certain restrictions. For example, she was on probation for a year and Raman had to approve her work before it could be officially recognized. Bose on the other hand , did not make any distinction between men and women as far as scientific ability were concerned. In 1951 he welcomed a Ph.D. student Purnima Sinha to his group at the University of Calcutta. Despite being the only woman in the team, Sinha succeeded in leaving her indelible imprint on a male dominated world, helped by the constant guidance and encouragement she received from Bose. Sinha's research was on crystallographic and thermal analysis of clay samples taken from all over India

**The First Bengali Woman To Receive A PhD In Physics**

She built sophisticated X-ray instruments using military scrap equipment sold on the streets of Calcutta (now Kolkata) after the Second World War.

In 1956 Sinha was awarded her doctorate, becoming the first woman to earn a PhD in physics from Calcutta University (and likely the first woman to get a PhD in physics from an institution in India). She went on to conduct research in biophysics at Stanford University in the US, and found similarities between clay structure and DNA structure, providing pioneering thoughts on the origin of life. Sinha further broke gender stereotypes by doing masonry work, carpentry and even playing the tabla. Bose was equally supportive of Asima Chatterjee, who started her research on medicinal plant extracts with Bose and conducted the first small molecule X-ray diffraction, which was ground-breaking work.




## Breaking through

While times have changed and women today have more freedom to pursue science, technology , engineering and mathematics (STEM), these areas continue to be dominated by men. India produces the highest percentage of female STEM graduates in the world (43%), but women make up only 14% of the STEM workforce in the country and 18.6% of those directly involved in research and development activities.

The representation of women in the science and technology sector remains strikingly low , both in terms of job applicants and leadership roles.

For example , a survey by the Council of Scientific Industrial Research (CSIR) in 2022 revealed that no woman had held the role of director general of CSIR until August of that year when chemical engineer Nallathamby Kalaiselvi became the first woman to lead the institute – a role that she still holds. Indeed, only five of the 35 CSIR labs were led by women at the time of the survey.


Gender bias and traditional role segregation are some of the key reasons why women remain under represented in STEM careers in India. Several studies have found that women leave the workforce at key phases in their life – notably when they have children and are also often rejected when seeking jobs because of gender discrimination.

However, the picture is changing rapidly, aided by educational initiatives and grassroots movements advocating for gender equity. The quickly growing quantum sector is no different, and the need for quantum education is greater than ever, as a shortage of trained researchers is being felt globally.

One person hoping to inspire and educate women and girls about quantum computing is Nithyasri Srivathsan – a student at Nanyang Technological University , Singapore , who founded SheQuantum in 2020. The start-up company has built an e-learning platform offering lectures, quantum computing courses and other educational resources, as well as articles and interviews with experts .

It was listed by The Quantum Insider as one of the "9 Educational Platforms to get the Quantum Workforce Up & Running", alongside IBM, Microsoft and MIT xPRO among others.

Another example is Women for Quantum (W4Q), which was set up by a group of female physics professors, mostly based in Europe and Japan, who work in the field of quantum optics, quantum many-body physics and quantum information. In its manifesto, the initiative highlights the "unsatisfactory current situation of women in quantum physics" and calls for a joint effort to make real change in the field.

## Celebrating success

The good news is that such efforts seem to be paying off. According to the latest All India Survey on Higher Education (AISHE) (2020–2021) women make up 42.3% of undergraduate, postgraduate, MPhil and PhD places in STEM education. There has also been a surge in women in all fields of STEM, including quantum science, where they are making significant contributions to the second quantum revolution.

To celebrate the growing presence of women at the forefront of quantum science in India, the S N Bose National Centre for Basic Sciences in Kolkata arranged an international conference in July 2024 on Women in Quantum Science and Technologies. The meeting was part of celebrations marking the 100th anniversary of Bose's seminal work, highlighting that his legacy encompasses both quantum science and gender equality in physics.

*Opportunity for change Women in Quantum Science and Technologies was a three-day conference held in Kolkata in July 2024. (Courtesy: S N Bose National Centre)*

The three-day conference consisted of six talks from accomplished female scientists, two panel discussions, three special lectures, 10 invited talks from early-career women working across quantum science and technologies and a poster session by PhD students. The panel discussions focused on the challenges faced by women in higher education and ways to overcome them, as well as opportunities for women in the quantum arena. Speakers included Rupamanjari Ghosh, Aditi Sen De, Indrani Bose, Anjana Devi, Shohini Ghose and Efrat Shimshoni.

Such events highlight the achievements of women in the field, providing a platform for sharing research and inspiring future generations . This visibility is crucial for normalizing women's participation in science and encouraging girls to pursue careers in physics and related disciplines . With the second quantum revolution in progress and the next likely to be driven by commercial innovations in areas such as cyber security, eco-materials and medical advancements, it is important to ensure that these breakthroughs do not reinforce societal inequalities. For that, we need women and other underrepresented groups in physics, to be encouraged into the field to ensure a diverse range of ideas.

To this end, here we highlight some women at the forefront of quantum science in India. The list is far from exhaustive, but it offers a glimpse of the broader picture.

Beyond academia impressive women in quantum science are not limited to academia. Government departments and industry in India can boast of some prominent female leaders. For example, Anindita Banerjee is a product manager for quantum technology projects at the Centre for Development of Advanced Computing (CDACINDIA) , a premier research and development organization founded by the Ministry of Electronics and Information Technology. Anupama Ray is an award winning senior research scientist at IBM Research in Bangalore, where she focuses on developing quantum machine learning algorithms. Meanwhile at Microsoft India and South Asia, Rohini Srivastava is the chief technology officer, responsible for driving technology innovation and growth across industry and the government.

In addition to the accomplished Indian women working in quantum in their home country, there are several who have built successful careers abroad. Notable cases are Anjana Devi, director of the Institute for Materials Chemistry at the Leibniz Institute for Solid State and Materials Research, Dresden, Germany; Nandini Trivedi, professor of physics at Ohio State University, US ; Nilanjana Datta, professor in quantum information theory at the University of Cambridge , UK ; Vidya Madhavan , professor of physics at the University of Illinois Urbana-Champaign , US ; Shohini Ghose , professor of physics and computer science , and director of research and programmes for the Centre for Women in Science at Wilfrid Laurier University in Waterloo, Canada, and chief technology officer at Quantum Algorithms Institute. The rise of women in quantum science in India is a tribute to Bose's legacy, and a sign of a more inclusive and dynamic future . To sustain this momentum, we must create ecosystems that support curiosity, collaboration and equal opportunity – ensuring that every brilliant mind, regardless of gender, has the chance to transform the world.

https://physicsworld.com/a/the-rise-of-women-in-quantum-science-in-india-and-the-legacy-of-satyendra-nath-bose/

# The Story Of The LASER (Part-I)

Prof. Dhruba J. Biswas, Former Senior Scientist, BARC

The journey of the laser began with a spark of genius—Albert Einstein's 1917 prediction of stimulated emission. Yet it took more than four decades of scientific perseverance before this idea became reality. The first successful demonstration of Light Amplification by Stimulated Emission of Radiation in 1960 was anything but simple. It demanded not only deep theoretical insight but also exceptional experimental ingenuity. When Theodore Maiman made a ruby crystal emit faint flashes of red light through one of its polished faces, the world witnessed the birth of a new kind of light—coherent, intense, and full of promise.

To truly appreciate the story of the laser, it is essential to understand both how it works and the profound ways it shapes our everyday lives. Accordingly, this article begins with an intuitive introduction to the principles underlying laser operation, followed by an exploration of key application areas that have transformed modern society in remarkable ways.

In an engaging, storytelling style, the article highlights how lasers underpin so many aspects of modern life, whether in the working of GPS, connecting continents with a mobile phone call in the blink of an eye, or countless other examples. Remarkably, while a large fraction of the global population today uses a mobile phone to connect with friends and family worldwide, or GPS for navigation, few—even among the educated, are aware of the technology that makes these feats possible. This article explains, in an intuitive way, how the union of semiconductor lasers, the smallest of all lasers, with hair-thin optical fibers has revolutionized global communication. The scale of this achievement is astonishing: the total length of optical fiber laid across land and ocean today exceeds four times the distance between the Earth and the Sun. It also explores how laser-cooled atomic clocks enable GPS systems to achieve extraordinary positional accuracy.

## 1.Introduction:

The laser was operated for the first time on May 16 , 1960 , by the American physicist Theodore Maiman (1927–2007) at the Hughes Research Laboratory in Malibu , California. In a deceptively simple experiment , he made a ruby crystal emit faint flashes of red light through one of its polished faces. From this modest beginning, laser technology has advanced in extraordinary leaps. Today, lasers span almost the entire electromagnetic spectrum—from the far infrared to the vacuum ultraviolet. Their output powers range from mere milliwatts, as in barcode scanners, to petawatts, as in frontier experiments probing the extremes of physics.

Lasers now come in an astonishing variety of forms and scales—from tiny semiconductor devices embedded in smartphones to massive installations such as the National Ignition Facility in Livermore, California, where hundreds of powerful laser beams are used to explore the possibility of controlled nuclear fusion. This remarkable versatility has made lasers an indispensable part of modern life.

Indeed, there is scarcely an area of human endeavor untouched today by lasers. In healthcare , they enable delicate surgeries, correct vision and treat life-threatening diseases. In security and defense, they guide missiles, detect intrusions and monitor borders. In science and education, lasers serve as essential tools for precision measurement, imaging and discovery . In industry , they drive cutting , welding and manufacturing processes with unmatched accuracy. In transportation, they support advanced sensing and autonomous navigation. In entertainment, they dazzle audiences with light shows and cinematic effects. Perhaps most profoundly, lasers form the backbone of modern communication—powering the internet, mobile networks and global data centers.

Looking ahead , they may even hold the key to unlocking clean, virtually limitless energy through nuclear fusion. The list of applications continues to grow as new uses emerge year after year.

To fully appreciate the story of the laser, it must be viewed from two complementary perspectives: how it works and how it has reshaped everyday life. Accordingly , this article is divided into two parts. **Part I** introduces the fundamental physics of lasers—how they generate light, what distinguishes laser light from ordinary sources, and why stimulated emission is so extraordinary. The discussion is presented with clarity and intuition , aiming to demystify the science without overwhelming the reader. **Part II** then turns to the broader impact of lasers on humanity, revealing how a once-mystifying laboratory curiosity has quietly woven itself into the fabric of modern civilization.

Using an intuitive, storytelling approach, I invite you to explore the remarkable journey of the laser and how it continues to shape our world.

## 2.0 Part-1: The story of Lasers : An Insight into Laser Science

### 2.1 The Long Road to Controlling Light

The year **1905**, often celebrated as the miracle year in the history of science, marked a profound turning point in physics. In that single year, **Albert Einstein** reshaped our understanding of nature in multiple ways. He unified mass and energy through his special theory of relativity, immortalized in the equation ($E = mc^2$)[1]. At the same time, he quietly ignited a revolution in optics by proposing something radical for its time : **light itself is quantized.** Einstein suggested that light, long understood purely as a wave, could also behave as a stream of discrete packets of energy—later called photons. This wave-particle duality cemented a new conceptual foundation for light. Yet this was only the beginning. The enigma of light had fascinated him since childhood[2]. He soon put forward a revolutionary concept that turned optical physics on its head planting the seed for one of the most transformative technologies of the modern age—the **laser.**

### 2.2 Humanity's Ancient Fascination with Light

Throughout history, humanity has sought to control and exploit light. One famous example, more legend than fact, centers around Archimedes, the renowned Greek scientist and mathematician. During the siege of Syracuse in 213 BC, he is said to have devised a death ray using large concave mirrors to focus sunlight onto approaching Roman ships, allegedly setting them ablaze and throwing the invading forces into disarray.

Although captivating, this tale has been thoroughly scrutinized. Studies suggest it would require approximately 440 men, each wielding a $1m^2$ mirror, or one colossal mirror, just to barely ignite a small patch of a wooden vessel from roughly 50 meters away. In reality, using this method to incinerate an entire ship would have been nearly impossible.

Archimedes' soldiers likely used the mirrors to blind, confuse, or perhaps even cause minor burns to the Romans on board, as the intensity of sunlight reaching Earth is simply too low for such a grand scheme to be viable. One imagines Archimedes himself might have wished sunlight packed just a bit more punch.

**[1] $E = mc^2$ is often considered the most famous equation in physics—and perhaps in all of science. It expresses the profound idea that mass and energy are equivalent and interchangeable. Though deceptively simple in appearance, this elegant equation has had far-reaching consequences: it laid the theoretical foundation for the atomic bomb, one of the most destructive weapons ever created by humanity.**

**[2] According to Einstein's own recollection, the early idea that the speed of light might be invariant—a thought that would eventually lead to the theory of relativity and forever change our understanding of the universe—first occurred to him in his early teen.**

## 2.3 Why Ordinary Light Is So Hard to Control

Just like the sun, all other conventional light sources emit light in all directions around them, essentially over the entire 4π solid angle[3]. This sounds quite logical too! How on earth would a source throw more light in a particular direction?

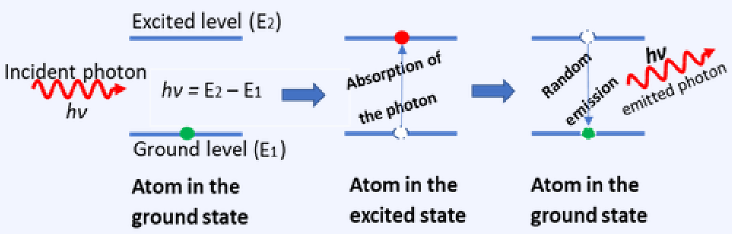



**Figure 1 : This figure schematically illustrates the process of spontaneous emission.**

In the first trace, an atom absorbs a photon when illuminated by light of the appropriate frequency, becoming electronically excited (middle trace). After a finite time in the excited state, the atom returns to the ground state, releasing the excitation energy as a new photon (last trace). This emitted photon can travel in a random direction. In practice, an ensemble of atoms leads to the emission of multiple photons in all directions

To understand this, consider how light is produced at the atomic level in a source such as a fluorescent lamp. According to Niels Bohr's atomic model (1913), electrons occupy discrete energy levels around the nucleus. When an electron absorbs energy in quantized amounts, it can jump from a lower energy level (the ground state, E1) to a higher one (an excited state, E2), as illustrated in Figure 1. This transition occurs only if the absorbed photon has an energy hν exactly equal to the energy difference (E2−E1), a process known as absorption (middle trace in Figure 1).

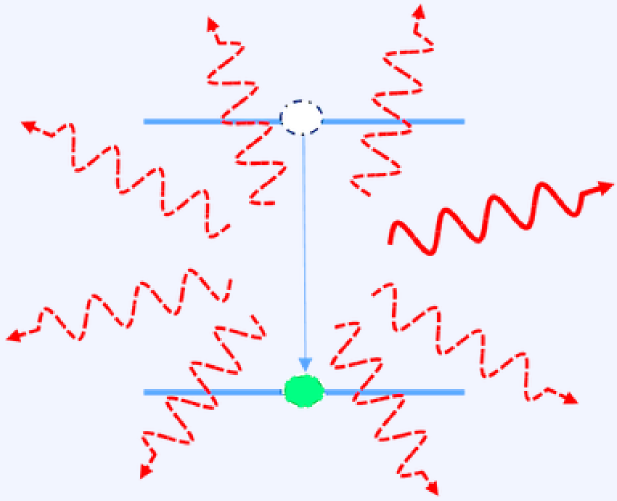


**Figure 2 : 2D view of an ensemble of excited atoms releasing their energy randomly by emitting photons in every possible**

An electron cannot remain in the excited state indefinitely. After a short and unpredictable time, it returns to the ground state, releasing the excess energy as a photon. Crucially, this emitted photon is radiated in a random direction. This process is called spontaneous emission (right trace in Figure 1).

Once an atom emits a photon, it can be excited again, only to repeat the same cycle. In a real light source, an enormous number of atoms undergo this process independently and continuously. The result is a flood of photons emitted randomly in all directions, effectively filling the entire 4π solid angle around the source. Figure 2 shows a two-dimensional schematic of this random emission. Thermal light sources—such as incandescent bulbs or flames—behave in exactly the same way. Consequently, the light spreads out uniformly in space, as shown in Figure 3

**[3] A solid angle is the three-dimensional counterpart of a plane angle. This can be easily understood by comparing a circle and a sphere. A circle of radius r has a perimeter of 2πr, which subtends an angle of 2π radians at its center. Similarly, a sphere of radius r has a surface area of 4πr², which subtends a solid angle of 4π steradians at the center**

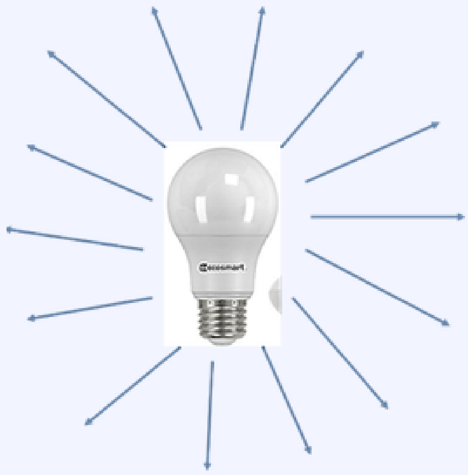


**Figure 3 : A conventional light source emits uniformly in all directions, covering the full 4π solid angle. This figure presents a 2D view of a typical LED bulb, illustrating light rays radiating outward in every direction.**

This isotropic emission has an important consequence: as light spreads out, the energy delivered per unit area decreases rapidly with distance from the source. Put simply, the farther you move away from an ordinary light source, the dimmer it appears. This unavoidable spreading is a direct result of the fundamentally random nature of spontaneous emission.

## 2.4 Einstein's Radical Idea: Stimulated Emission

Against this backdrop, Einstein introduced a startling idea in **1917.** He proposed that under the right conditions, light could be emitted not randomly, but **in a highly organized and directional manner.** The key mechanism was something he called **stimulated emission.**

To appreciate what makes stimulated emission so special, imagine an atom already sitting in an excited state (Figure 4). Ordinarily, it will soon decay spontaneously, emitting a photon in a random direction. But Einstein asked a bold question: **What happens if this excited atom encounters a photon whose energy exactly matches its energy of excitation?**

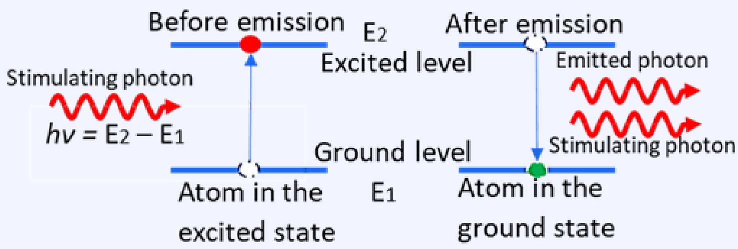



**Figure 4 : A photon whose energy matches the difference between the excited and ground states—called the stimulating photon.**

Such a photon can interact with an excited atom (left trace), causing it to return to the ground state and emit a second photon (right trace). This emitted photon travels in the same direction as the stimulating photon and matches it in all other properties. Directionality is thus inherent to the process of stimulated.

The answer is remarkable. Instead of waiting to emit spontaneously, the atom is **forced to emit immediately**, dropping to its ground state. In doing so, it releases a second photon that is an **exact twin** of the incoming one. The two photons are identical in every respect: energy, phase, polarization, and—most importantly—**direction of travel.**

In his seminal 1917 paper, Einstein established the theoretical basis for this process. Though purely theoretical at the time, it laid the foundation for what would later become the **laser**, the defining light source of the twentieth century and beyond.

## 2.5 Competing with Nature's Preferences

Nature strongly favors the lowest possible energy state. At room temperature, almost all atoms reside in their **ground state**. When an atom is excited — say , by absorbing light — it will eventually return to the ground state through spontaneous emission .

This decay occurs over a characteristic lifetime[4] , typically a few microseconds for electronic transitions. Importantly, this decay is a **statistical** process : while some atoms may return to the ground state almost immediately, others linger for longer periods, up to the full lifetime. The situation is akin to the case of radioactive decay of an ensemble of unstable nuclei; some would decay just at the instant you are reading through this line, while some may decay after years!

In contrast to spontaneous emission, a resonant photon can induce stimulated emission instantaneously. This means stimulated emission can easily beat the process of losing excitation through random (spontaneous) emission. This validates our first assumption: many excited species will indeed be available for stimulation.

The second assumption is more problematic. A resonant photon does not distinguish between excited atoms and ground-state atoms. If it encounters an excited atom, it stimulates emission and creates an extra photon. But if it encounters a ground-state atom, it is **absorbed and lost.**

Stimulated emission adds one photon; absorption removes one. For light amplification to occur, stimulated emission must dominate. This requires a highly unusual condition: **more atoms must be in the excited state than in the ground state.** This situation, known as **population inversion,** directly contradicts nature's normal preference for low energy.

Achieving population inversion turned out to be the central obstacle to realizing Einstein's idea. That it took more than **four decades** from Einstein's 1917 proposal to the first working laser in 1960, speaks volumes about the subtlety and difficulty of the challenge.

### 2.6 How the Laser Finally Came to Life

Two major breakthroughs ultimately made lasers possible.

The first was the clever creation of **population inversion.** This was achieved by engineering a energy-level schemes in which the lower laser level is effectively decoupled from the true ground state. In such systems, the lower laser level remains nearly empty, so transferring even a modest fraction of atoms to the upper laser level is enough to establish inversion.

The second breakthrough addressed the problem of limited interaction length. The solution was the **optical cavity** : the population-inverted medium is placed between two parallel mirrors—one perfectly reflecting, the other slightly leaky. Photons bounce back and forth between the mirrors, passing repeatedly through the excited medium and stimulating more and more emissions.

With each pass, the photon population grows rapidly. A small fraction escapes through the partially transmitting mirror, emerging as a narrow, intense, highly directional beam of light—the **laser output.**

Part II of this article will give a broader impact of lasers on humanity and how a once-mystifying laboratory curiosity becomes one in the fabric of modern civilization. This part will appear in the newsletter of next quarter.

***[4] In common terms, the lifetime of an excited energy state is defined as the time over which approximately 66% of the excited population decays to the ground state.***

# LASER Isotope Separation for Medical Isotopes

Dr. Manmohan Singh Bhatia, Former Outstanding Scientist, BARC

Traditionally the source of Radionuclides, used for making Radio-pharmaceuticals, for use in nuclear medicine were produced by irradiating some stable elements through the abundant neutrons in research reactors. For DAE it has New Apsara and Dhruva research reactors in BARC since 1985 till now. After irradiation, generally a mixture of isotopes is obtained, and this entails separation of the radioisotope of interest from the mixture of other isotopes often at the purity level of 95% and above (higher the better). This cannot be done via physical or chemical means. Laser Isotope Separation (LIS) method brings in the technique to achieve the required purity.

The laser was invented in 1960 and matured as a technology in the late 1970s when various lasers were marketed for a plethora of applications. At BARC, a program of laser isotope separation was introduced in late 1970s which was dedicated to nuclear applications [1]. By 2015, the idea to use the facility for preparing Medical Isotopes was mooted and good progress is recently reported in this effort. [2, 3]

Few more production methods besides research reactors have come to the fore. They are accelerators (predominantly Cyclotrons) and more recently generators which rely on decay of parent radionuclide to useful daughter products of short half-lives.

This serves the most important purpose of causing least side effects in cancer treatment or radio-treatment. The half-life of the selected isotope in such cases is such that it adequately treats (kills) malignant cells and thereafter it is left with no radioactivity.

There is lot of potential to generate new modalities for treatment which needs to be fruitfully tapped in future. While the basic principle remains the same across various isotopes, the variation in details like spectroscopic parameters, evaporation method, internal design of separator are varied according to generation of the isotope. As reported recently [2,3], BARC has accomplished separation of $^{177}$Lu used for treating neuroendocrine cancer and $^{169}$Yb for use in medical and industrial applications. In the near future, more isotopes for medical application are likely to be produced. Work is also in progress to increase purity in the final product for increased efficiency in the entire separation process.

LIS is most suited for this task of purifying the isotopic mixture in small quantities needed for Nuclear Medicine. The process is explained hereunder with illustration for the benefit of general readers.

The working principle of LIS is illuminating only one isotope with an intense narrow line width laser which excites only the atoms of the isotope of interest and leaving the others practically untouched

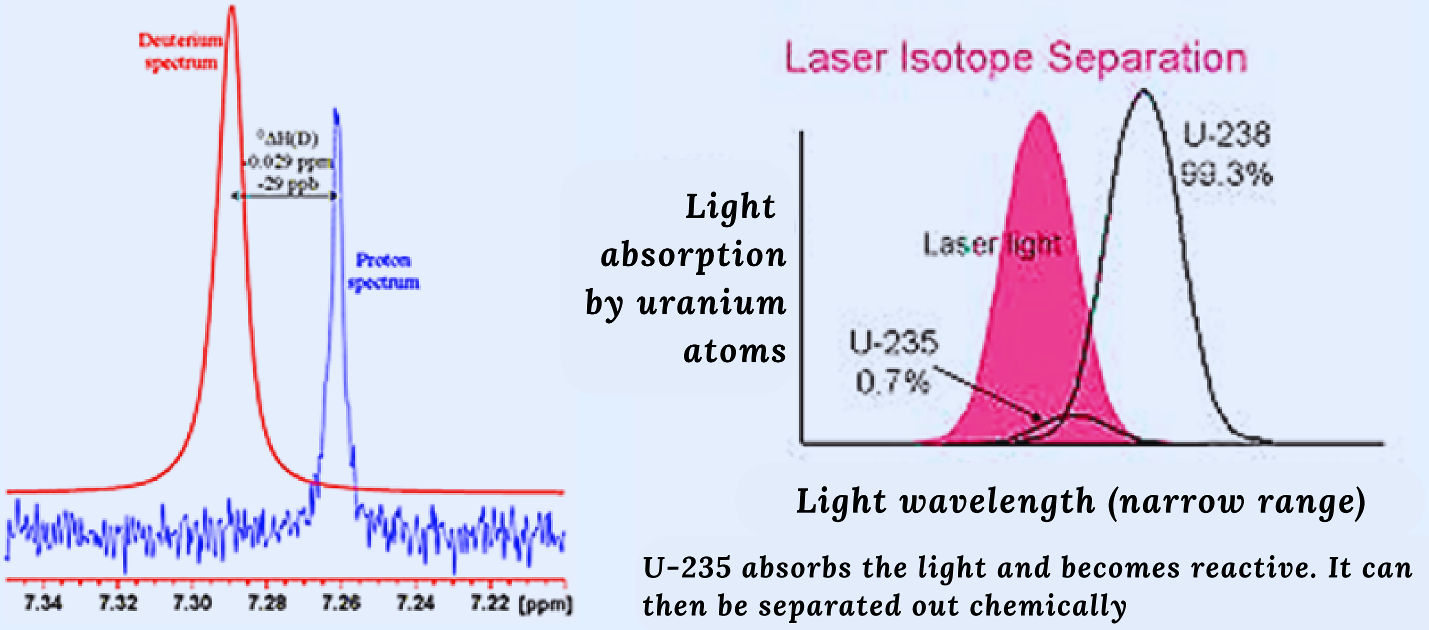



**Figure 1: Left: Isotope separation in absorption spectrum of Hydrogen (lightest element) and Right: Uranium (heavy element).**

The left picture in Figure 1 is separation in absorption spectrum between isotope H2 and D2. The right picture in Figure 1 is separation in absorption spectrum of isotopes U-235 and U-238. It can be seen in the two pictures that frequency shift between isotopes is usually very small compared to wavelength of light (usually ppm of the frequency) and thus require extremely narrowband lasers that can be tuned suitably to address any one isotope.

For LIS to materialise the isotope shifts in the optical transitions used should be large enough (certainly more than the spectral linewidth of the laser).

Fortunately, this is so for many elements in the periodic table making LIS suitable to those elements (unlike the centrifuge technology where separation suitability is highly restricted).

Once the selective laser excites the desired isotope it can ionise the atomic species by providing another laser step that is tuned to the absorption spectra of the desired atomic species. Once selective ionisation is realised, it is a simple process to sweep them out of the atomic beam by applying electric fields yielding highly enriched collection on the biased ion collector. The overall scheme is illustrated in Figure 2.

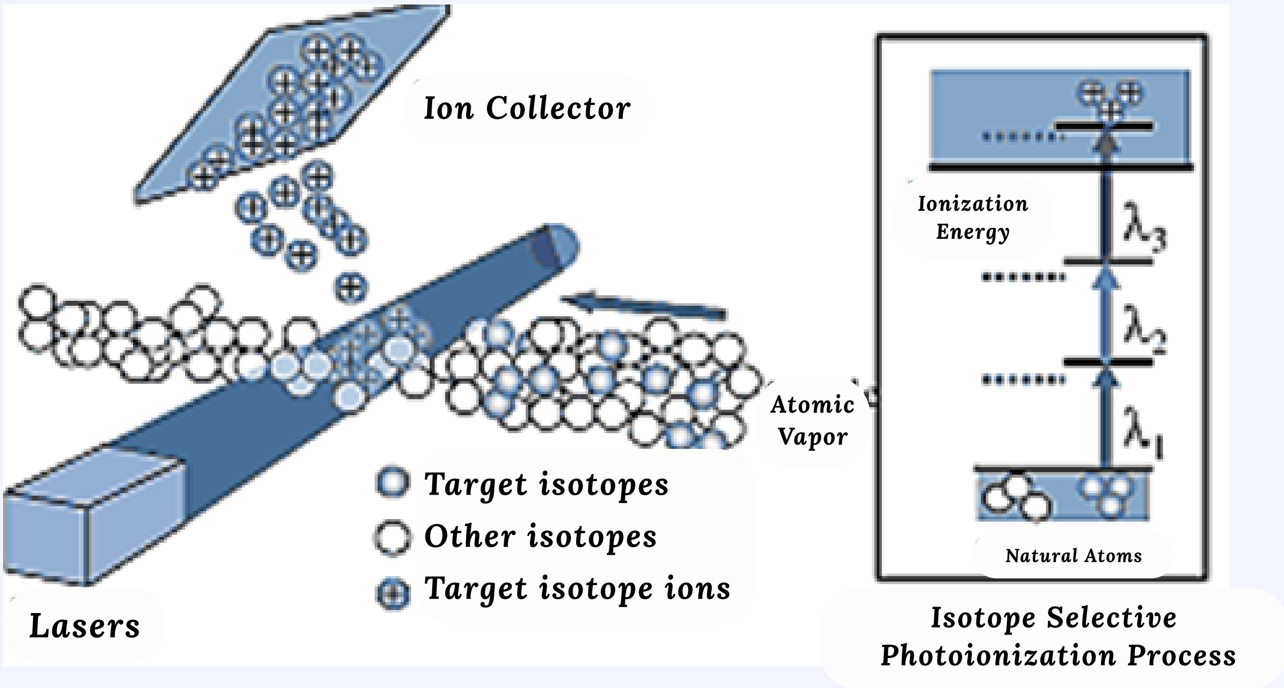



**Figure 2: The schematic of LIS process.**

Suitability of LIS for producing medical isotopes can be shown by its superior characteristics brought out is the list below.

- LIS can be done in small scale or in a plant scale. LIS is also called a garage technology as its entire setup can fit into a garage.
- In single step LIS can achieve the desired enrichment or purity as required by medical standards.
- LIS needs modest capital investment compared with other methods of isotope separation.
- The technology required for LIS is quite mature and readily available.
- LIS products often turn out to be cheaper in cost.

BARC has taken lead in maturing this technology. One can look forward to cheaper and abundant supply of Radiopharmaceutical for use by oncologists and other medical professionals. Cancer free nation is the final objective that can be steadily accomplished by adopting this technology!

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**1**. P.R.K. Rao, Current Science, Vol. 85, Jan 2015, pp 615.

**2**. B. Dikshit and A. Sharma, IEEE Trans. on Nuclear Science, Vol. 67, Dec. 2020, pp 2465-2471.

**3**. A. Majumder, A.K. Pulhani, A. Ghosh, P. Singh and N. Maiti, Applied Radiation and Isotopes, Vol. 202, 2023, pp 111038.

# An Homage to Dr. B. Anantha Dasannacharya
# ($6^{th}$ October 1937 - February $15^{th}$ 2026)

India lost one of its most respected physicists, Dr. B. Anantha Dasannacharya, this year. Though he is no longer with us, his extraordinary contributions to condensed matter physics, nuclear instrumentations, and nation-building in research and developments continue to inspire and guide us. After completing BSc in Physics from Banaras Hindu University, he joined the Atomic Energy Establishment, Trombay, now Bhabha Atomic Research Centre, (BARC), and graduated from the first batch of the DAE Training School in Physics in 1957. He started his career in neutron instrumentation and neutron scattering with Dr P K Iyengar in 1958. He received MSc and PhD degrees by research from University of Bombay under the guidance of Dr. Raja Ramanna and teaching of PK Iyengar while working at BARC. He then worked in various positions at BARC; Scientific Officer (1958-86); Head, Nuclear Physics Division (1987-90); Director, Solid State and Spectroscopy Group (1990-96), and Additional Director, Multi-disciplinary Technology Group (1993- 1996). Following that, he served as Director of Inter University Consortium for DAE Facilities (IUC-DAEF) (now called UGC-DAE CSR), Indore during 1995-2002.

Dr. Dasannacharya had worked under Prof. Bertram Neville Brockhouse (who owned the Nobel Prize in Physics in 1994) at Chalk River Nuclear Laboratories, Canada on neutron scattering in early sixties. He also worked with Dr. T Springer as a Guest Scientist at Institute fur Festkorperforschung, Julich, Germany during 1973-75. He served as an expert in IAEA, Vienna at Philippines Atomic Research Centre (1966-67); Royal Society-INSA exchange Fellow at (then) Rutherford Appleton Laboratory and Atomic Energy Research Establishment, UK (1981), and INSA-JSPS (Japan) Exchange Fellow (1994). Significantly, the ΔT-Window spectrometer, developed at the spallation neutron source ISIS, UK under his able leadership, resulted a long-term research collaboration between BARC and ISIS.

Dr Dasannacharya contributed immensely to the growth of neutron beam research at Cirus and Dhruva reactors at BARC, Trombay by building neutron spectrometers. He strongly promoted the use of neutron beamlines at Dhruva reactor by university researchers, and was also instrumental in developing a dedicated beam line at Dhruva for this. He played an important role in the development and utilization of the synchrotron source INDUS at Indore. He was the recipient of The Homi Jehangir Bhabha Medal (1999), an elected fellow of Indian National Science Academy, and the Indian Academy of Sciences. The prestigious AONSA Prize was awarded to him in July 2013 during the International Conference on Neutron Scattering meeting in Edinburgh, UK for his pioneering contributions to neutron scattering in the Asia-Oceania region, through his early development of neutron spectroscopy and its applications for the dynamics in low-temperature liquids and molecular solids, and his active promotion of regional and international science as well as the national user program in India.

Beyond his scientific endeavours, he served as the President of Indian Physics Association during 1995-1997, and was recognized as passionate advocate for science serving society. His tireless commitment to excellence in science and indigenous development of instrumentation was a big inspiration to all of his colleagues. His contributions and mentorship qualities will be remembered for their originality and brilliance. He left a legacy that continues to illuminate India's scientific research landscape.

**Prof. S. M. Yusuf, Ph D,**
**D. Sc (hc), FTWAS, FNAE,**
**FNA, FASc, FNASc,**
**J C Bose Fellow (BARC),**
**Director, UM-DAE CEBS, *Mumbai***

# President, INS meets office bearers and EC members of INS Mysuru Chapter

Prof. V. K. Manchanda, visited Mysuru as Chief Guest and Key note speaker for Science Day celebrations at Crawford Hall, University of Mysore, on the invitation of Vice Chancellor of University. He availed the opportunity to meet the office bearers and EC members of INS Mysuru Chapter on 5 th March, 2026 at 3 P.M.

**Following were present :**
**Prof. V.K. Manchanda, President, INS**
**Shri Veeresh Kumar, M.R., President, INS Mysuru Chapter and Project Director, RMP**
**Shri Ajai, S.S., Secretary**
**Shri Nargund, I.N., Treasurer**
**Shri Ankush Roy, Member**
**Shri Aman Mathur, Member**

Secretary, Shri Ajai, SS explained eloquently about the successful programs carried out by the Mysuru Chapter during July-October, 2025. It included a Quiz Competition, an Essay Writing Competition and a Seminar.

Prof. Manchanda deeply admired the activities of chapter and requested that the initial announcement as well as the reports of the conducted programs may be sent to INS HQ for inclusion in our NL as well as INS Annual Report **(Secy, Shri Ajai, SS sent the comprehensive report of the activities of Mysuru Chapter on 7 th March, 2026).**

There was some discussion on the enrollment of new members of INS and the nature of support from HQ for the Chapter activities. President, INS informed that new membership is open and form can be downloaded from website and membership fees can be paid online. It was suggested that specific requests for support should be sent well in advance to HQ for INS-EC to deliberate on the proposal.

**Sitting from L to R : Shri Ajai, S.S., Secretary, Shri Veeresh Kumar, M.R., President, INS Mysuru Chapter, Prof. V.K. Manchanda, President, INS**
**Standing from L to R: Shri Nargund, I.N., Treasurer, Shri Ankush Roy, Member, Shri Aman Mathur, Member**

# Report on outreach program on Essay Competition in Atomic Energy Central School (AECS), Mysuru, Karnataka held on 28$^{th}$ July 2025

Indian Nuclear Society (Mysore) in association with Bhabha Atomic Research Centre, Mysuru and Atomic Energy central School (AECS), Yelwala, Mysuru organized a science related **"Essay writing competition"** on 28.07.25 in AECS school premises, for students of 6$^{th}$ & 7$^{th}$ Stds. The topics announced were **"Save Water, Save Earth"** for 6$^{th}$ Std.; **"Cleanliness drive for Swatch Bharat"** for 7$^{th}$ Std.; **"Plastic Pollution-A threat to the world ecology"** for 8$^{th}$ Std.; Total 55 students participated.

**Shri Veereesh Kumar M.R.**, President (INS, Mys Chpt.) and Project Director, BARC, Mysuru felicitated the prize winners with a memento certificates . The winners read their respective essays for the benefits of other students. The principal of AECS, Mysuru expressed his gratitude to INS, Mysuru for conducting such knowledge enriching program.

**Essay Writing Test conducted at AECS, Mysore premises on 28.07.2025**

**Prize Distribution Ceremony**

**Group Photo of Essay Writing Winners, INS (Mysore Chapter) Executive Member and Organizing team**

**Compiled by S S Ajai, Secretary INS Mysuru**

# Report on outreach program on Science Quiz in Atomic Energy Central School (AECS), Mysuru, Karnataka organized in July-August, 2025

Indian Nuclear Society (Mysore) in association with Bhabha Atomic Research Centre, Mysuru and Atomic Energy central School (AECS), Yelwala, Mysuru conducted a science related **"Quiz competition"** in two stages i.e. screening MCQ test on 28.07.25 with 40 participants and finalist six teams (two per team) live Quiz on 25.08.25 in AECS school premises, for students of 9th & 10th standards. The program began with a welcome address by AECS Principal and Introductory talk by INS Secretary followed by technical Talk on **"Radiation Awareness and Nuclear Energy Benefits"** by Dr. A.Chandrashekara, rtd OIC, Safety and Environment, Proj. SMFC BARC, Mysuru. It was followed by the live quiz event, with quiz master Shri. Ankush Roy, from INS (Mys Chapt) EC member & supported by other EC members. For audience random quiz was conducted as filler for encouraging other students.

Finally the program concluded with Shri Veeresh Kumar, President, INS (Mys Chapt) and Project Director, BARC, Mysuru honoring the Prize winners. Shri Pramod Kumar Gangadharan, Principal, AECS, Mysuru expressed his gratitude to INS, Mysore Brach and Bhabha Atomic Research Centre, Mysuru for arranging the Science Quiz Program and Essay Writing Competition and also requested for district level competition. He also opined that there is a great need for removing public misconception about nuclear energy by conducting public interaction programs. In her remarks, Smt. Dipti Srivastava V. Principal, AECS, Mysuru mentioned that the programs was beneficial and they desire to have such events every year.

**Quiz Screening Test conducted at AECS, Mysore premises on 28.07.2025**

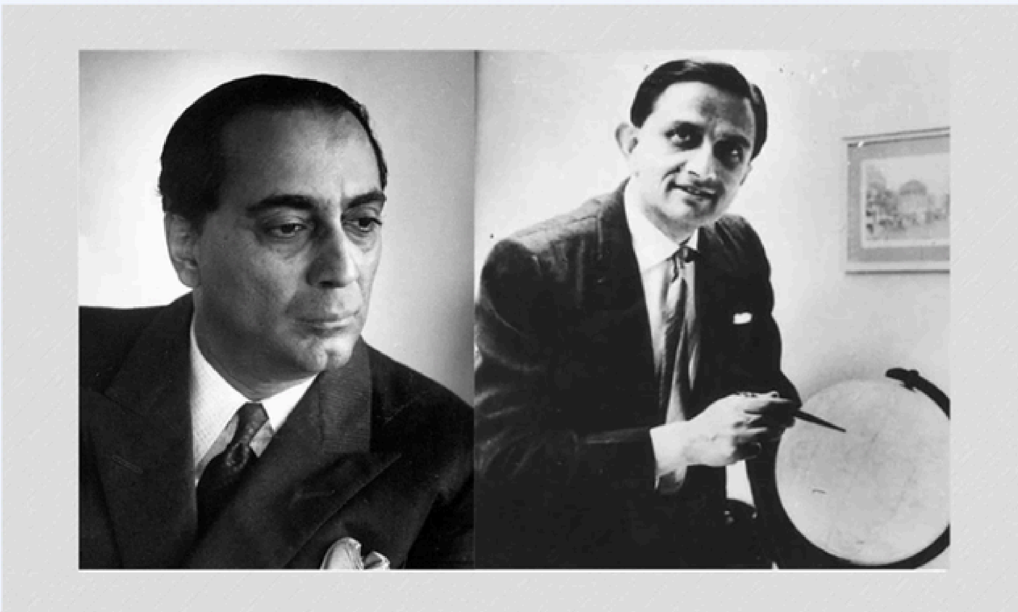
**Shri Ajai S.S., Secretary, INS (Mysore Chapter) addressing to the students during Quiz Screening Test and Essay Writing Competition**

**Some glimpses of Live Science Quiz**

**Group Photo of Science Quiz Winners, Finalist, INS (Mysore Chapter) Executive Member and organizing team**

**Shri Veeresh Kumar President, INS (Mysore Chapter) handed over thanks giving letter to Shri Pramod Kumar Gangadharan, Principal, AECS, Mysore for his valuable support for conducting program**

**Compiled by S S Ajai,**
**Secretary INS Mysuru**



## Homi Bhabha and Vikram Sarabhai, The Real 'Rocket Boys'

# Report on one - day INS seminar at Seshadripuram Institute of Technology, Mysuru

A one-day seminar was organized jointly by the Seshadripuram Institute of Technology (SITM) and the Indian Nuclear Society (INS), Mysuru Chapter on 15th October, 2025. The event brought together eminent scientists, academicians and students to deliberate on the theme of "**Applications of Nuclear Energy and Radiation".**

The Seminar was organized with the objective of highlighting the **peaceful and beneficial uses of nuclear science for societal development.** The discussions focused on how nuclear radiation, when applied safely and within regulated limits, contributes to the progress in **healthcare, industry, food preservation and agriculture.**

The seminar was inaugurated with the unveiling of a functional model of a nuclear reactor by **Shri. Anantharam B A., Chairman, Governing Council**, Seshadripuram Institute of Technology, Mysuru.

The event took off with **introductory remarks by Shri Ajai S. S., Secretary, INS Mysuru Chapter**, outlining its objectives and significance in the current energy scenario and the inaugural address by **Chief Guest Shri Dinesh Babu R., Associate Director (P), Ch.TG, BARC, Mumbai**, emphasizing the **importance of energy generation with reduced carbon emissions & Shri Veeresh Kumar M. R., Project Director, BARC, Mysuru and President, INS (Mysuru Chapter)**, highlighted the role **of nuclear energy in nations' progress.**

The technical session began with a **Keynote Address** on **"Application of Radiation for Societal Welfare,"** by **Dr. Ramamoorthy**, Outstanding Scientist, Ex-Associate Director, BARC; Ex-Chief Executive, BRIT; and Ex-Director (Physical & Chemical Sciences, Department of Nuclear Applications , IAEA ). Followed by other presentations by **Shri Ankush Roy,** BARC, Mysuru, on **"Fundamentals of Atomic Nucleus,"**, **Shri Malay Ghosh**, BARC, Mysuru, on **"Radiation Protection"**, **Dr. C. Ningappa**, Professor of Physics, SIT &EC member **"Radiation in Indoor Environment"** The final technical session from **Shri Ajai S. S.**, BARC, Mysuru & Secretary, INS (Mys Chapt) on **"An Overview of India's Decarbonisation Mandate to Meet Net Zero."** & **Smt. Mohini Gupta**, BARC, Mysuru, with an inspiring talk on **"Career Opportunities in DAE,"** providing students with valuable insights into various career prospects within the Department of Atomic Energy.

The session concluded by highlighting the presence, measurement and mitigation of natural background radiation in living spaces. Overall, the seminar served as an effective **platform for researchers, faculty members and students** to share knowledge, explore recent advancements and engage in meaningful discussions on the applications of nuclear energy and radiation for societal welfare.

Explaining working of a nuclear reactor with a model

Poster Presentation

Release of Seminar booklet

Presentation by Secretary INS Mysore Chapter

Presentation of Certificate to winners

Compiled by S S Ajai,
Secretary INS Mysuru

# Report on NE & CM - 2026 Conference on NUCLEAR ENERGY AND CRITICAL MINERALS: EXPLORATION, MYTHS AND SOCIETAL IMPACT held on $24^{th}$ and $25^{th}$ February 2026 in University of Punjab,Bathinda

The national conference entitled "Nuclear Energy and Critical Minerals : Exploration, Myths and Societal Impact" (NE&CM-2026) was convened on February $24^{th}$ and $25^{th}$, 2026, at the Central University of Punjab (CUP), Bathinda. It was organized through a highly strategic institutional collaboration involving the Indian Nuclear Society (INS), Mumbai, Atomic Minerals Directorate for Exploration and Research (AMD), Hyderabad and Anusandhan National Research Foundation (ANRF) New Delhi. The event represented a critical intersection of high-level scientific research, legislative policymaking and regional civil administration. The two-day conference included structured technical sessions, extensive doubt clarification dialogues, interactive student placard competitions and a massive participation in an attractive public walkathon.

The overarching strategic context of NE&CM-2026 was rooted in the unprecedented expansion of India's energy sector. The nation is currently navigating a complex, dual-mandate mission : sustaining accelerated trajectory of industrial and economic growth while simultaneously honouring binding international commitments to achieve "Net Zero" carbon emissions by the year 2070. The foundational premise for establishing the conference's relevance was with reference to the inherent intermittency of renewable energy sources such as solar and wind power. While crucial to the ecological transition, renewable energy lack the capacity to provide the continuous, uninterrupted base-load power required to drive a massive, rapidly industrializing economy. Consequently, advanced nuclear energy technologies, coupled with the secure, sovereign acquisition of critical minerals, the essential building blocks for modern clean energy infrastructure have been elevated to the status of priorities important for national security.

The conference was attended by over 200 delegates who were addressed by assemblage of distinguished scientists from the:

1. Indian Nuclear Society, Mumbai
2. Central University of Punjab, Bathinda
3. Bhabha Atomic Research Centre (BARC) , Mumbai
4. Post Graduate Institute of Medical Education & Research (PGIMER) , Chandigarh
5. Atomic Minerals Directorate for Exploration and Research (AMD), Hyderabad
6. Gujarat Mineral Development Corporation (GMDC) , Ahmedabad
7. Central University of Jammu, Jammu
8. Guru Kashi University, Punjab
9. Lovely Professional University , Punjab

Leading academicians, domain experts, and local administrators participated in this event. Beyond the highly technical deliberations regarding basic Nuclear Chemistry , reactor physics , geological exploration and mineral beneficiation, a core mandate of NE&CM-2026 was the sociological imperative to bridge the chasm between high-level scientific research and public understanding. The event sought to actively dismantle entrenched, historically pervasive myths surrounding radiation by illuminating talks on profound societal applications of nuclear technology in non-power sectors such as agriculture, oncology and hydrology.

**The following talks were delivered by**

| SPEAKERS | TOPICS |
|---|---|
| Prof. V.K. Manchanda (President, INS) Former BARC | 1) "Journey of Indian Atomic Energy Program of Seven Decades and the Role of INS" 2) "The Nuclear Fuel Cycle and Thorium as an Abundant Source of Nuclear Energy". |
| Dr. Debabrata Datta, Member INS Former NPCIL, | "National Nuclear Mission and Relevance of SMRs" |
| Shri M.K. Mathur, Member INS, Former NPCIL, | "Safety of Nuclear Power Plants and Impact of SHANTI Act 2025 on Indian Nuclear Program" |
| Shri Shaker Gupta, SO/G, AMD, Jaipur, | "Augmentation and Development of Atomic and associated Critical Mineral Resource: A pathway to empower India's Energy Future and Net Zero Goals". |
| Shri K.L. Mundra, Former AMD | "Self-Reliance in REEs for Atmanirbhar Bharat: My Perspective" |
| Dr. Hrishikesh Mishra, Member INS, Former BARC, | "Nuclear Waste to Wealth: Strategic Management and Career Pathways in DAE" |
| Dr. S. Gangotra, Member INS, Former DAE, | "Nuclear Energy and Net Zero Carbon Emission" |
| Dr. Ankit Watts, PGIMER, Chandigarh, | "Nuclear Medicine: Redefining Diagnosis and Therapy" |
| Dr. Shraddha Singh, SO/G, BARC | "Nuclear Agriculture" |
| Shri R.K. Singh, Jt Treasurer, INS, Former BARC, | "Nuclear Energy in Daily Life" |
| Shri Devendra Verma, GMDC, Ahmedabad | "Strategic Development of Rare Earth and Critical Mineral Deposits in India: Geological Potential, Processing Constraints, and Pathways to Net Zero Resource Security" |


**Conference Inaugural session**


**Chief Guest, Conference Speakers and Organisers**

**In preparation for Walkathon**


**Display of Posters and Walkathon**

**Compiled by Prof Smeer Durani.**
**Professor of Practice,**
**Convenor, NE&CM-2026,**
**Central University of Punjab**

# Report on Webinar on "The Legislative Framework for Nuclear Energy in India" by Prof. R.B. Grover, Member, AEC

The webinar commenced with a welcome address by **Shri S.K. Bhatia, Secretary, INS**, who warmly welcomed the **Guest of Honour**, the **Speaker**, Executive Committee (EC) members, Life Members of INS, and participants joining both in person and through the online platform.

This was followed by the address from **Prof. Manchanda, President, INS**, who outlined the objectives and key activities of the Indian Nuclear Society (INS) and provided a brief overview of the webinar, including an introduction to the eminent guests. He also paid tributes to the two doyens of Indian Atomic Energy , Dr. M.R. Srinivasan and Dr. R.C. Chidambaram who played very significant roles in mentoring INS in its years of infancy.

The programme was coordinated by **Dr. H. Mishra, Member, EC, INS.** The **Guest of Honour, Shri A.K. Balasubrahmanian, Chairman, AERB**, and the **Speaker, Dr. R.B. Grover,Member, Atomic Energy Commission,** were formally felicitated by the Secretary, Treasurer and EC members of INS with mementos, shawls and plant saplings.

On this occasion, the INS Newsletter (October – December 2025 issue) was formally released by the eminent guests. The dedicated efforts of **Dr. A. Rama Rao, EC, INS** (Editor, INS Newsletter), along with the members of the Editorial Board, were duly acknowledged and appreciated.

The eminent guests were formally introduced by **Dr. Archana Mishra, Member, EC, INS**. In his address, the **Guest of Honour, Shri A.K. Balasubrahmanian** , shared insightful views on the pivotal role of INS in promoting awareness about nuclear science and technology and highlighted its increasing relevance in the present national and global context.

Subsequently, **Dr. R.B. Grover** delivered an in - depth lecture on " The Legislative Framework for Nuclear Energy in India." He elaborated on the **SHANTI Act (Sustainable Harnessing and Advancement of Nuclear Energy for Transforming India Act, 2025)**, describing it as a landmark reform that consolidates regulation, enforcement, civil liability and dispute resolution into a single statutory framework. He emphasized that while the Act enables private sector participation in the construction and operation of nuclear power plants, the core responsibilities continue to remain with the Central Government. He further highlighted the clear distinction between licensing to establish a nuclear facility by Government of India (Department of Atomic Energy) and authorisation to operate it safely by AERB, a statuary body under SHANTI act. The lecture comprehensively covered the key provisions, safety, security and safeguards, and implications of the SHANTI Act, underscoring India's commitment to responsible management of nuclear facilities.

The presentation was followed by an interactive **question and answer session**, coordinated by **Dr. H. Mishra, Dr. S. Gangotra and Prof. Indira Priyadarshini** during which the speaker addressed a large number of queries raised by participants attending both physically and online.

The webinar was highly appreciated by the participants, with **45 attendees participating in person and 101 participants joining online**, reflecting strong engagement and interest in the subject.

The online transmission and technical coordination of the webinar were efficiently managed by **Shri S. K. Sinha, Member, EC, INS**, ensuring the smooth conduct of the programme.

The programme concluded with a **Vote of Thanks** proposed by **Dr. H. Mishra**, who expressed sincere gratitude to the Guest of Honour and the Speaker for their valuable time and insightful contributions, as well as to the organizers, INS EC/INS Life Members and participants for the successful conduct of the webinar. The event formally concluded with the **National Anthem.**


**Compiled by Dr. Archana Mishra**
**INS Member**

# *Report on Seminar on "An Overview of the Canadian Nuclear Energy Program" by Prof. S. Sriram University of Toronto, Canada.*

On an invitation by INS President, Prof Sriram Suryanarayan gave a talk on Canadian Nuclear program to INS members on 9th February 2026. Large number of INS members attended the seminar. Prof. S Sriram is a Canadian Citizen presently working as Director, Innovation, Kinectrics Inc., Etobicoke, Ontario, Canada and holds a post of Adjunct Professor at University of Toronto. He did his Ph.D. at BARC with Prof. Manchanda as his supervisor in early nineties.

Dr H. Mishra welcomed the speaker and introduced him to the members. President, INS in his opening remarks highlighted the past collaboration between India and Canada that resulted in setting up of CIRUS research reactor in BARC and the first two PHWRs in Rawatbhata. He also mentioned about the tradition of INS to invite eminent speakers to give talk on nuclear energy.

Before the talk, the speaker was felicitated by INS members Dr D. Datta and Shri K.T.P. Balakrishnan. Prof Sriram was actually on visit to India to attend SESTEC-2026 on 11-14th February in IGCAR, Kalpakkam. In his talk Prof. Sriram gave a brief historical development of Canadian Nuclear program from mid-1940's and recounted the contributions of Harriet Brooks (early radioactivity researcher), Wilfred Bennett Lewis (father of CANDU reactors), Nobel laureate Art McDonald (neutrino research), Harold Johns (cobalt-60 therapy), George Laurence (early nuclear reactor research), Louis Slotin, Bert Brockhouse (neutron scattering) etc.

He traced back the roots of Canadian Nuclear Program starting from pioneering research at Chalk River Lab in 1940s and later on the development of the CANDU reactor, which established Canada as a leader in heavy-water technology for peaceful use of nuclear energy. In view of limited uranium in our mines, India adopted the CANDU design to suit closed nuclear fuel cycle involving reprocessing of spent fuel of PHWR.

He mentioned about Canada entering a new phase of nuclear expansion, advancing multicycle refurbishments, launching new projects, deploying Small Modular Reactors (SMRs), investing in the long term development of Gen IV fission reactors, nuclear fusion concepts and novel method of producing medical isotopes in the core power plants. He further talked about the contribution made by his firm M/s Kinectrics in developing inspection tools for the nuclear program. He expressed his company's interest in collaborationg with INS for mutual benefit, especially in the field of training and journal publication.

The talk generated lot of interest in the participants, who were very inquisitive to know about the Canadian program and mutual exchange of information. The talk was followed by Q & A session and concluded with a Vote of Thanks by Dr Mishra. The program ended with National Anthem.



*Compiled by Dr. H Mishra*
***INS, Member***

# Report on INS Theme Meeting on "National Target of 100 GWe Nuclear Energy by 2047"

After a push was given by Government of India by the way of Nuclear Energy Mission of 100 GWe by 2047, INS considered it important to organize a meeting to address the private industry in India about the important nuclear technology, commitment and managerial responsibilities in running a Nuclear plants. This became more important after SHANTI act came into existence in December 2025. After a thorough planning among INS members, a Theme Meeting titled "National Target of 100 GWe Nuclear Energy by 2047 "was organised on 18th and 19th February, 2026 in Mumbai to share broad knowledge and experience about Nuclear power, Nuclear Fuel Cycle, Regulatory and Legislative frame work with the professionals proposing to join the Nuclear Industry from the government and private sectors. Around 35 professionals from the industries participated in the theme meeting. The talks were delivered by domain experts selected from Industry and DAE units.

The theme meeting started with Convener Shri KU Agarwal, welcoming all participants to the meeting on behalf of the organizing team of INS. This was followed by opening remarks by INS President Prof. V.K.Manchanda. The Chief Guest Shri Bhuwan Chandra Pathak, Chairman NPCIL inaugurated the event and delivered the keynote address by stressing the importance and relevance of the theme meeting and the role to be played by NPCIL and the government sector in piloting this mission to the intended goal. Dr D. Datta, Co-convenor, delivered the Vote of Thanks.

The meeting also had an interactive session which was moderated by Shri K U Agrawal. Specific industries who desired to briefly speak were invited to put their point in the context of nuclear mission.

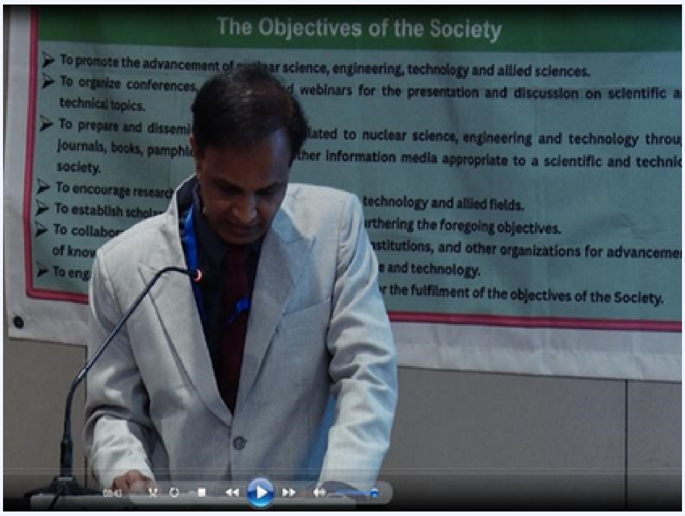
Many spoke on "Concerns and Challenges in partnering to build nuclear power plants. Dr Anil Parab, Whole-time Director and Sr Executive Vice President (Heavy Engineering), L&T. delivered a special talk in the session acknowledging the freedom granted by SHANTI Act 2025 in the light of nuclear mission of 100 GWe in terms of clarity for industry to gear-up to partner in the mission. He was optimistic about the mission and felt that it will take some time to see changes on the ground.

On 19th February, a panel discussion was organized with the participation of Industry, Nuclear professionals and regulators. The topic for the discussion was "Aspirations and Expectations of Indian Industries". The panellists were Dr R B Grover (Panel Chair), Shri S.A. Bhardwaj, Shri R. Sharan, Shri Raghavan and Dr D.K. Shukla. The session was initiated by Dr A. Rama Rao, INS EC Member. After an hour long deliberations on nuclear plant management, regulatory boundaries, role of PSU and private nuclear expansion, nuclear fuel cycle and operational challenges, Panel Chair gave his concluding remarks. He conveyed that clarity on safety clearance and licensing guidelines are under preparation and it could take 6 months to 1 year time to know the details. He responded to many questions flagged by industry on regulatory approvals during pre-project stage. He observed that while India will need large plants for speedy addition of clear power to the grid, SMR could play a stabilizing role for power grid connected to major renewables like solar plants. The theme meeting ended with national anthem.

**The important topics selected & speakers are listed below.**

| Sno. | Topics | Speakers |
|---|---|---|
| 1 | The legislative framework for nuclear energy in India | Dr RB Grover, Member, AEC |
| 2 | Indian Nuclear Power Programme - Journey So Far | Shri Mukesh Singhal, Former CMD(in-charge), NPCIL |
| 3 | Nuclear Reactor Technology - Relentless Commitment to Quality, Reliability and Safety | Shri Sameer Hajela, ED(RSA), NPCIL |
| 4 | Operational Priorities and Challenges involved in NPPs. | Shri Sanjay Mulkalwar, Former Site Director, TAPS |
| 5 | Overview of NPP Project Management | Shri Ranjay Sharan, Former Director (Projects) NPCIL, President(Nuclear), Reliance Industries Ltd. |
| 6 | Nuclear Fuel Cycle | Shri S.A. Bhardwaj,<br>Former Chairman, AERB<br>Former CMD(in-charge), NPCIL |
| 7 | Nuclear Power Expansion and the role of PSUs and Private Industry | Shri R Raghavan,<br>VP & Head, Power Business, TCE |
| 8 | Role of Small Reactors and SMRs | Dr A.K. Nayak,<br>Former Head, NCPW, DAE |
| 9 | Siting of NPPs including SMRs | Shri Arvind Srivastava<br>Ex-AD(Civil), NPCIL |
| 10 | Regulatory Framework and Safety of NPPs | Dr D.K. Shukla,<br>Former Chairman, AERB |


Indian Nuclear


The Objectives of the Society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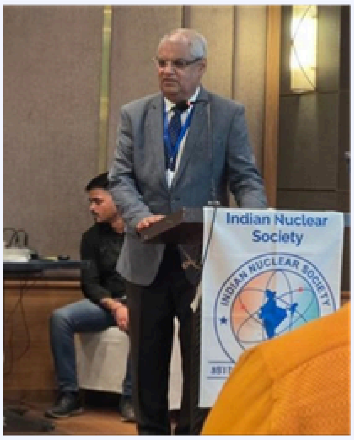


**Compiled by Dr. Debabrata Datta**
**INS Member**

# Report on Republic Day Celebrations 2026


Republic Day was celebrated in Indian Nuclear Society (INS) premises at Project Square, Anushakti Nagar on 26th January, 2026 at 10:30 A.M. in association with Atomic Energy Retirees Welfare Association (AERWA). Secretary, INS welcomed the gathering. National Flag was unfurled by the President, INS followed by singing of national anthem. In his brief address, the President paid tribute to the freedom fighters that made supreme sacrifice for the nation. He also remembered Dr. Homi Bhabha and other distinguished scientists like Dr. K.S.Krishnan and Dr. S.S.Bhatnagar, members of the first Atomic Energy Commission, who laid strong foundation of the Atomic Energy Program in India.

President AERWA in his address gave a brief account of the activities of association and highlighted its work related to Digital Life Certificate of pensioners and C.H.S.S. issues. He informed that AERWA is recognized by DOPPW and receives financial support for some of its activities. Secretary AERWA proposed the vote of thanks. Program ended with singing of national song (Vandhe Mataram). INS would like to thank the members for participation and EC members for the excellent arrangements.


Republic Day Celebrations 2026

1). A Historic First: NRC Clears TerraPower's Natrium Nuclear Reactor for Construction.
The Nuclear Regulatory Commission (NRC) on March 4 authorized staff to issue a construction permit for TerraPower's Kemmerer Power Station Unit 1 in Kemmerer, Wyoming the first commercial reactor the agency...

https://www.powermag.com/a-historic-first-nrc-clears-terrapowers-natrium-nuclear-reactor-for-construction/?utm_source=omeda&utm_medium=email&utm_campaign=pwrnews+eletter&oly_enc_id=1950A0974023F5V

2). NRC Approves New Approach to Streamline Advanced Reactor Licensing Process

https://www.energy.gov/ne/articles/nrc-approves-new-approach-streamline-advanced-reactor-licensing-process

3). Building Now For What Comes Later: How Nuclear Fits Into the Grid's Next Decade
Ten years ago, utilities could plan for new 100-megawatt (MW) load requests. That size of energy load fit inside existing forecasts: it could be absorbed, modelled and planned around. Today,...

https://www.powermag.com/building-now-for-what-comes-later-how-nuclear-fits-into-the-grids-next-decade/?utm_source=omeda&utm_medium=email&utm_campaign=pwrnews+eletter&oly_enc_id=1950A0974023F5V

4). Beyond Reactors: The Full Fuel Cycle Investment Needed for a Nuclear Future
A resurgent nuclear industry cannot succeed unless the U.S. invests in the entire nuclear fuel cycle from uranium mining to long-term waste storage. Without strengthening this industrial backbone, nuclear power's potential may remain more aspiration than reality.

https://www.powermag.com/beyond-reactors-the-full-fuel-cycle-investment-needed-for-a-nuclear-future/?utm_source=omeda&utm_medium=email&utm_campaign=pwrnews+eletter&oly_enc_id=1950A0974023F5V

5). How Radiation Dosimetry Supports Safe Medical Care.
Radiation therapy is one of the most effective treatments for many kinds of cancer, helping to destroy tumours and save lives. Because these treatments use high-energy radiation directed at specific parts of the body, accuracy is critical regardless of how small the dose is...

https://www.iaea.org/newscenter/news/how-radiation-dosimetry-supports-safe-medical-care

6). Battery Storage Comes of Age: From Grid Accessory to Essential Infrastructure
From plunging costs to policy upheaval, the global battery storage sector is transforming grid design and facing unprecedented challenges. The energy storage industry stands at a pivotal crossroads. On one side,...

https://www.powermag.com/battery-storage-comes-of-age-from-grid-accessory-to-essential-infrastructure/?utm_source=omeda&utm_medium=email&utm_campaign=pwrrenewable+eletter&oly_enc_id=1950A0974023F5V

7). Research aims to bring MSRs closer to commercialisation.
Researchers from the University of Liverpool and Copenhagen Atomics say that salt purity is the critical factor in preventing corrosion of stainless steel in molten salt reactors. Meanwhile, irradiation testing of materials for such reactors has begun at the High Flux Reactor in the Netherlands

https://www.world-nuclear-news.org/articles/research-aims-to-bring-msrs-closer-to-commercialisation

8). Cameco uranium agreement a highlight of Canada-India deals
One of the more significant deals is a long-term agreement that would supply nearly 22 million pounds of Canadian uranium concentrate (U3O8) to India's burgeoning nuclear reactor fleet over the next decade.

***https://www.ans.org/news/2026-03-06/article-7823/cameco-uranium-agreement-a-highlight-of-canadaindia-deals/***

9). US micro-reactor transported by air
A Valar Atomics micro-reactor has been transported on a US Air Force cargo plane from California to Utah and will eventually be moved to the Utah San Rafael Energy Lab for testing and evaluation. Part of the Reforming Nuclear Reactor Testing in the Department of Energy executive order signed by President Donald Trump in May, its goal is "to construct, operate, and achieve criticality of at least three test reactors using the DOE authorisation process by 4 July, 2026"……

***https://www.world-nuclear-news.org/articles/us-microreactor-transported-by-air***

10). Nuclear energy: France to host the second world summit on civil nuclear energy.
10 March 2026
On 10 March 2026, France will host the second world Nuclear Energy Summit, in close liaison with the International Atomic Energy Agency (IAEA). Heads of State and Government, leaders of international organizations and financial institutions, industrial actors and experts will discuss the role of civil nuclear energy in addressing major energy and climate challenges.

***https://www.diplomatie.gouv.fr/en/french-foreign-policy/economic-diplomacy-foreign-trade/world-nuclear-energy-summit-10-march-2026/***

11). Copenhagen Atomics secures thorium supply from Norway
Friday, 20 February 2026
Denmark's Copenhagen Atomics has signed a Letter of Intent with Rare Earths Norway to secure future access to thorium - the key fertile material in its molten salt reactor technology - extracted from the Fensfeltet deposit in Norway.

***https://www.world-nuclear-news.org/articles/copenhagen-atomics-secures-thorium-supply-from- norway***

12). The EU has outlined plans to deploy small modular reactors (SMRs) and advanced modular reactors (AMRs) by the early 2030s to support climate targets, energy security and industrial growth.

***https://www.innovationnewsnetwork.com/eu-strategy-to-rapidly-deploy-small-and-advanced- modular-reactors/67559/***

13). Canada's first-mover advantage in SMRs faces growing geopolitical risks:
Pessimism is growing concerning Canada's ability to capitalize on its first-mover advantage in deploying small modular reactors. Few in Canada's nuclear sector are willing to publicly acknowledge the strategic missteps that now threaten the country's ability to turn its SMR leadership into international project sales.

***https://macdonaldlaurier.ca/canadas-first-mover-advantage-in-smrs-faces-growing-geopolitical-risks-jeff-kucharski-for-inside-policy/***

14). NuScale Power expands Framatome partnership to supply SMR fuel globally
The move aims to support NuScale's global deployment strategy for its small modular reactor technology.

***https://mugglehead.com/nuscale-power-expands-framatome-partnership-to-supply-smr-fuel- globally/***

**Compiled by Dr. A. Rama Rao,**
**INS member**