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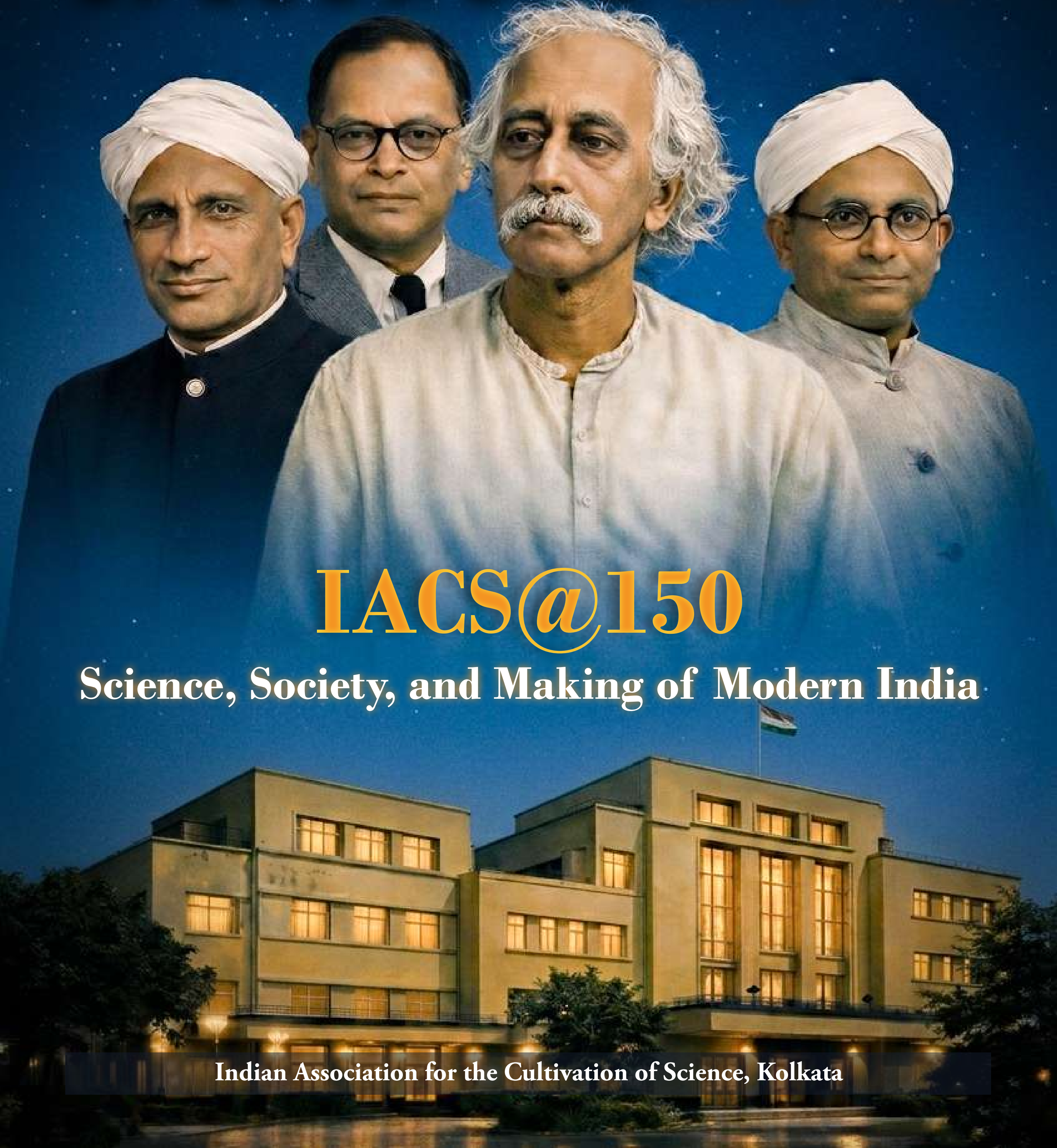
DREAM 2047



IACS@150

Science, Society, and Making of Modern India

Indian Association for the Cultivation of Science, Kolkata

Contents

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FROM THE CHIEF EDITOR'S DESK

A. Dhanalakshmi

Joint Secretary
Department of Science & Technology
Government of India

The celebration of 150 years of the Indian Association for the Cultivation of Science marks an important moment for reflection as well as pride within India's scientific community. Established in 1876 through the vision of Dr. Mahendra Lal Sircar, IACS emerged in an era when organised scientific research in India was still in its infancy. The institution was created with a bold purpose to provide a space where science could be practiced, taught, and advanced within the country, nurturing confidence in Indian scientific capability. Over the decades, IACS has grown into an enduring symbol of how institutions built on vision and perseverance can influence generations of scholars and contribute meaningfully to the evolution of science in India.

The legacy of IACS is closely linked with some of the most significant milestones in modern scientific history. It was within these halls that Sir C. V. Raman carried out the research leading to the discovery of the Raman Effect in 1928, a breakthrough that earned him the Nobel Prize in Physics in 1930 and brought international recognition to Indian science. The institution also provided an intellectual environment that resonated with the work of remarkable scientists such as Jagadish Chandra Bose, Satyendra Nath Bose, and Meghnad Saha, whose ideas shaped modern physics and influenced scientific thought far beyond national boundaries. As one walks through the IACS campus, a stone inscription bearing the words of C. V. Raman, "Science is the highest form of creative art" captures the spirit of the institution. It serves as a reminder that science is driven not only by discipline and precision but also by imagination and the courage to explore the unknown.

As Chief Editor of this special commemorative edition, I feel privileged to be part of a moment that honours a century and a half of scientific pursuit and institutional legacy. The foresight of the founders and the dedication of successive generations who built and sustained IACS reflected an ability to think beyond the constraints of their time and to imagine a future where India would stand confidently among the world's top most scientific nations. This edition seeks to celebrate that journey to recognise exemplary achievements, acknowledge the contributions of renowned scientists, and inspire young minds who will shape the future of science in the country. As we mark IACS@150, we do so not merely to celebrate the past but to renew our commitment to the values that have sustained this institution's curiosity, perseverance, and excellence. The legacy entrusted to us calls upon each generation to aim higher, think boldly, and carry forward the spirit of scientific endeavour in service of society and humanity.

EDITOR'S NOTE

Dr Kinkini Dasgupta Misra
Scientist-F, Indian National Science Academy
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There are moments in the life of an institution when looking back becomes inseparable from looking forward. The completion of 150 years of the Indian Association for the Cultivation of Science (IACS) is one such moment. This special issue has been conceived not merely as a commemoration, but as an invitation to revisit a remarkable scientific journey and to reflect on why that journey still matters today.

When the Indian Association for the Cultivation of Science (IACS) was founded in 1876, India was still under colonial rule and opportunities for scientific research were scarce. Modern science largely existed within institutions meant for administration or teaching rather than original inquiry. The founders of IACS envisioned an institution shaped by Indian initiative where science could be pursued through curiosity, experimentation, and intellectual independence.

The emergence of IACS was closely linked to a wider intellectual awakening in nineteenth-century India. Reformers and public intellectuals such as Bankim Chandra Chattopadhyay, Keshab Chandra Sen, and Ishwar Chandra Vidyasagar stimulated debates on the role of knowledge in shaping a modern society. Through their writings, educational reforms, and public engagement, they encouraged Indian participation in modern science. Many among them also emphasized the need to nurture an indigenous scientific tradition, seeing scientific advancement as part of the intellectual foundations of the emerging national movement.

From the beginning, IACS developed a distinctive identity through its commitment to research in the basic sciences. At a time when colonial education largely emphasized examination-oriented learning, the institution chose to invest in foundational disciplines such as physics, chemistry, and mathematics. This emphasis on fundamental inquiry helped shape an intellectual culture that valued curiosity-driven research and long-term scientific thinking.

Over the decades, the laboratories and research environment at IACS nurtured many scientists who went on to become leading names in Indian science, contributing significantly to national and global scientific progress. The institution's legacy demonstrates how sustained support for basic research can create generations of influential scholars and researchers.

Across its long history, IACS has witnessed profound transformations, from colonial rule to independence and from modest beginnings to the growth of India's scientific infrastructure. Yet its central idea has remained remarkably constant: that science flourishes when inquiry is guided by intellectual freedom and sustained commitment to research. Even as the institution evolved with changing times, it remained anchored to this core purpose, continuing to nurture rigorous scientific exploration across disciplines.

Why, then, a special issue now? Because the questions that shaped the early years of Indian science remain relevant in our own time. We live in an era defined by rapid technological change and complex scientific challenges, where the need for critical thinking and scientific temper is greater than ever. Revisiting the story of IACS allows us to understand how scientific culture is built, not only through discoveries, but through institutions that create environments for learning, collaboration, and persistence.

This issue brings together multiple perspectives on that journey. It explores the intellectual climate that shaped scientific institutions in nineteenth-century India, the evolution of research traditions, and the contributions of scientists associated with IACS whose work helped shape modern Indian science. Rather than presenting history simply as a sequence of achievements, this issue highlights science as a living process shaped by ideas, people, and sustained collective effort.

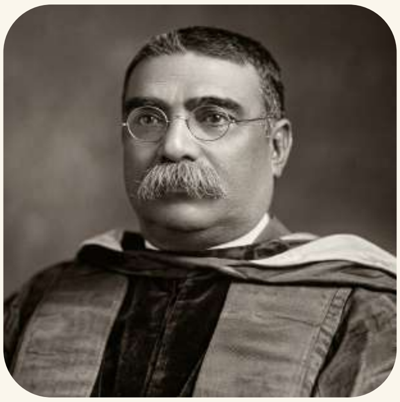
For today's readers–students, researchers, teachers, and curious minds, this special edition offers more than reflection. It shows how institutions grow through vision and patience, how research cultures evolve, and how foundational science continues to influence the future. The story of IACS reminds us that science is not only about results, but also about the environments that nurture curiosity and sustained inquiry.

From Vision to Legacy: The Makers of IACS


Dr. Mahendra Lal Sircar


Amrita Lal Sircar


Sir C. V. Raman


Ashutosh Mukherjee


Bankim Chandra Chatterjee

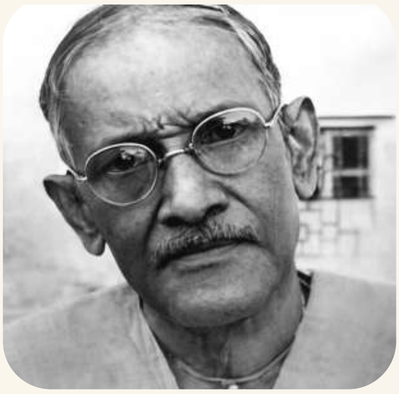

Father Eugène Lafont


Meghnad Saha


Jagadish Chandra Bose


K. S. Krishnan


Satyendra Nath Bose


Priyadaranjan Ray


Prafulla Chandra Ray

प्रो. अभय करंदीकर
Prof. Abhay Karandikar

सचिव
भारत सरकार
विज्ञान एवं प्रौद्योगिकी मंत्रालय
विज्ञान एवं प्रौद्योगिकी विभाग
Secretary
Government of India
Ministry of Science and Technology
Department of Science and Technology

27th February, 2026

MESSAGE

The completion of 150 years of the Indian Association for the Cultivation of Science (IACS) marks an important milestone in the evolution of scientific research and culture in India. Founded in 1876 through the visionary efforts of Dr. Mahendra Lal Sircar, IACS was built on the conviction that scientific knowledge must be generated within India through experimentation, critical inquiry, and intellectual independence. At a time when organised scientific research opportunities were limited, the institution created an environment where Indian scholars could engage directly with experimental science and cultivate confidence in indigenous scientific capability. The very idea of the "cultivation of science" reflected a deep understanding that scientific progress grows through sustained effort, collaboration, openness to ideas, and academic freedom. Over the decades, IACS has remained true to this spirit, adapting to changing scientific priorities while preserving its commitment to fundamental inquiry.

IACS occupies a distinguished place in the history of modern science in India. During the pre-independence period, research carried out at the institution demonstrated that rigorous experimental science could flourish within the country at globally comparable standards. The pioneering work of Sir C. V. Raman, culminating in the discovery of the Raman Effect, brought international recognition to Indian science, while the intellectual contributions of Satyendra Nath Bose, Meghnad Saha, and Professor Amal Kumar Raychaudhuri left lasting imprints on modern physics, astrophysics, and cosmology. Following independence, IACS continued to strengthen national scientific foundations through its unwavering dedication to basic research and through the mentoring of generations of scientists who went on to contribute across universities, national laboratories, and strategic research programmes. Today, while maintaining its strong base in fundamental science, the institution has expanded into interdisciplinary and emerging areas such as quantum science, advanced materials, nanoscience, energy and sustainability research, molecular and chemical biology, soft matter, and computational sciences, helping bridge discovery-driven research with outcomes of national relevance.

Equally significant is IACS's role in education and human resource development through rigorous doctoral training and research-led learning that nurtures young scientific talent. As an autonomous institution under the Department of Science and Technology and a deemed university dedicated to advanced research and higher learning, IACS continues to contribute to knowledge creation, research excellence, and national capacity building.

It gives me immense pleasure to present this special commemorative edition of Dream 2047 marking the 150th anniversary of IACS, an institution whose legacy has shaped scientific thought in India while inspiring future generations. As we look ahead, strengthening institutions grounded in scientific rigour and intellectual integrity remains essential, for they represent our investment in people, ideas, and discoveries that will shape the next chapter of Bharat's scientific journey.

(Abhay Karandikar)

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A Legacy of Science
Positioning India in the Global Leadership

Dr Renu Swarup
Former Secretary to Government of India
Department of Biotechnology
Ministry of Science & Technology
Chairperson, IACS and President, IACS–Society

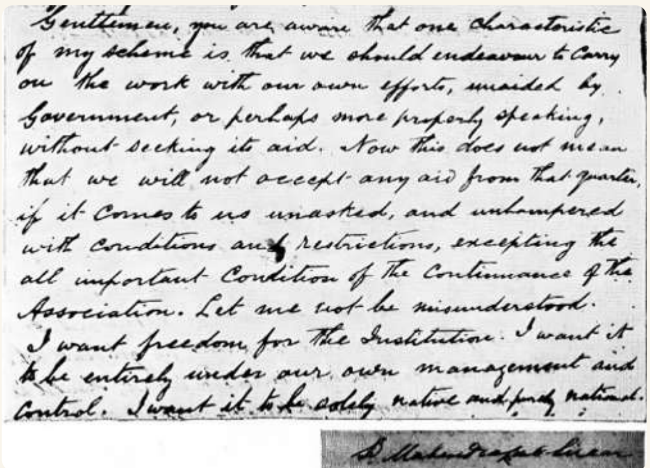
India's scientific strength, which today is moving at an exceptional pace, has its foundation in the legacy of science built in the portals of the first global-level Science & Technology institute established in India in 1876, The Indian Association for the Cultivation of Science (IACS). The objective of the Association was, and still remains, "to cultivate science in all its departments both with a view to its advancement by original research and to its varied applications to the arts and comforts of life."

The founder of IACS, Dr. Mahendralal Sircar, a pioneering nineteenth -century Bengali physician, social reformer, and champion of scientific education in India, was among the first to perceive that India would greatly benefit from scientific excellence and that scientific interventions would play an important role in shaping societal development. At that time in the early nineteenth century, there was a pressing need to establish an institute of excellence that would allow Indian scientists to pursue scientific research independently.

Dr. Sircar was also very clear that if a strong foundation of science was to be established in the country, it was imperative that a culture of science and scientific teaching be introduced early in schools. His desire and vision in establishing IACS was that it should be an institute that focused both on science learning and science teaching. What was needed was an institution that would create mass interest in science and train scientists capable of undertaking original research. This vision was inspired by institutions such as the Royal Institution of Great Britain and the British Association for the Advancement of Science.

The Indian Association for the Cultivation of Science (IACS) has a rich heritage. Established on 29 July 1876, the institute was founded to cultivate and encourage creativity and innovation in the natural sciences. Regarding the branches of science to be pursued, the initial focus was on **General Physics, Chemistry, Astronomy, Systematic Botany, Systematic Zoology, Physiology and Geology**.

The visionary Dr. Sircar observed that General Physics and Chemistry constituted the backbone of science. The claim of astronomy was based on recent discoveries through spectroscopy. The importance of the life sciences, Botany, Zoology and Physiology, hardly needed to be over-emphasized.


Gentlemen, you are aware that one characteristic of my scheme is that we should endeavour to carry on the work with our own efforts, unaided by Government, or perhaps more properly speaking, without seeking its aid. Now this does not mean that we will not accept any aid from that quarter, if it comes to us unasked, and unhampered with conditions and restrictions, excepting the all important condition of the continuance of the Association. Let me not be misunderstood. I want freedom for the Institution. I want it to be entirely under our own management and control. I want it to be solely native and purely national.

Dr. Mahendra Lal Sircar's ideas about the control and management of the Association. Proceedings of the first meeting of subscribers dated April 4, 1875.

Geology, which called up the past history of the globe and revolutionized the idea of time, was considered an essential branch of science without which **'an institute of science would be incomplete'**.

This institute stands tall with an unparalleled history, with many of India's leading scientists who laid the foundation of modern Science and Technology being associated with it. It was here that Sir C. V. Raman began his experimental research on the Raman Effect, which later won him the Nobel Prize. Eminent scientists such as Prof. S. N. Bose, famous for the Bose–Einstein statistics, Sir J. C. Bose, Prof. K. S. Krishnan, Dr. Amal Kumar Raychaudhuri, and Dr. Meghnad Saha, who later served as Director at the new campus, have all been associated with this institute.

The First Global Recognition, Discovery of the Raman Effect and the Nobel Prize

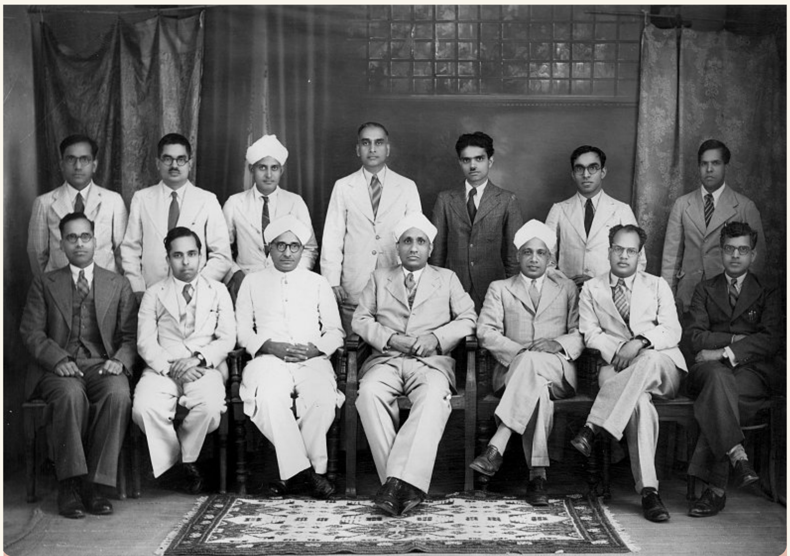
It was in August 1907 that Dr. C. V. Raman, then an officer in the Finance Department of the Government of India, enrolled himself as a member of the Indian Association for the Cultivation of Science because of his research interests.
He obtained permission to carry out research in its laboratories during his spare time. Within a short time, he was able to communicate a large number of research papers in many journals of international repute. A new era of scientific research activity dawned, and researchers from across the country began assembling at the Association.

In July 1921, Raman travelled to Europe as a delegate of **Calcutta University and Benaras Hindu University (now Banaras Hindu University)** to the University Congress held at Oxford, England. During his voyage, the mystery of the blue colour of the sea drew his attention. Soon after his return, he undertook a comprehensive programme of research on the molecular scattering of light by solid, liquid, and gaseous media. This programme attracted many young and enthusiastic scientists who collaborated in these investigations.

The high quality of his research work led to Raman being elected a Fellow of the Royal Society, London, in 1924, in recognition of his outstanding contributions to physical optics, molecular diffraction of light, X-ray scattering by liquids, and molecular anisotropy. In June 1924 he was invited to Canada to inaugurate a discussion on "The Scattering of Light" and visited several laboratories in Canada and the United States. In September 1925 he travelled to Russia as a representative of Calcutta University at the Bicentenary Celebrations of the Russian Academy of Sciences. In Moscow he delivered a lecture on "The Structure of Benzene" at the Congress of Chemistry.

The work on the molecular scattering of light by Raman and his group of researchers in Calcutta eventually led to the discovery of a new light effect. The discovery of this new radiation was published in the Indian Journal of Physics.

Following this publication, further investigations were undertaken in the laboratories of the Association by Raman and his associates, including K. S. Krishnan, S. Bhagavantam, L. A. Ramdas, S. Venkateswaran, A. S. Ganesan, S. C. Sirkar, S. Parthasarathi, and others.



C. V. Raman with his scholars at IACS. Sitting (left to right): A. S. Ganesan, L. A. Ramdas, K. S. Krishnan, C. V. Raman, K. R. Ramanathan, S. Venkateswaran, and S. S. M. Rao. Standing (left to right): C. Ramaswamy, S. Bhagavantam, S. Paramasivan, S. Rao, N. S. Nagendranath, A. Ananthakrishnan and C. S. Venkateswaran.

The new light effect was subsequently called the "Raman Effect," a term that was later universally accepted. The discovery brought honours to Raman from many quarters and firmly established the name of India on the scientific map of the world.

In June 1929, Raman was knighted by the British Government. In the same year he was invited to England to open a discussion on "Molecular Structure and Molecular Spectra" arranged by the Faraday Society. In 1930, he was awarded the Nobel Prize in Physics for this landmark discovery, and travelled to Stockholm to receive the award.

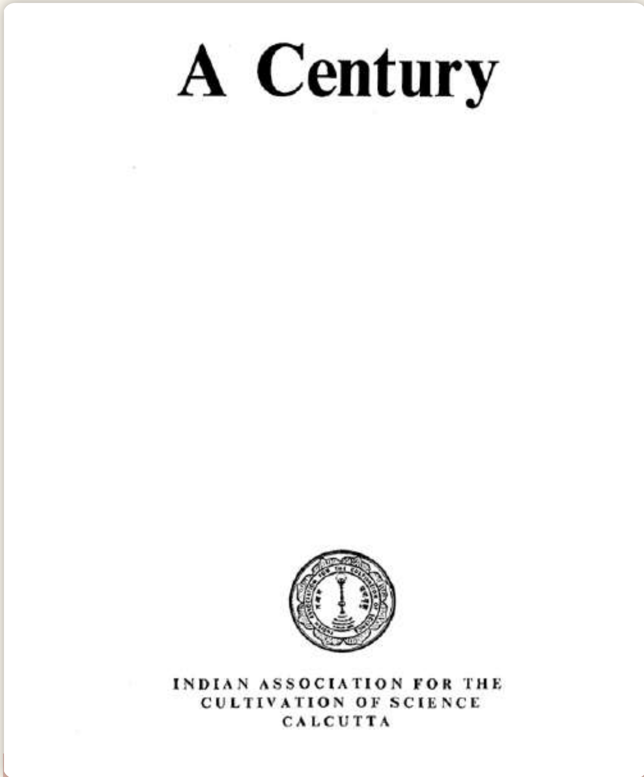
Expansion and Specialisation of Scientific Research at IACS

The institute continued to grow in strength and excellence with the association of leading scientists and their contributions. By 1956, eight departments of physics and chemistry were making a significant impact:

- General Physics and X-rays
- Magnetism
- Optics
- Theoretical Physics
- Physical Chemistry
- Organic Chemistry
- Inorganic Chemistry
- Macromolecules

Leading researchers included S. C. Sircar, B. N. Srivastava, A. Bose, P. Ray, N. K. Dutt, S. R. Palit, Sadhan Basu and P. C. Dutta. By 1975, these departments had produced more than two thousand research papers and more than three hundred doctoral degrees.

IACS completed one hundred years in 1976, marking a period of celebration and expansion. Several reforms were introduced during this period. In 1973, the Society became an autonomous institute under the administrative control of the Department of Science and Technology (DST). In 2018, it attained the status of a Deemed University.


A Century

INDIAN ASSOCIATION FOR THE
CULTIVATION OF SCIENCE
CALCUTTA

Book titled 'A Century' published to commemorate 100 years of IACS in 1976

As a deemed university today, the institute provides high-quality education in emerging areas of science and technology, with a focus on basic research, translational research, and innovation. A unique feature of the institute is its strong emphasis on interdisciplinary and integrated cross-cutting sciences.

In 2003, three new units were established:

- Energy Research Unit
- MLS Professors Unit
- Polymer Science Unit

During 2004–2005, along with the existing eight departments and three units, three new centres were created:

i) Centre for Theoretical Sciences
ii) Centre for Advanced Materials
iii) Centre for Renewable Energy Resources

In 2016, the Technical Research Centre for Molecules and Materials was established with support from the Department of Science and Technology (DST) to bridge fundamental research and industrial fabrication.

Technical Research Centre of IACS at Jadavpur, Kolkata

In May 2018, based on the recommendations of the Academic Reforms Committee, the **School of Applied and Interdisciplinary Sciences (SAIS)** was established through the reorganisation of the erstwhile Polymer Science Unit, Centre for Advanced Materials, Director's Research Unit and Organic Chemistry. Scientists from the Technical Research Centre at IACS and recipients of the DST Ramanujan Fellowship are also affiliated with the School.

Current research activities at SAIS span a wide range of emerging interdisciplinary areas, including soft matter, polymer and supramolecular science, colloidal science, electronics and photonics, liquid crystals, drug delivery, chemical biology, environmental science, and related domains.

Similarly, the **School of Biological Sciences (SBS)** was founded through the reorganisation of the erstwhile Department of Biological Chemistry. Research activities at SBS cover a wide range of biological sciences including cell biology, molecular mechanisms of cellular processes such as dedifferentiation, neuritogenesis, migration and cell division; coagulation biology; monocyte-to-macrophage differentiation; cancer signalling; and the design and development of functional amphiphiles, gels, vesicles, carbon nanomaterials, nanocomposites and metal nanoparticle-based self-assemblies. The work also extends to biocatalysis and biomedical applications, including intracellular cargo delivery of drugs, DNA and proteins.

The Schools of Material Sciences, Physical Sciences, Chemical Sciences, and Mathematics and Computational Sciences continue to pursue research excellence through both individual and collaborative research programmes.

Today, the institute has six subject-specific schools, a **Technical Research Centre**, and state-of-the-art infrastructure facilities that support high-quality research excellence and strong global collaborations.

Instrumentation and High-End Equipment Facilities

In the early years after its establishment, the institute expanded largely through donations from members of the Association. The creation of various departments required specialised instrumentation and equipment. Gradually laboratories were established and strengthened with the latest instruments. As the institute grew in size and stature, funding was received from the Government of India as well as extramural research funding from national and international sources.

Today the institute has reached global standards in research facilities, teaching infrastructure, and advanced instrumentation. Government support has enabled the establishment of high-end equipment facilities, and extramural funding has helped build strong research collaborations.

The institute laid early emphasis on advanced instrumentation. The first X-ray experiment in India was carried out by Mahendralal Sircar on 20 June 1896, when he photographed a human hand using Roentgen's apparatus. He noted in his diary that his first attempt did not produce a good image due to overexposure. He repeated the experiment and succeeded on 23 June 1896. According to his diary, the first successful X-ray photograph in India was produced on that day in Calcutta, sowing the seeds for the use of X-rays in medical diagnosis and later scientific research.

As research activities expanded, advanced instrumentation facilities were further strengthened. Recently, the research infrastructure has been enhanced with state-of-the-art equipment, including TEM ARM3000F2 (FS), AFM (Oxford), Element Analyzer, Single Crystal X-Ray Diffractometer with Macromolecular Diffraction Facility, Micro-volume UV-Vis Spectrophotometer, Pulsed Laser Deposition Chamber with in-situ RHEED facility, Leica Stellaris STED super-resolution microscope, Rigaku sequential wavelength dispersive X-ray spectrometer system, Rheometer with Dynamic Mechanical Thermal Analysis system, DNA sequencer, advanced confocal microscopy systems, high-performance computing infrastructure including NVIDIA A100 and NVIDIA L40S GPUs, and an ultrafast laser spectroscopy facility.

These facilities have enabled cutting-edge research in nanomaterials, photophysical processes, and emerging scientific domains, helping the institute maintain the high standards of research excellence envisioned by its founders.

Collaborations and Partnerships

With the steady growth in research publications, there has also been a strong emphasis on patents, technology development and innovation. Today the institute has generated a significant number of patents, technologies, and products, many of which have been transferred to industry and start-ups. The institute has also created an enabling ecosystem for innovation-driven research and entrepreneurship among faculty members.

Another major strength of the institute lies in the collaborations and partnerships it has built over the years. International collaborations have resulted not only in high-quality publications but also in patents and technologies, contributing significantly to the institute's national and international recognition.

With increasing faculty participation in international and industrial partnerships, the number of publications with high impact factors and citation indices continues to grow each year, along with an increase in patents and technologies.

Average metrics over the last 20 years (2005–2025):

No. of Publications: 9,031

H-Index: 153

Sum of Times Cited: 231,299

Average Citations per Item: 25.61

Average Citations per Year: 9,637.46

Governance Structure – As We Stand Today

With such a rich legacy, it is a matter of pride and honour for every scientist, student, and faculty member associated with this institute, and also a responsibility to uphold its stature as an institution of great eminence working in cutting-edge scientific domains.

Over the past 150 years, the institute has evolved from an organisation founded by a few intellectuals and eminent scientists into a globally recognised research institution. For many years it was managed by a small group of trustees on the board along with the Honorary Secretary.

In the post-independence period (1947–1953), following India's independence, the administrative structure was reformed in line with national priorities. The title of the administrative head was changed from "Honorary Secretary" to "Honorary Director."

A new campus was established at Jadavpur, which became a large complex of educational, research, and industrial establishments. The laboratories were shifted from Bowbazar Street to this new campus. The then Premier of West Bengal, Dr. Bidhan Chandra Roy, provided land for the new campus through a Gazette Notification of the Government of West Bengal dated 20 November 1947.

Under the presidency of Professor Meghnad Saha in 1947, the institute received its first significant recurring government grant, marking the beginning of sustained state support. On 26 February 1948, Dr. Meghnad Saha, with the help of prominent architects in Calcutta, prepared a master plan for the Jadavpur campus. Over the next two decades the institute transitioned from a largely volunteer-run association to a professionally managed research institute with strong government support. Dr. Meghnad Saha became the first salaried Director, marking the formal professionalisation of the institute.

In 1971, the institute became an autonomous institute under the Department of Science and Technology (DST), Government of India. Attaining the status of a Deemed University under the University Grants Commission (UGC) in 2018 marked another transformative milestone.

Today the institute, with a Governing Board at its apex, is well positioned to contribute to India's leadership in global science and technology. It continues to uphold the vision, mission, and mandate with which it was founded – The Institute continues to encourage the free exchange of ideas and nurture young scientists and researchers to pursue cutting-edge scientific inquiry, thereby playing an important role in shaping India's scientific growth trajectory. As the Indian Association for the Cultivation of Science enters its 150th year, it carries forward its rich legacy while contributing to India's emergence as a global leader in science and technology.

> *The object of enabling the natives of India to cultivate science in all its departments by original research and to its varied applications to the arts and comforts of life.*

Bust Photo of Meghnad Saha, first Director of IACS, Kolkata

IACS, Indigenous Science and the Public Idea of Science in India

Prof. Shekhar C. Mande

Distinguished Professor, Bioinformatics Centre, Savitribai Phule Pune University, Pune and JC Bose Fellow, National Centre for Cell Science, Pune,
President, Indian National Science Academy (INSA)

"Gentlemen, I am convinced as everyone ought to be, that there is intelligence enough in my countrymen, only that it requires to be properly directed and duly equipped, in order that it may effect what the intelligence of other national has done, namely, grapple with the facts of nature, discover their laws and bend them to our material and moral uses and the general progress of humanity at large" Mahendralal Sircar spoke in his famed lectures delivered on 1 February 1872 at a meeting of the Bethune Society, held in the Medical College Theatre, and again on 14 February 1872 at a meeting of the Literary Branch of the Uttarpara Hitkari Sabha, held at Uttarpara.

Mahendralal Sircar was one of the important figures in the famous Bengal renaissance, and a prominent leader in the Swadeshi movement.

The nineteenth century witnessed a profound intellectual awakening in Bengal, shaped principally by exposure to the West. During the Bengal Renaissance, thinkers, philosophers, artists, poets, and scientists selectively engaged with Western ideas to reinterpret and defend India's own philosophical, religious, and scientific traditions, producing a creative synthesis in which Western modernity acted as a catalyst for intellectual self-renewal and the early foundations of Indian nationalism rather than a model to be simply imitated. This renaissance can be traced to the pioneering work of Raja Rammohan Roy, who, as noted by Susobhan Sircar, studied Sanskrit in Banaras, immersed himself in Arabic and Persian learning in Patna, engaged with diverse regional cultures including Tibetan Buddhism, mastered English thought and Western culture, and translated the Vedas and Upanishads into English.

Through this, Roy attempted to synthesise ideas of the East and the West (Sircar, On the Bengal Renaissance, 1946). While the Bengal Renaissance is often remembered for its social and cultural ferment, a central and defining strand was the deliberate cultivation of institutionalised scientific inquiry alongside reformist and nationalist thought.

IACS Old Campus, 210 Bowbazar Street, Kolkata

As this intellectual churning matured, it became clear to visionaries such as Mahendralal Sircar that the regeneration of India could not be achieved without the cultivation of a strong scientific outlook. A deeper challenge lay in reclaiming the very domain of science, which colonial rule had systematically projected as an exclusive preserve of Europe. Even figures such as William Jones, the founder of Asiatic Society of Bengal, articulated views that reinforced this hierarchy, describing Indians as "the Asiaticks, if compared with Western nations, are mere children".

It was against this backdrop that Sircar posed his provocative question in 1872: Did Indian youth look upon scientific experiments in the same way as they viewed the feats of jugglers and magicians, mysterious and incomprehensible, referable not to definite laws but to the will of the performer? His answer was an emphatic no (Sircar, 1872). The question itself exposed the deep cultural damage inflicted by a colonial discourse that sought to naturalise the idea of Indian intellectual inferiority. Sircar therefore argued that scientific inquiry in India must be pursued through indigenous institutions, sustained by public support, and guided by a spirit of national self-confidence, rather than dependence on colonial patronage.

Raja Ram Mohan Roy and the Bengal Renaissance, promoting institutional scientific inquiry alongside social reform and nationalist thought.

This conviction found concrete expression in 1876 with the founding of the Indian Association for the Cultivation of Science (IACS) by Mahendralal Sircar, the first scientific research institution in the country created by Indians, for Indians. IACS represented a bold harmony between the rigour of modern science combined with a cultural ethos that valued knowledge as a public good. In many ways, it marked the moment when the Bengal Renaissance decisively turned toward the institutional foundations of modern Indian science.

Alongside Mahendralal Sircar, several other thinkers had begun to deliberate on the foundations of modern educational and scientific institutions in India. Notable among them were Jamsetji Tata and Swami Vivekananda; Rabindranath Tagore, Sister Nivedita, Sara Chapman Bull and Jagadish Chandra Bose; and Pandit Madan Mohan Malaviya. Each, in distinct ways, sought to imagine institutions that could combine modern knowledge with India's civilizational ethos.

A particularly consequential exchange occurred in 1893, when Jamsetji Tata had a chance meeting with Swami Vivekananda aboard the SS Empress of India while travelling from Yokohama to Vancouver. Swami Vivekananda was en route to the United States to attend the World's Parliament of Religions in Chicago, while Jamsetji Tata was heading to the World's Columbian Exposition, a grand celebration of industrial and technological progress. During their conversations, Swami Vivekananda spoke of his experiences as a wandering monk across India, reflecting on the social and intellectual condition of the country. He also shared his observations from travels in China, where ancient Sanskrit manuscripts had been carefully preserved in Buddhist monasteries. Their discussions gradually turned to the idea of creating an institution rooted in Indian values and culture, yet committed to educating the youth in a holistic and modern manner.

In a letter that followed this encounter, Jamsetji Tata wrote to Swami Vivekananda in 1898:

I recall these ideas in connection with my scheme of a Research Institute of Science for India, of which you have doubtless heard or read. It seems to me that no better use can be made of the ascetic spirit than the establishment of monasteries or residential halls for men dominated by this spirit, where they should live with ordinary decency, and devote their lives to the cultivation of sciences, natural and humanistic.

This exchange of ideas between Jamsetji Tata and Swami Vivekananda eventually culminated in the establishment of the Indian Institute of Science, Bangalore, ironically realised only after both visionaries had passed away, yet standing as a lasting testament to their shared belief in science as a moral and national endeavour.

A historic dialogue between Jamsetji Tata and Swami Vivekananda helped inspire the creation of the Indian Institute of Science in 1983.

Much like the exchange between Jamsetji Tata and Swami Vivekananda starting 1893, sustained intellectual conversations among Swami Vivekananda, Rabindranath Tagore, Sister Nivedita and Jagadish Chandra Bose over many years culminated in the establishment of the Bose Institute in Kolkata in 1917. These efforts were strengthened by the generous philanthropy of Sara Chapman Bull, whose support proved crucial in translating ideas into institutional reality.

A profound bond of intellect and mutual support, Sister Nivedita and Sir Jagadish Chandra Bose together nurtured the growth of Indian Science.

Bose's address at the foundation of the Institute, titled "The Voice of Life," eloquently articulated a vision of scientific advancement firmly rooted in Indian ethos. Central to Bose's philosophy was the conviction that the fundamental laws of nature must be understood in their totality, unconstrained by the artificial boundaries separating academic disciplines.

Sara Chapman Bull, American philanthropist, donated nearly $40,000 to Jagadish Chandra Bose to establish an interdisciplinary science research centre that later became the Bose Institute.

This principle was exemplified throughout his own work. A true polymath, Bose's scientific pursuits ranged from wireless communication to the study of electrical responses in plants, seamlessly bridging physics, biology and philosophy. The founding of the Bose Institute thus marked an early and deliberate commitment to interdisciplinary research in India.

Bose Institute at Kolkata, established in 1917 by Acharya Jagdish Chandra Bose

Elsewhere in India, the late nineteenth and early twentieth centuries also witnessed the emergence of new centres of learning. Although the year 1857 saw the establishment of the Universities of Bombay, Calcutta and Madras, these institutions were largely modelled on the British university system and primarily intended to train administrators for the colonial government. In contrast, the rise of nationalist sentiment across the country stimulated the creation of alternative spaces of education that sought to align learning with national aspirations. Institutions such as Fergusson College in Pune, established by Lokmanya Tilak and his colleagues, reflected this impulse.

The founding of Banaras Hindu University, through the combined efforts of Annie Besant and Pandit Madan Mohan Malaviya, stands as a particularly significant example of this movement to reimagine higher education in India. Pandit Malaviya believed that Indian youth should be educated in Indian values and ethos, while simultaneously engaging with the full spectrum of modern knowledge. Consequently, BHU was conceived as a comprehensive institution encompassing music and fine arts, science, engineering, economics, medicine, and other disciplines, embodying the idea of a truly multidisciplinary university.

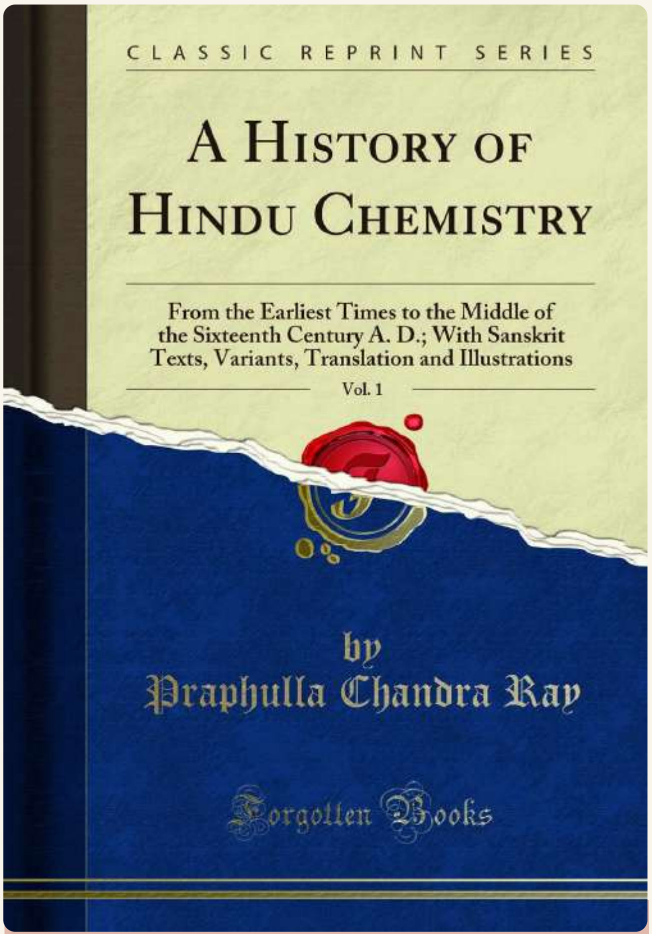
Even as institutional building in India progressed under colonial rule, a number of individuals began to make their presence felt by attempting to recover and catalogue India's scientific knowledge from ancient times. Their aim was to underscore a fundamental point that science was not an activity confined to Europe, but a universal human enterprise that had evolved in different civilisations and historical contexts. This process of intellectual recovery constituted an important strand of the Bengal Renaissance.

Acharya Prafulla Chandra Ray, the Father of Indian Chemistry, helped shape the intellectual and historical foundations of modern Indian science

A distinguished figure of this movement was Acharya Prafulla Chandra Ray, who complemented the building of scientific institutions through a different, yet equally foundational, intervention. While the Indian Association for the Cultivation of Science, the Indian Institute of Science, and the Bose Institute sought to create physical spaces for scientific research and education, Ray worked to construct an intellectual and historical foundation for modern Indian science.

Beyond his seminal experimental work on the nitrites of mercury, Ray authored ***A History of Hindu Chemistry,*** a powerful narrative that was not an exercise in antiquarian pride but a rigorously argued response to colonial claims that had denied Indians a rightful place in the development of modern science. By documenting the continuity of empirical chemical knowledge in India, particularly in metallurgy, pharmaceuticals and chemistry, Ray restored historical depth and self-confidence to Indian scientific self-understanding.

During the late nineteenth and early twentieth centuries, an outstanding example of individual excellence emerging outside formal institutional structures was that of Srinivasa Ramanujan. In many ways, Ramanujan represents a distinctive, and deeply



Through 'A History of Hindu Chemistry', Prafulla Chandra Ray challenged colonial narratives about Indian science.

poignant strand of Indian scientific creativity during the late colonial period. Unlike figures such as Ray or Bose, Ramanujan emerged largely outside formal institutional structures, shaped instead by India's long-standing mathematical culture, self-study, and intellectual intuition.

Working in isolation in Madras, with limited access to libraries or mentors, Ramanujan nevertheless produced mathematical insights of extraordinary depth, drawing upon an indigenous tradition in which mathematics was pursued as a contemplative and aesthetic endeavour as much as a formal discipline.

Ramanujan's work was embedded in India's long and continuous mathematical traditions, in which numbers were not merely tools of calculation but objects of deep contemplation. From the early development of the decimal system to later advances in algebra, trigonometry and infinite series, Indian mathematics had historically valued intuitive reasoning alongside formal proof. Ramanujan, largely self-taught and working in intellectual isolation in Madras, absorbed this tradition through texts, notebooks and personal reflection.

His extraordinary ability to perceive deep numerical relationships, often arriving at results through intuition before formal derivation, echoed this cultural inheritance, even as it posed challenges within the conventions of Western mathematical formalism. In this sense, Ramanujan's genius represented not an anomaly, but a powerful continuity of India's mathematical imagination under colonial constraints. Ramanujan's journey, eventually leading to collaboration with G. H. Hardy at Cambridge, laid bare both the creative potential of Indian intellect and the structural constraints imposed by colonial education.

His life underscored a central paradox of Indian science under colonial rule, that is exceptional individual genius could still flourish, but often in spite of, rather than because of, prevailing institutions. In this sense, Ramanujan powerfully reinforced the very argument advanced by the Bengal Renaissance and its institutional architects that India required its own supportive ecosystems for nurturing scientific talent, grounded in confidence, continuity, and cultural self-respect.

Taken together, the figures of Ray and Ramanujan illuminate two complementary responses to the conditions of colonial period in India. Ray confronted the epistemic challenge of colonial rule by reclaiming history–demonstrating that India possessed a continuous and credible tradition of empirical scientific practice that could stand alongside European science. Ramanujan, by contrast, embodied the persistence of creative scientific thought independent of historical recovery or institutional validation, revealing how indigenous intellectual traditions could still generate original and transformative knowledge even in isolation. Where Ray sought to restore confidence

Srinivas Ramanujan, the Indian mathematician who produced profound mathematical insights rooted in a rich intellectual tradition, embodied the Bengal Renaissance ideal, an India confident enough to cultivate its own scientific genius.

through historical and institutional grounding, Ramanujan revealed the irreducible autonomy of individual genius shaped by cultural inheritance rather than formal structures. Together, they underscore that the emergence of modern Indian science was not a single, linear process, but a plural and layered one, rooted simultaneously in institutional construction, historical self-recovery, and extraordinary individual creativity.

The intellectual and institutional currents set in motion during the Bengal Renaissance did not dissipate with the end of colonial rule; rather, they found mature expression in the post-Independence scientific architecture of India. The establishment of the Council of Scientific and Industrial Research (CSIR) and the Indian National Science Academy (INSA) represented a conscious extension of earlier efforts to build a self-reliant scientific ecosystem. If institutions such as IACS, IISc and the Bose Institute created the first indigenous spaces for scientific inquiry, CSIR translated this legacy into a nationally coordinated programme of research aligned with industrial and societal needs, while INSA provided an apex platform for scientific excellence, deliberation and advice to the nation.

The contributions of CSIR in addressing multiple societal and developmental challenges through the application of science and technology have been exemplary. CSIR's interventions in areas such as the large-scale production of mentha, enabling India to emerge as a global leader in mint-based products, the drive towards self-reliance in the leather sector through improved tanning technologies and processes, and the nurturing of a robust indigenous chemical and pharmaceutical industry, illustrate how scientific research was systematically aligned with national needs. These efforts demonstrated that science in India could move beyond the laboratory to directly impact livelihoods, industry and economic self-sufficiency, fulfilling the vision of earlier institution-builders who saw scientific research as an instrument of societal transformation.

In this sense, CSIR and INSA inherited not only laboratories and researchers, but also a philosophical legacy, one shaped by Ray's recovery of scientific memory, Bose's integrative vision of nature, Vivekananda's emphasis on moral and cultural grounding, and the philanthropic nation-building exemplified by Jamsetji Tata and Sara Chapman Bull. Together, these strands converged after Independence to affirm a distinctive Indian approach to science: confident in its historical depth, committed to global rigor, and oriented toward national purpose.

In recent times, the practice of science in close collaboration with policymakers, industry, and administrative machinery has yielded spectacular results in India. Scientific inputs have been central to achievements such as highly accurate prediction of cyclones and their impact zones, and the development of cost-effective processes for pharmaceutical production. Together, these advances demonstrate how science, when embedded within governance and industry, can directly contribute to inclusive growth and societal resilience.

Science in India stands at a critical juncture, poised to deepen its impact through stronger synergistic partnerships. Having demonstrated its capacity to address national challenges with ingenuity and scale, Indian science is now increasingly positioned to contribute meaningfully to global problems, from climate resilience and public health to digital technologies and sustainable development, while also engaging thoughtfully with the ethical questions emerging from rapid advances in areas such as artificial intelligence and gene editing. In this context, institutions such as the Indian National Science Academy (INSA) play a crucial role as spaces for informed deliberation, ethical reflection, and evidence-based advice, drawing upon India's long cultural heritage and deep philosophical traditions to ensure that scientific progress remains aligned with human values and societal well-being.

Contemporary Scientific activity in India stands on the shoulders of a rich intellectual tradition that has learned to engage with the world without losing its own voice, its greatest impact will therefore lie not merely in technical achievement, but in shaping a science that is inclusive, ethically grounded, and responsive to human needs, reaffirming India's role as both a producer of knowledge and a responsible global partner in the scientific enterprise.

Acknowledgement

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IACS – A Cradle of Science in India

Prof. Kalobaran Maiti

Director
Indian Association for the Cultivation of Science (IACS)
Kolkata

Around mid-19th century, the country was going through a difficult time ruled by British Government exploiting Indians. Facilities for science education were practically non-existent in the educational institutions. The emphasis was largely on arts and humanistic subjects with no scope for learning what was going on in science in the European countries. Even in medical colleges, teaching of science was hardly sufficient for career in science. Few institutions, such as the surveys, were established by the Government which were equipped for advanced studies and research.

However, these were exclusively manned by, and meant for, the Europeans; their gates were closed to Indians citing lack of training or incompetence. In the backdrop of such a dismal situation, Dr. Mahendra Lal Sircar, a topper in Calcutta Medical College, realized the necessity of educating Indians in modern science led by Indians for a ***self-reliant India*** and the Indian Association for the Cultivation of Science (IACS) was born on 29th July 1876 – a unique Institute built to cultivate the culture of science and spread it to the mass. The aim is to uncover the knowledge within via open-minded teaching the advancement in science for the arts and comforts of life; the concept reverberated later in the teaching of Swamy Vivekananda, ***'education is the manifestation of perfection already in man.'***

The initiative started with a dual effort of encouraging scientists to carry out research by creating research facilities and initiating a series of public lectures in scientific topics of current interest to awaken and amplify public awareness of science. Indian Association soon became well known to the scientists as a place where they could "indulge" in scientific research in their spare time.

IACS was established at 210 Bow Bazar Street entirely from the money earned by Dr. Sircar from his medical practices and donations received from well-wishers. Pandit Ishwar Chandra Vidyasagar, Keshab Sen were the first trusty board members. The collected funds were used for the expenses of education with the honorary service by the teachers. Dr. Sircar's emphasis was to complement the existing education system with modern scientific knowledges – a novel idea of ***City Cluster*** and/or ***Hub and Spoke Model*** conceived 150 years ago. The other focus was women's education – science education of Sarala Devi, a niece of Tagore, were facilitated by Sircar through specially arranged evening classes. Dr. Sircar helped Abala Das (later married to Sir Jagadish Chandra Bose) to get admitted to Madras Medical College when Calcutta denied her admission due to their conservative mindset.

Classroom teaching was arranged with maximum number of classes taken by Dr. Sircar. Among other teachers were father Eugène Lafont (a Belgian Jesuit at St. Xavier's college), Sir J. C. Bose, Asutosh Mukhopadhyay, Nil Ratan Sircar, etc. The popularity of the science classes grew rapidly; from about a dozen to about 200 students around 1890. Students from various Calcutta Colleges such as Presidency College, women students from La Martiniere Institution and Doveton College attended these lectures. Prafulla Chandra Ray, a student of the Presidency College, was a regular attendee. Dr. Sircar believed in importance of experimental science and procured instruments from abroad. Father Lafont helped set up laboratories in optics, meteorology, and Spectro-telescopic setups. Sir J. C. Bose introduced students to electromagnetic wave propagation and his home-built crescograph. Efforts were made to bring in inventions happening in scientifically advanced countries. For example, Rontgen-tubes were procured soon after its discovery in November 1895 and the first x-ray image was produced by Dr. Mahendra Lal Sircar in June 1896.

In 1907, Chandra Sekhar Venkata Raman started his work in the laboratories of IACS. He started publishing his groundbreaking research in various international journals such as Nature. In addition to production of high-quality research, there used to be regular discussion meetings. In 1915, it was decided to print the ***Proceedings of the Indian Association for the Cultivation of Science***, a platform for the publications of the papers discussed; the first volume appeared in 1917. Subsequently, the publication became ***The Indian Journal of Physics***, which made its appearance in 1926 to take care of the expanded volume of works. Between 1928 and 1933 more than sixty papers, dealing with the Nobel Prize winning discovery (February 28, 1928) of the modification of light due to scattering by materials, known as ***'Raman Effect'***, were published in this journal. IACS is the only institute in India publishing a high impact international journal which is on the verge of completing 100 years.

In 1946, Prof. Meghnad Saha became the president of IACS and made a new development plan at Jadavpur – first attempt of expansion in the vicinity of platinum jubilee. The Foundation Stone of the laboratory building was laid on Sunday the 26th September, 1948, by Dr. B. C. Roy, Chief Minister of West Bengal. He formulated development plans of the Association to which he gave practical shape with his characteristic energy and drive. Since 1953, as the first full-time Director of IACS till the day of his death, he worked ceaselessly for the consolidation of development of IACS.

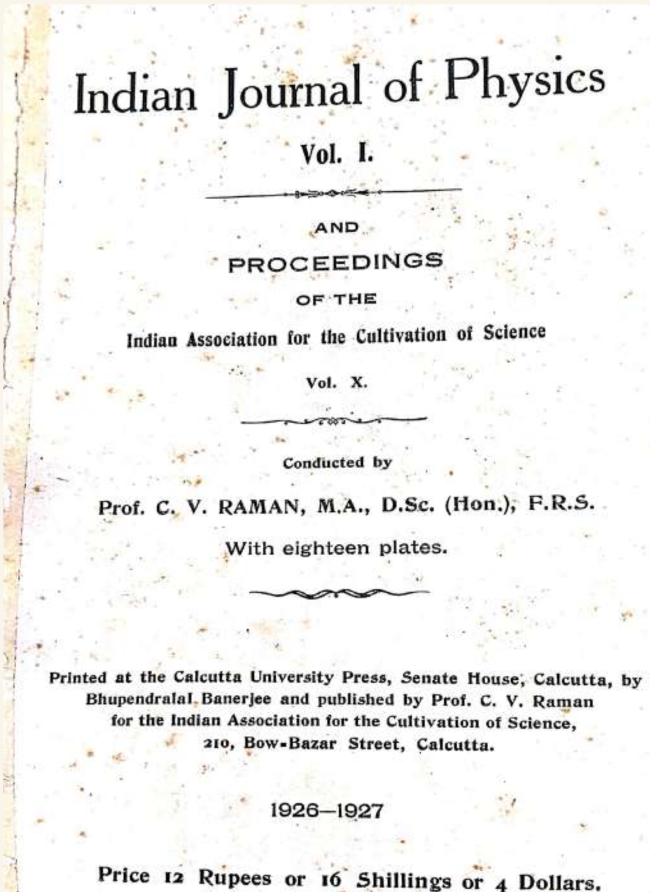
Big Science Facilities and Research Infrastructure

IACS maintains highest standard in their research endeavour via setting up state-of-the-art research infrastructure such as ultra-cold facility, ultra-fast laboratory, design and fabrication of solar cell, identification of cancer cell and drug delivery, CO2 capture, pathway to fabricate DMD drug, etc. At present, IACS houses several state-of-the-art research facilities available to external users in addition to catering the research need of the scientists in-house. We also put significant effort to build new facilities keeping in view of self-reliance for Vikshit Bharat by 2047.

International Collaborations

International collaboration has been one of the main features of IACS. Dr. Sircar's idea was to train Indians in the advancement of science globally which is possible only via mutual visit, international collaborations, etc. Since inception, several luminaries visited IACS, offered prized lectures, lecture courses. We continue to invite global leaders in science including Nobel Laureates to expose our students and academic fraternity in general to the recent developments in science.

The flagship journal of IACS, **Indian Journal of Physics** is published jointly with Springer-Nature. It has now an impact factor of 1.7, which is excellent for a physics journal. Large number of IACS Faculty are in the editorial board of major international journals. Many of our faculty secured grants from welcome trust and Max Planck Society. We are one of the key contributors in India-DESY collaboration.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Vol. I.

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Vol. X.

Conducted by

Prof. C. V. RAMAN, M.A., D.Sc. (Hon.), F.R.S.

With eighteen plates.

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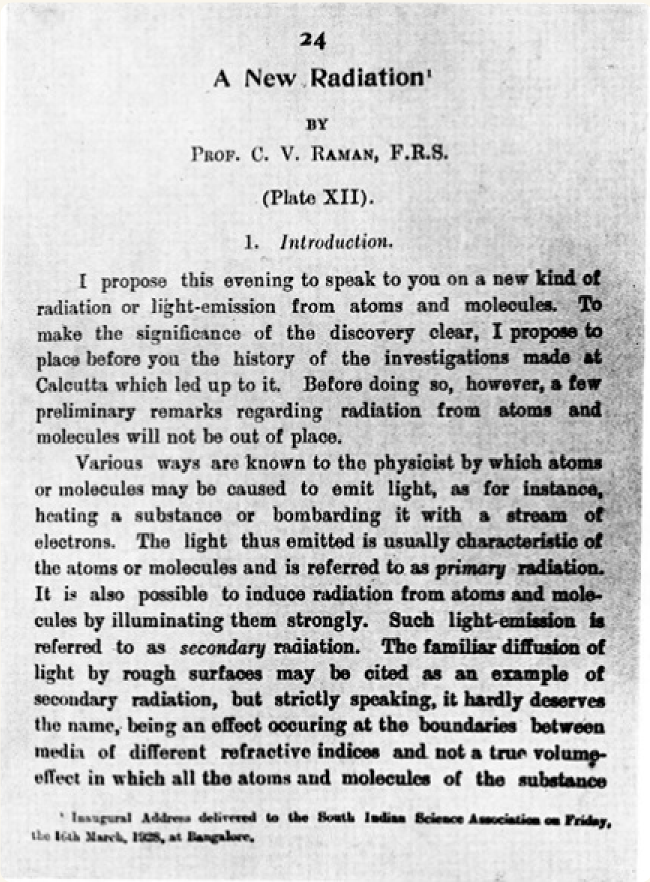
The Indian Journal of Physics, the Association's flagship scientific publication, first published in 1917

IACS is the nodal center for India as a member country of the Asia Pacific Center for Theoretical Physics (APCTP), founded in 1996 to serve as an Asia-Pacific hub to host in-house junior research groups, organize workshops and facilitate collaboration and exchange of scientists as well as acting as a forum for regional scientific development and cooperation. APCTP coordinates many joint activities with the International Center for Theoretical Physics (ICTP, Trieste), hosts the Association of Asia Pacific Physical Societies (AAPPS) and financially supports the AAPPS Bulletin which is now published by Springer-Nature.



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A New Radiation[1]

BY

PROF. C. V. RAMAN, F.R.S.

(Plate XII).

1. *Introduction.*

I propose this evening to speak to you on a new kind of radiation or light-emission from atoms and molecules. To make the significance of the discovery clear, I propose to place before you the history of the investigations made at Calcutta which led up to it. Before doing so, however, a few preliminary remarks regarding radiation from atoms and molecules will not be out of place.

Various ways are known to the physicist by which atoms or molecules may be caused to emit light, as for instance, heating a substance or bombarding it with a stream of electrons. The light thus emitted is usually characteristic of the atoms or molecules and is referred to as *primary* radiation. It is also possible to induce radiation from atoms and molecules by illuminating them strongly. Such light-emission is referred to as *secondary* radiation. The familiar diffusion of light by rough surfaces may be cited as an example of secondary radiation, but strictly speaking, it hardly deserves the name, being an effect occuring at the boundaries between media of different refractive indices and not a true volume-effect in which all the atoms and molecules of the substance

[1] Inaugural Address delivered to the South Indian Science Association on Friday, the 16th March, 1928, at Bangalore.

Announcing the Discovery of Raman Effect
Facsimile of a page from Indian Journal of Physics, 2, 387 (1928)

German Research Foundation (DFG), one of the largest funding organizations in Germany work in close cooperation with the Indian funding agencies namely, Department of Science & Technology (DST), Department of Biotechnology (DBT), Indian Council of Medical Research (ICMR), Indian National Science Academy (INSA), Indian Council of Social Science Research (ICSSR), etc. DFG along with the representatives of German organizations such as Max Planck Society, Humboldt Foundation and some German Universities participated in the XXXVIII International Ethological Congress, Behaviour 2025 in August 2025 and visited IACS to strengthen existing collaborations and explore future cooperation avenues.

IACS has initiated an interaction with the National Cheng Kung University (NCKU) Academy of Innovative Semiconductor and Sustainable Manufacturing (AISSM) for collaborations in semiconductor-based technology. As a leading institution ranked first in Taiwan and among the top 24 globally in the Higher Education Impacts Ranking 2023, NCKU's expertise in semiconductor manufacturing and energy-related applications presents a remarkable opportunity for collaboration with IACS, an intellectual hub of India in the areas of Integrated Circuit Design, Semiconductor Manufacturing Technology, Semiconductor Packaging and Testing, Key Materials, and Smart and Sustainable Manufacturing. These programs, underpinned by core competencies in Artificial Intelligence, Big Data, and sustainability-focused areas such as energy-efficient technologies and carbon neutrality, align closely with our institution's goals of advancing research and education in cutting-edge technologies in line with the semiconductor mission of India.

Jointly with Freie University Berlin and Hertie School, IACS planning to organize an AI event in October 2026 on ***"What can Indo-German collaboration learn by designing AI governance, scientific innovation, and technology policy for North East India's realities first?"***

IACS participated in the event organized last year on "Rethinking International Affairs in the Age of AI - A Policy Dialogue" at Jadavpur University. The focus areas of this year's event will be technology governance, AI policy, and international security.

Autonomy and Governance

The Association was formally established at the meeting of subscribers to the projected Science Association, held on January 15, 1876 at 4 pm in the Senate House of the Calcutta University. A Committee of Management was appointed with the Lieutenant Governor, Sir Richard Temple as President, Dr. Rajendra Lal Mitra was the vice-president and Dr. Mahendra Lal Sircar as Secretary; other members were all members of the Provisional Committee plus Rajendra Dutt, Jadu Lal Mallick, Nilmadhab Mookerjee, Keshab Chandra Sen and Ananda Mohan Bose. Dr. Sircar served as the secretary till his death in February 1904. After that, his son, Dr. Amrita Lal Sircar was elected the next Secretary – these positions including the teachers and researchers were honorary as there was not enough fund available to provide salary.

In 1933, a whole-time research Professorship, named Mahendra Lal Sircar Professor of Physics was created with full power of administration over Research Laboratories, Library and Workshop by combining donations from Raja Veharilal Mitra with the Mahendra Lal Sircar Memorial Fund and other funds.

This partially fulfilled the long-cherished desire of the Founder, to establish full time research Professorships. Since then, eminent scientists used to be the MLS Professor and lead IACS at different times. A new administrative structure was formed and Prof. Meghnad Saha became the first full-time Director of IACS in 1953 and served till the day of his death in 1956. In 1959, Dr. Kedareshwar Banerjee became the Director and created a Director's Research Unit (DRU).

Now, IACS is an autonomous institute under the Department of Science & Technology (DST), Government of India. Since 2018, IACS held the status of a "Deemed to be University" under the de novo category. This dual identity presents a complex and evolving landscape of governance via balancing academic freedom necessary for top-tier research with administrative and financial accountability mandated by public funding from the DST.

The Genesis

Autonomy of IACS is rooted in its vision as stated by the Founder at the 24th Annual Meeting of the Association dated September 5, 1901,

"Let me not be misunderstood. I want freedom for the institution. I want it to be entirely under our own management and control. I want it to be solely native and purely national."

It was registered as a Society under Act XXI of 1860 bearing a Registration No. 1933 of 1910. Till 2005, IACS was governed by the General Body of IACS having a President elected from among the Learned Members. The rules, regulations and functioning were decided by the General Body.

From a Society to a Research Institute

After nearly 128 years of its inception, the Governing Council in 2004 observed necessity of structural reforms to get back its National Character and for the excellence in research and development. In 2006, a Structural Reforms Committee was formed to give a concrete shape to the overall upgradation of

Indian Association for the Cultivation of Science, Kolkata

IACS in terms of its research activity keeping in view the National and International developments. They suggested several steps for improving the quality and procedure of recruitment of faculty. This included giving competitive salary to the prospective faculties, flexibility of the designation of a faculty position, quick hiring system, etc.

Suggestions for improving infrastructural facilities had also been made. It also strongly endorsed that the overall quality and competence of the non-faculty staff should also be upgraded via a continuous training programme and appropriate scales for them commensurate with qualifications and experience should be implemented for the efficient use of the technical backup and administrative support.

The issues related to managing a learned society (which is like a club of enlightened people from a broad cross-section of society) and a full-fledged research institute (which should enjoy a range of autonomy and flexibility that can be overseen effectively only by eminent scientists of proper expertise) are quite different and their respective roles - while complementary – were felt to be clearly demarcated and delineated.

The Structural Reforms Committee suggested that the Society and the Institute components of IACS should be administratively and functionally separated. With the approval of the Governing Council, the functional separation between the Research Institute and Societal Component of IACS was effected through the Structural Reforms in 2006. Since then, the Governing Council is the executive authority of IACS and constitutes the apex body responsible for smooth running of the organization.

From a Research Institute to a de novo Deemed to be University

For over a century, IACS functioned as an autonomous research center, primarily conducting PhD and post-doctoral research. Its recognition as a "Deemed to be University" under Section 3 of the UGC Act, 1956, marked a paradigm shift in its governance. De Novo Status comes with a focus on teaching and research in emerging areas of science (e.g., Chemical Biology, Material Science). IACS also has Academic Autonomy and design its curriculum, conduct examinations, and award degrees (integrated Master's-PhD, PhD).

IACS is one of the 24 Autonomous Institutes (AIs) under DST. The grants-in-aid is provided by DST allowing the governance model to facilitate, rather than control, scientific pursuits. The Governing Council (GC) is the apex policy-making body, allowing the institute to make decisions regarding its research direction, recruitment and infrastructure development.

Challenges and Opportunities in Governance

While the autonomy framework is designed to promote excellence, it needs to maintain accountability and balance between administrative control and scientific freedom. The Comptroller and Auditor General (CAG) of India often highlight the need to maintain rigorous internal controls while enjoying autonomy. IACS adheres to strict financial norms even if it sometimes slows down the process. IACS also ensures that its Bye-Laws and Regulations remain in conformity with the applicable Central/State Societies Registration Act and the guidelines for deemed universities under UGC.

Adapting to "Atmanirbhar" Governance: As in the academic pursuit, IACS continuously adapt itself towards Atmanirbhar Bharat (self-reliant India) policies emphasizing ***Internal Resource Generation*** via enhancing extra-mural funding from industry and foreign sources, and ***Technology Transfer*** via translating research into societal benefits (e.g., solar energy, drug synthesis).

Key Features

The autonomy and governance underscore their inseparable and complementary roles in shaping the effectiveness of scientific and academic institutions. While autonomy provides the intellectual and operational freedom necessary for innovation, excellence, and responsiveness, governance ensures that such freedom is exercised with responsibility, transparency, and accountability. Neither can function optimally in isolation; it is their careful integration that enables institutions to fulfil their mandates in a rapidly evolving global knowledge ecosystem.

In the Indian context, scientific research institutions such as IACS exemplify the enduring value of autonomy rooted in a strong historical legacy and a clear institutional mission. From its origins during the colonial period to its present status as a premier research and teaching institution, IACS illustrates how academic freedom, supported by visionary governance, can contribute to national pride, global scientific recognition, and societal advancement. At the same time, its experience highlights the practical challenges that arise when uniform administrative and financial regulations are applied to institutions engaged in highly specialized and unpredictable research activities. Granting calibrated autonomy within a well-defined governance framework can enhance efficiency, attract and retain talent, and enable institutions to operate at international standards, without compromising public accountability.

Ultimately, strengthening autonomy and governance in tandem is essential for advancing country's scientific and educational aspirations. By reforming regulatory structures to recognize institutional diversity and by fostering trust-based oversight mechanisms, the state can empower its premier research institutions to innovate boldly while remaining accountable to society. Such a balanced approach will not only preserve the legacy of institutions like IACS but also ensure their continued contribution to knowledge creation, national development, and global scientific leadership.

The Making of Scientists and Institutional Culture

From its inception, IACS has nurtured numerous pioneering scientists who have made remarkable contributions to the advancement of science. In 1928, C.V. Raman discovered the Raman Effect, for which he was awarded the Nobel Prize in Physics in 1930. Professor Kedareswar Banerjee, a world-renowned x-ray crystallographer, introduced a novel strategy to address the crystallographic phase problem, paving the way for the development of the highly powerful direct methods that define modern crystallography.

Professor Amal Kumar Raychaudhuri gave the Raychaudhuri equation describing the gravitational friction for pressure-free matter, which made him an acclaimed theoretical physicist in the field of relativity and cosmology.

Professor Phanindra Chandra Dutta, head of the Department of Organic Chemistry of IACS, first introduced the stereo-controlled synthesis of organic compounds including terpenoids and various other natural products.

Professor Priyadaranjan Ray, a renowned inorganic chemist and former Director of IACS, has made significant contribution in establishing the rhombic twist mechanism and the stabilization of metal ions in unusual oxidation states named as Ray-Dutt Twist.

Professor Santi Ranjan Palit, who joined IACS in 1947 as Head of Physical Chemistry, made pioneering contributions to physical and polymer chemistry and is rightly regarded as the father of polymer research in India. Several other distinguished scientists including S. N. Bose, K. S. Krishnan, M. N. Saha, K. Banerjee played pivotal role in strengthening the research culture of IACS during its formative decades. In subsequent years, many eminent scientists joined IACS and carried forward its rich scientific legacy.

Their outstanding research contributions have earned numerous prestigious honors and accolades including the TWAS Prize, Shanti Swarup Bhatnagar Prize, and several other national and international awards. In recognition of their scientific excellence, many of these scholars have been elected as Fellows of leading national and international academies, such as the Royal Society, London; The World Academy of Sciences (TWAS); the Indian National Science Academy (INSA); and the Indian Academy of Sciences (IAS), among others.

IACS is celebrating 150 years of journey in making generations of scientists through nurturing a distinctive institutional culture that includes curiosity driven fundamental scientific knowledge, freedom of thought and academic excellence. IACS has created suitable environment for the young minds to engage deeply in rigorous scientific investigations through emphasizing the fundamental research over routine experiments. Close mentorship and direct interaction between distinguished scientists and the young researchers, rigorous discussions and critical questioning have implanted scientific independence and creativity among researchers, which encourage them to challenge conventional ideas and contribute meaningfully to the progress of science.

Another notable hallmark of institutional culture of IACS is interdisciplinarity that enables researchers to solve complex problems from diverse perspectives through exchange of ideas across various disciplines including physics, chemistry, biology, material science, mathematics, and computer science. Further, informal discussions, colloquia, regular seminars and outreach programmes have helped to strengthen collaborative research, expand scientific outlooks, and establish scientific mindset in society. Scientific excellence of IACS can be judged by the originality, depth, and long-term impression of research.

Throughout this journey, IACS has created the required environment for high-end research along with comprehensive development of the researchers while adhering to the foundational principles. Hence, IACS has not only produced groundbreaking scientific outcomes but also shaped researchers enriched with ethical values, intellectual discipline, and a lifelong devotion to the progress of science.

Training and Mentorship Practices

While IACS carry forward a long history of excellence in research, it also developed centers and groups of research scientists and their scholars. Mentorship and collaboration have always been central to this activity. The long legacy of this mentorship can be seen from the illustrious heights reached by the alumni of IACS in academia, industry, and government echelons. Over the years and especially in the last few decades, IACS has evolved as an attractive destination for student training and teaching activities geared towards younger generations.

From the decade of 2000-2010, IACS started its Integrated MS-PhD courses in Chemistry and Physics. These courses were an attempt to train students towards research and development activities from an earlier stage. To hone the skills of scientific enquiry and building a culture of novel developments towards the goals of our ever-burgeoning nation. This was at that time quite rare to have a curriculum including both classroom teaching and novel aspects of state-of-the-art research. Furthermore, these courses were in collaboration with neighboring institutes and universities which also built the culture of collaborative research towards mission-oriented goals.

These programs were expanded and further enriched from 2018 when these hallowed halls transitioned into a new deemed-to-be-university under the de-novo category. Within the university structure, there were schools that offered courses in basic subjects such as physics, chemistry, mathematics, and biology, but there were also courses that catered to the growing fields of applied and interdisciplinary sciences, material sciences, computation, and artificial intelligence.

Career counselling, placement cells and internship opportunities for students are aspects that are now crucial elements of this transition. Therefore, the mandate of IACS was expanded to encompass training of manpower towards the visions of a developed nation at 2047.

In addition to research and academic training, IACS views outreach and capacity building as important contributors to India's goal of becoming a developed country by 2047. The institute conducts regular seminars, workshops, and lectures that support the exchange of knowledge and academic growth. It also engages with school and college students through campus visits, laboratory interactions, and exposure to advanced research facilities.

In the coming years, these activities will be strengthened by expanding organized outreach programs for students and teachers, introducing early exposure to research within training programs, building stronger links with industry and national laboratories, and promoting research that addresses national needs, including areas such as artificial intelligence, machine learning, nanoscience, and quantum technologies. Together, these efforts reinforce the broader role of IACS in developing skilled human resources, encouraging scientific thinking, and supporting innovation essential for long-term national development.

Building on this broader engagement with education and society, IACS has, over the last 150 years, evolved from a primary focus on doctoral mentorship to an expanded mandate of training and mentorship in basic, applied, and translational sciences. Several centers of excellence are proposed in the near future, and the teaching programs are envisaged to complement these centers so that students receive training in relevant state-of-the-art fields. Close ties with industry, along with structured internship and exchange programs, will allow students to gain exposure to industry practices while continuing their academic training at IACS. This will further facilitate the smooth and timely transition of these highly trained students into appropriate industrial positions and research careers.

The vision is to build upon our original motto of developing well-trained personnel in the sciences who are capable of carrying out novel research across all areas of science, and who are trained in scientific inquiry and scientific temper. In doing so, IACS seeks to strengthen the scientific and technical ecosystem required for sustained national development.

Acknowledgement

Contributions on Autonomy and Governance were provided by Mrs. Sarbani Saha (Registrar, IACS); the section on The Making of Scientists and Institutional Culture was contributed by Prof. Prasanta K. Das, and inputs on Training and Mentorship Practices were provided by Prof. Debashree Ghosh (Dean, Graduate Studies) and Prof. Raja Paul (Academic Coordinator).

The Birth of a National Institution
IACS in its Formative Years

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Origin and the Vision of the Founder

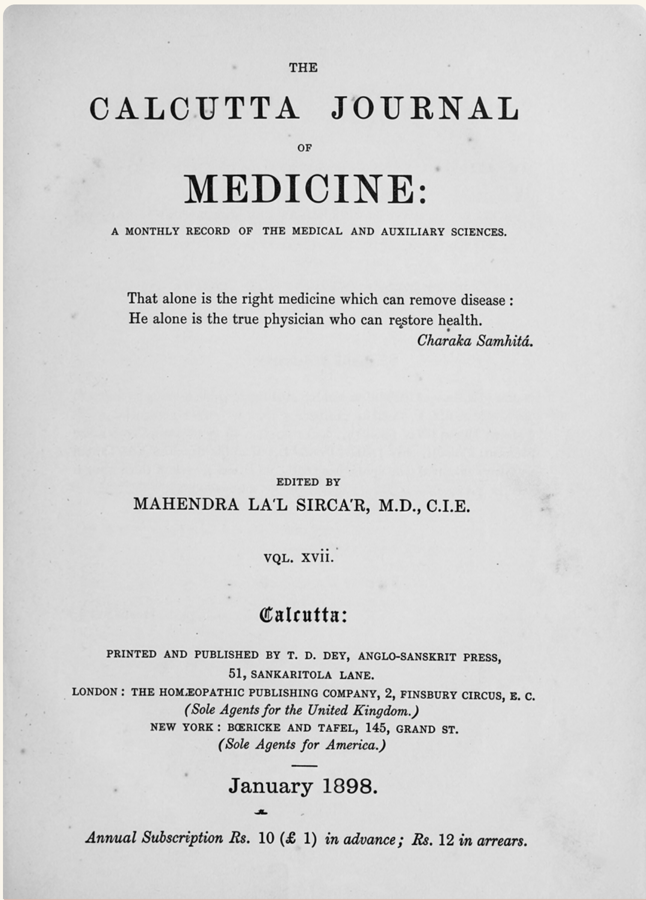
Mahendra Lal Sircar (1833-1904) laid the foundations of the first 'native' scientific institution, embodying the aspiration for intellectual self-reliance in colonial India. [1]This institution, Indian Association for the Cultivation of Science (IACS)–at 210 Bow Bazar Street, Calcutta, convened, incubated and forged the first community of Indian intellectual interlocutors who thought that science was the key to moral, intellectual and economic regeneration of the then 'nation in the making'. The institution was inaugurated on 29 July 1876 and started functioning from the same address.[2]

Sircar wore a rustic look but remained a very sophisticated intellectual with indulgences in many spheres of knowledge. He intimately interacted with Ramkrishna Paramhansa as his physician. [3]His other indulgences in homeopathy, initiation and establishment of IACS, while editing journals and books including his long-drawn dialogues with Ishwar Chandra Vidyasagar, Keshab Chandra Sen, Raja Peary Mohan Mukhrjee along with other remarkable individuals bear amble testimony to his polymath creativity and charisma.[4]

'History,' it has been said, 'is unkind to polymaths.' Peter Burke has hinted that some polymaths are forgotten, while many are 'squashed into a category we can recognize.'[5] Therefore, it is pertinent to start with Sircar based on a category we have associated him with the most. Needless to say, Dr. Mahendra Lal Sircar the homeopath has been frozen in frame as the founder of IACS, where he sought to cultivate science for national regeneration. Sircar besides this vocation wore many hats and was an intellectual and cultural interlocutor of considerable eminence and excellence.

Born on 2 November 1833, in Paikpara into a 'family of actual tillers of the soil' about eighteen miles west of Howrah, Sircar went on to become an allopathic doctor. [6]He passed his LMS examination in 1860 obtaining the highest honours in medicine, surgery, and midwifery with several scholarships.[7] In the same year, Mahendra Lal and his wife Rajkumari were blessed with their only son, Amrit Lal Sircar[8] topped the MD examination acquiring the first position in 1863. After Chandra Kumar De, Sircar became the second MD from Calcutta Medical College. While in May 1863, Sircar referred to homeopathy as an occult science and regarded its pursuit by any intelligent person as unworthy, this position did not last long.[9] Sircar's disquiet over the failure of dominant western medicine to effectively confront epidemics like cholera[10] grew sharper in the years immediately following his celebrated address, in which he had so forcefully and disparagingly denounced homoeopathy. A journalist friend invited him to review Morgan's ***Philosophy of Homoeopathy for the Indian Field***. Initially seeing this as a chance to expose what he assumed to be an absurd system, Sircar agreed. Yet his first reading of the Hahnemanian intervention persuaded him to conclude that no fair judgment was possible without practical and deeper familiarity with the method of the new radical pathy and a careful examination of its claims before dismissing them as false was sine qua non.[11]

In his times, Sircar saw homeopathy as a newfound claim to scientific physic, and the rebuttals he faced by the dominant pathy convinced him about the prevailing bane of medical orthodoxy and dogmatism.[12] In January 1868, less than a year after he had publicly declared his faith in homoeopathy, he began editing The Calcutta Journal of Medicine, a journal catholic in name, nature and spirit, with the sole purpose of drawing public attention to the rationale and efficacy of homoeopathy as a medical option in juxtaposition to others without being in dogmatic and unreasonable opposition to any other system.[13] More particularly Sircar was interested in 'drug proving' by homoeopaths, that held the potential possibility to include new drugs that expanded the medicinal repertoire of a doctor to mitigate suffering.


THE

CALCUTTA JOURNAL

OF

MEDICINE:

A MONTHLY RECORD OF THE MEDICAL AND AUXILIARY SCIENCES.

That alone is the right medicine which can remove disease :
He alone is the true physician who can restore health.
Charaka Samhitá.

EDITED BY
MAHENDRA LA'L SIRCA'R, M.D., C.I.E.

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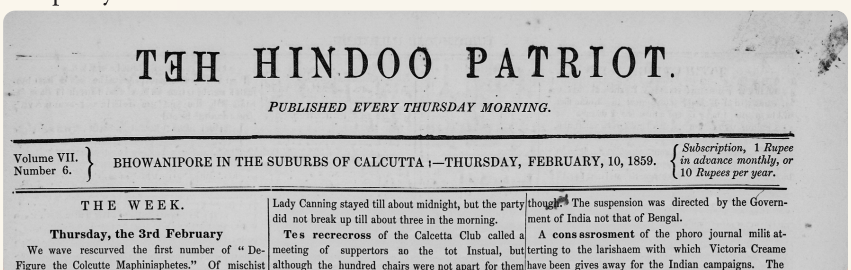
The Calcutta Journal of Medicine, founded by Dr. Mahendra Lal Sircar in 1868

The context that induced Sircar to appreciate homoeopathy for the contention it raised on allopathy and the resolution it offered was based on scientific enquiry and spirit. When Sircar was ridiculed and cornered for his new found appreciation for homoeopathy, he defended himself in the spirit of science. Science not as a dogma but as an ever evolving and regularly refining domain of knowledge and as a moral value. Sircar was clear in his mind that one could not confront the uncertainties of medicine and prevailing physik by dogmatism. It was only through scientific spirit of enquiry that one was to arrive at more reliable medical knowledge. This required dialogue and dialogue in turn required toleration. This led him towards the establishment of IACS and made him amenable towards the cultivation of science as a broader goal that may in future allow for open dialogue in the pursuit of knowledge.[14] The metaphor of 'cultivation' espoused by Sircar stood for inculcating, imbibing, and domesticating science in its epistemological, ontological, methodological and moral forms. It is not incidental, therefore, that he dedicated a great deal of his life, time and energy in nurturing IACS. Initially it was an institution that was demonstrative in nature in the sense that it demonstrated science for the people to imbibe its method and spirit but gradually IACS acquired the status of a site of knowledge production and dissemination.[15]

The Struggle and the Gestation for the Science Association (1869-76)

On 3 January 1870, Sircar formally announced in The Hindu Patriot his proposal to establish an institution to be called the Indian Association for the Cultivation of Science and appealed to the public for donations to realize this vision.[16] It was not limited to Bengal alone, as the reverberations were heard in Odia public sphere as well.[17] Soon, donations were received from several noteworthy citizens such as Jay Krishna Mukherjee (the first donation was received on 24 January 1870), Raja Kamal Krishna Bahadur, Pandit Ishwar Chandra Vidyasagar, Maharaja Joteendro Mohun Tagore, and Rajendra Lal Dutt, among others.[18] Keshab Chandra Sen, widely known as a religious reformer and mystic, also made notable contributions to the advancement of science in India.[19] On 28 November 1870, Sen founded a workingmen's institute and a technical school, providing instruction in carpentry, watch-repairing, lithography, engineering, and related skills. Appreciating Sircar's larger vision for science, Sen aligned himself with Sircar and Father Eugène Lafont in the emerging science movement. Speaking at the Medical College on 1 February 1871, Sircar warned, "it


THE HINDOO PATRIOT.

PUBLISHED EVERY THURSDAY MORNING.

Volume VII. Number 6. BHOWANIPORE IN THE SUBURBS OF CALCUTTA :—THURSDAY, FEBRUARY, 10, 1859. *Subscription, 1 Rupee in advance monthly, or 10 Rupees per year.*

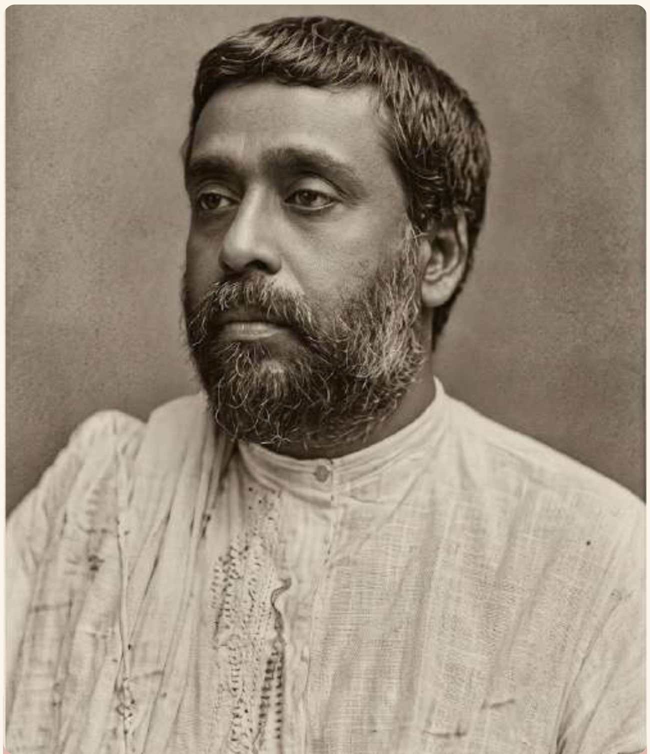
THE WEEK.

Thursday, the 3rd February

The Hindu Patriot

would be a shame if the elaborate and generous system of Government education were to result in a generation incapable of appreciating the revelations of science."[20]

Several modest donations proved significant not for their monetary value, but for the intellectual authority they represented. Contributions came from figures such as Ishwar Chandra Vidyasagar, Dwijendranath Tagore, Gunendranath Tagore, Dwarkanath Mitter, Kristodas Pal, Nawab Abdul Lateef, Gooroo Dass Banerjee, Keshab Chandra Sen, Surendranath Banerjee, Rajendralal Mitra, Ananda Mohan Bose, Bankim Chandra Chatterjee, and Ganesh Chunder–all prominent names in contemporary intellectual life.[21] Among the benefactors, two merit special attention: Kanai Lal Dey and Babu Omesh Chunder Dutt. A medical graduate, Dey served as Assistant Surgeon and Chemical Examiner at the Campbell and Calcutta Medical Colleges. Dey authored a seminal work on medical jurisprudence and was equally revered as a discerning connoisseur of indigenous medicine. His landmark tome, Indigenous Drugs of India (1867), stands as a



Amrita Lal Sircar, son of Mahendra Lal Sircar

testament to his deep engagement with India's pharmacological traditions. In recognition of his scholarship and authority in the field, he was elected president of the pharmacology section of the Indian Medical Congress in 1894, and the following year was appointed to the Central Indigenous Drugs Committee by the government.[22]

An honorary member of the Pharmaceutical Society of Great Britain and Ireland, he delivered lectures on physics at the Medical College during 1873–74. Though expected to begin chemistry lectures at the Science Association in 1876, he did not do so, having perhaps turned more decisively towards physics. By 1879, he was conducting scholarship examinations in chemistry at the Science Association and offering a prize for proficiency in physics, also awarded to Mahendra Lal Sircar's son, Amritalal. Omesh Chunder Dutt also remained steadfast in his support to the Science Association.

The Maharaja of Pattiallah (Patiala), Maharani Sarnamayi (Kasim Bazar), Srimati Darimba Devi, widow of late Govind Prasad Pandit, Raniganj, proved to be early benefactors of the science movement launched by Sircar and Lafont. The list of subscribers and donors in the 1870s have also Maharaja Ramnath Tagore Bahadur, Maharaja Narendra Krishna Dev Bahadur, Maharani Shamamoni of Dinagepore apart from Hon'ble Durga Charan Law and Pandit Mahesh Chandra Nayaratna.[23] Others who become subscribers and donated money to the Science Association included, Babu Kalikissen Tagore, Raja Odoy Pratap Singh Bahadur of Bhinga, and in later years Maharajas of Darbhanga, Cooch Behar and Vizianagram.[24] It must be noted that from among the emerging middle class comprising doctors, teachers, pleaders, school inspectors and the likes donated and subscribed to the IACS scheme in good numbers. This speaks of the convergence of conviction for the need and necessity of a native institution for science cultivation.

Sircar was well aware of the importance of official support and legitimacy as being 'the only key to unloose[n] the purse-strings of his wealthy countrymen.'[25] After languishing for almost seven years, the project drew the attention of the then Lieutenant Governor of Bengal, the passionate and pragmatic administrator, Sir Richard Temple who lent his whole-hearted support. Sir Richard Temple was also one among the subscribers in 1876. In February1876, the Bengal Government agreed to give a house for a term of years to the Association provided it raised £7,000 and invested £5,000 in government securities, with monthly subscriptions of at least £10 for two years.[26]

IACS and the Indian Renaissance

The IACS's establishment on 29 July 1876, has been regarded as '**a milestone in the history of renaissance of modern India.'**[27] The Association itself was founded with the objective of 'enabling the natives of India to cultivate science in all its departments by original research and its varied applications to the arts and comforts of life.'[28] From its earliest days, the

IACS organized regular lectures in physics, chemistry, and botany. Initially, the Association struggled with sparse attendance and a shortage of both students and teachers. Over time, however, lecture halls filled with eager learners, and many accomplished scholars stepped forward to teach voluntarily. This growing success was further strengthened by the Association's ability to adapt its programmes to the evolving requirements of the university system.[27]

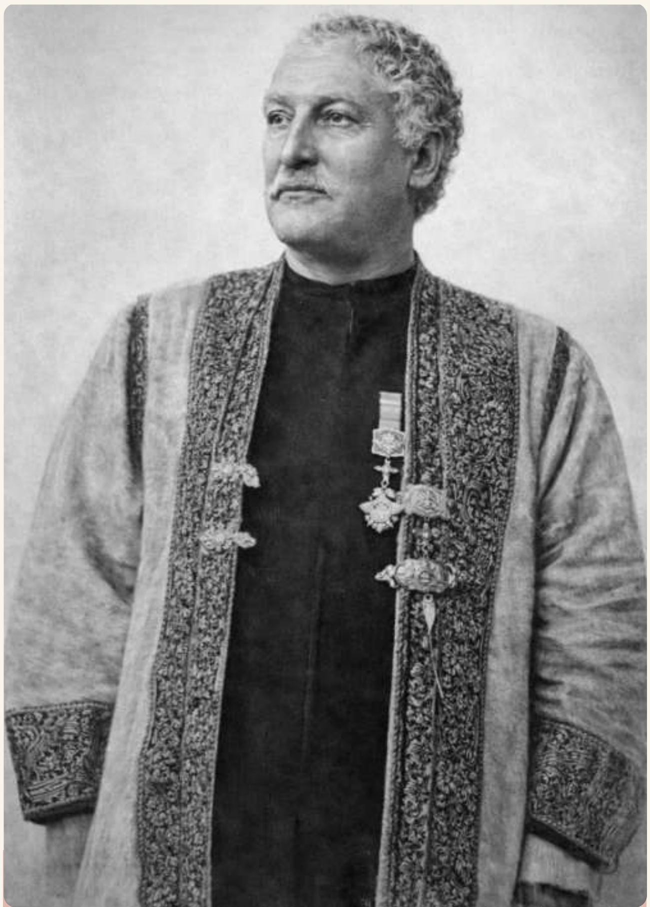
Sircar had envisaged the IACS as an institution where Indians after completing their university education would, on their own initiative, conduct original research work in the different branches of science. His sole idea was **'to popularize science among his countrymen and to found a National Institution "entirely under Indian management and control," where his people would pursue those investigations which unravel the mysteries of Nature'**.[30] He practically devoted his entire life to the fulfillment of the objectives that he had laid for the Association–'its prosperity was his happiness, its adversity his grief.'[31]

Apart from his role as a physician and the founder of IACS, Sircar was now a public figure shouldering several responsibilities. In 1877 he was appointed Honorary Presidency Magistrate and in 1883 he was made a CIE. In 1887, he was appointed the Sherriff of Calcutta and member of the Bengal Legislative Council by three successive Lieutenant Governors until 1893. Despite his demanding public life, Sircar's commitment to the IACS never waned, and the Association–though modest in origin and financially insecure–was steadily taking shape as a centre of scientific learning.

In March 1880, Lord Lytton and his staff went to hear a lecture by Sircar on the 'Ultra-Gaseous State of Matter,' and at the close of the lecture, the Viceroy also made an eloquent speech.[32] In 1884, Lord Ripon inaugurated the Lecture Hall at the IACS.[33] The Viceroy, in declaring the building open, said it would be an honour to connect his name with the Professorship, and he readily agreed to the proposal made by subscribing one thousand rupees for the purpose.[34] The Viceroy was responding to the proposal of "The Ripon Professorship". By 1891, IACS had a proper lecture hall and in the following year it had a new separate building for its laboratory known as the Vizianagram laboratory whose foundation stone was laid by Lord Lansdowne a year earlier. Sircar viewed the building only as the outward shell of the laboratory and reiterated that the 'life blood…is constituted by instruments of illustration and research, and the animating spirit must be the men who will devote their lives in it to use those instruments for the exploration of Nature.'[35] From time to time until Sircar's death there were subscriptions made to the Ripon Professorship fund enabling subscribers to become life members of the IACS.[36] Unfortunately, the fund did not become large enough and Sircar failed to see the fund materialize as the financial basis for a Professorship during his lifetime.

The Role of Raja Peary Mohan Mukherjee

Peary Mohan Mukherjee (1840-1922) continued with his late father's subscription of Rs. 200 a year for prizes and Rs. 300 a year as subscription to the general fund. The entire amount which the Raja had left at the Association's disposal to utilize in any way was again used for instituting two scholarships 'in the name of the late Babu Joykissen Mookerjee who was one of its early patrons, and that of Raja Peary Mohan, who [continued to be] one of its staunchest supporters'.[37]



Raja Peary Mohan Mukherjee

Raja Peary Mohan worked closely with Sircar through every phase of the Association's development, helping it withstand repeated financial and institutional strains.[38] After serving as Vice-President for nearly twenty-five years from its inception, he became its first non-official President in 1912, when the Lieutenant-Governor of Bengal declined to assume the office, breaking with earlier convention. He continued to guide the Association with notable efficiency until his death in 1923.[39] A cursory look at the writings and speeches of Peary Mohan makes it hardly surprising that he emerged as one of the central pillars of the early science movement. The Raja, a modernist by orientation was a keen observer and participant in the intellectual world of the second-half-nineteenth-century Calcutta.

Speaking on malaria in 1910, he emphasized how his definition of the disease was taken from 'a medical dictionary published only the year before (1909) and not 'from a lay dictionary of the 16th century.'[40] Similarly, at a speech delivered in the Town Hall, Calcutta, on 'Industrial Education,' he maintained that 'prosperity reigns where science and art count their votaries by millions.'[41] Peary Mohan, in this sense, was not a benefactor alone, but had a temperament of a co-traveller of the science movement, who believed in the vision of Sircar.

Towards Cultivation and Institutionalization of Science

Father Lafont began lecturing in physics for the Science Association in 1876 and continued until 1893. Covering topics like light, sound, and general physics, he delivered 20–30 lectures annually–nearly 400 in total–besides numerous popular lectures at other venues across the city as well. Rajendra Nath Chatterjee taught optics and general physics from 1894 for several years, while lectures on astronomy were introduced in 1880 by the Jesuit Father A. de Peneranda. Sircar first began his lectures on static and dynamic electricity and magnetism and later added heat to his subjects of discourse. Jagadish Chandra Bose's academic success in England and his return to India were noted in the Indo-European Correspondence, and the following year he undertook one of his earliest assignments in India–assisting Father Lafont and the Science Association in organising practical experimental work.[42]

In 1887, Asutosh Mukherjee was elected a Fellow of the Royal Society of Edinburgh for his contributions to mathematics, after which Sircar and Lafont promptly enlisted his services for the IACS. Between 1887 and 1890, he delivered a series of lectures on physical optics, mathematical physics, and pure mathematics.[43] Similarly, Pramatha Nath Bose (1855–1934), a student of Father Lafont, was a geologist and the first Indian scientist to practice professionally. He discovered the rich iron ore deposits of Mayurbhanj State, later developed by the Tata Steel Company founded by Jamsetji Nusserwanji Tata. The major leaps towards professional science did not stop with individuals but multiplied as institutions. For instance, Ruchi Ram Sahni candidly reported that the lectures at 'Dr Mahendra Lal Sircar's Institute' only 'led myself and Professor Oman to start the Punjab Science Institute at Lahore.'[44] The protagonists of Orissa Bigyan Prachar Samiti–which was established in 1949 were also clearly inspired by IACS, Sircar's Bigyan Sabha had been prominent in the minds of Odia public since 1869.[45]

The early twentieth century marked a decisive turning point in the history of the Association with the arrival of CV Raman.[46] From 1907 onwards, Raman's association transformed the institution into a centre of original scientific research. Working largely in his spare time while employed in the Indian Finance Department, he carried out pioneering experiments in acoustics and optics that brought international recognition to the Association. Raman was fortunate in receiving full support from Amrit Lal Sircar and also from Raja Peary Mohan Mukherjee and his family as far as logistics and finances of his early experiments were concerned.

The Peary Mohan passed away in 1923, but his descendants continued their support to IACS and Raman. K.S. Krishnan as an able researcher and disciple along with Ashubabu or Ashutosh Dey by their exertions also helped Raman to tide over day to day difficulties in setting up experiments.[47] Raman's Nobel Prize in 1930 retrospectively vindicated Sircar's founding vision, demonstrating that research of the highest order could emerge from an institution founded and managed by Indians.[48] At the same time, his tenure exposed the fragility of an organization reliant on individual brilliance rather than sustained institutional support.

Following Raman's unfortunate departure from Calcutta, the need for professional administration and stable research leadership became increasingly evident. Raman's successor K.S. Krishnan arrived at the Association in 1933 and established a pioneering school of modern magnetism and structural physics. Krishnan, temperamentally softer than Raman, kept doing good work with his associates like Santilal Banerjee and B.C. Guha.[49] He was elected as a Fellow of the Royal Society (London) in 1940, and left IACS in 1942 to become Professor of Physics at Allahabad University.

Fortunately, Meghnad Saha had already arrived in Calcutta since he had joined as a Palit Professor and head of the Physics Department in the University College of Science and Technology in July 1938.[50] Saha was a life member of IACS since 1926 but had not engaged actively in its management. After the death of Nilratan Sircar in 1942, U.N. Brahmachari was elected as president of IACS. Saha became secretary in 1944.

After Brahmachari's death in 1946, Saha was elected as the president. He played a crucial role in not only reorganising research activities but also spearheaded the expansion of the Association.

Meghnadh Saha secured funds from the government to purchase 10 acres of land at Jadavpur, since there was no scope for expansion at Bow Bazar Street. He also persuaded the Government of India to raise the annual grant from Rs. 20,000/– to Rs. 350,000/– per year.[51] A new building at Jadavpur was built under his supervision, and in 1951 the IACS relocated there, where it continues to function. Under his leadership, research programmes were diversified and expanded, institutional governance strengthened, and the Association was brought into closer alignment with national frameworks of scientific planning.

Saha's appointment in the 1950s as the full-time Director of the Association marked the culmination of IACS's long transition towards professional science. In the context of India attaining independence Saha's vision differed in significant ways from that of Sircar. While equally committed to scientific autonomy, he placed greater emphasis on integration with state-supported research institutions and universities. This shift reflected broader changes in India's scientific landscape, as science increasingly became an arena of national policy rather than civic philanthropy.

The history of the IACS from its intellectual, cultural and civic origins in the late 1860s to its professional consolidation in the twentieth century reveals a complex interplay of vision, constraint, and adaptation. Founded as a civic experiment in scientific self-reliance, it survived decades of financial uncertainty and institutional fragility through the commitment of individuals who believed that science was central to India's moral and intellectual future. Raman came to IACS as a researcher pilgrim scientist who through his work earned the Nobel and brought IACS and India fame and limelight. Saha returned to Calcutta as the prodigal son of the soil and reconfigured rather redeemed the IACS to a new place at Jadavpur. The pilgrim scientist and the prodigal son both contributed immensely to Sircar's lofty vision and brought greater glory to the nation in its march towards self-reliance.

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49. D.C.V. Mallik and S. Chatterjee, Kariamanikkam Srinivasa Krishnan: His Life and Work (Delhi: Orient BlackSwan, 2011).

50. Meghnad Saha (1893–1956) was an eminent astrophysicist and nuclear physicist, Saha was also a visionary organizer of science and an engaged humanist. He played a decisive role as the principal architect of the post-independence reorganization of the IACS.

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When Science Met Society

The Making of Scientific Bharat

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The emergence of modern science in India during the nineteenth century did not occur suddenly within laboratories or universities. It developed gradually through a wider intellectual awakening that reshaped the cultural and educational life of the country. Across Bengal and other regions, reformers, educators, writers, and thinkers increasingly recognised that scientific knowledge grounded in observation, experiment, and rational inquiry could play an important role in the progress of society.

During this period, Bharat experienced a significant transformation in its intellectual life. A new generation of thinkers began to argue that knowledge based on reason and empirical observation could expand intellectual horizons and influence social change. This awakening formed part of the Bengal Renaissance, a period marked by debate, reform, and the search for new ways of understanding the world. Indian scholars engaged with modern ideas while reflecting on how these ideas could be interpreted within Indian society.

The movement was therefore not only a phase of social reform and literary revival. It was also a moment when the foundations of modern scientific thought in India began to take shape. Gradually a powerful idea emerged that the country needed institutions devoted to scientific learning and research. Such institutions would help cultivate scientific inquiry within Indian society itself.

The founding of the Indian Association for the Cultivation of Science (IACS) in 1876 represented the realisation of this aspiration. The institution grew out of a wider intellectual transformation taking place across nineteenth-century India, where reformers and scholars increasingly saw scientific knowledge as central to cultural and intellectual progress.

Intellectual Awakening and the Rise of Scientific Thought

The origins of this movement can be traced to the intellectual ferment of nineteenth-century Bengal. Social reformers and educators recognised that modern knowledge systems could play an important role in transforming society. Among the early reformer who helped shape this intellectual climate was Raja Ram Mohan Roy, widely regarded as one of the pioneers of modern Indian thought. Roy strongly supported modern education that included scientific subjects. He argued that the study of mathematics and natural philosophy could encourage rational thinking and intellectual independence. His advocacy influenced debates on education in Bengal and encouraged younger generations to view science as a universal way of understanding nature.

These ideas gradually influenced the intellectual culture of Bengal. Discussions about education, science, and social reform began to intersect, creating an environment in which scientific thinking could take root.

Another influential figure in this transformation was Pandit Ishwar Chandra Vidyasagar, one of the leading educators of nineteenth-century India. Vidyasagar strengthened educational institutions and promoted vernacular learning. He believed that education should nurture reasoning and intellectual confidence. Through his work in schools and colleges, he helped prepare a generation of students capable of engaging with modern scientific ideas.

Education, in this vision, became a means of intellectual empowerment. As access to learning expanded, the idea that science formed an important part of cultural progress gained wider acceptance. Yet while interest in scientific knowledge was growing, opportunities for scientific research within India remained limited.

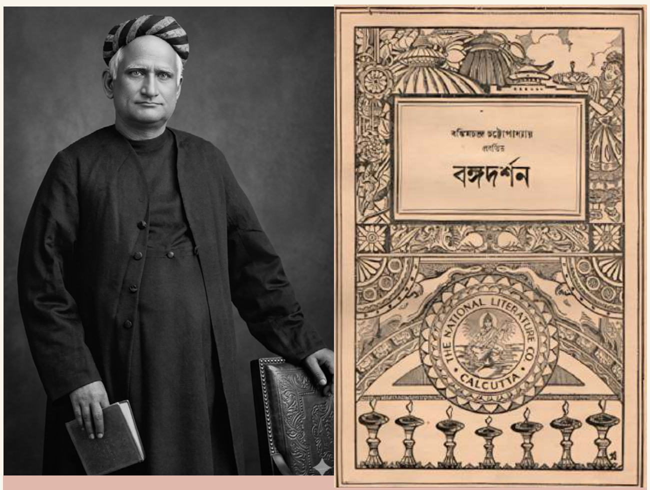
Ishwar Chandra Vidyasagar

Bankim Chandra and the Idea of a Scientific Institution

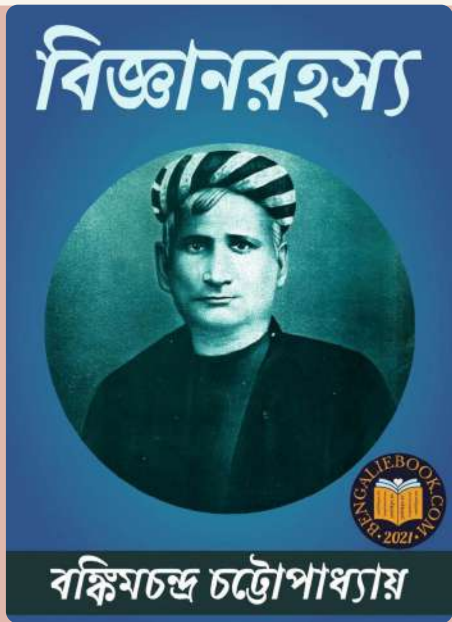
The idea of establishing a scientific institution in India had begun to take shape even before IACS was founded. One of the earliest expressions of this idea came from Bankim Chandra Chattopadhyay, the renowned novelist and editor of the journal Bangadarshan.

Through Bangadarshan, founded in 1872, Bankim Chandra sought to cultivate a broader intellectual culture among Bengali readers, one that included literature, philosophy, and scientific thought. In an essay titled **Bharatvarshiya Vigyan Sabha,** published in the journal in 1872, he argued that the intellectual progress of a nation depended not only on learning scientific ideas but also on creating institutions where experiments and investigations could be carried out.

Bankim Chandra strongly supported the efforts of Dr. Mahendra Lal Sircar, who was advocating the establishment of a scientific association in India. Scientific knowledge, he suggested, should not remain confined to books or examinations. Laboratories, instruments, and communities of investigators were essential for the growth of scientific understanding. These ideas found concrete expression when the Indian Association for the Cultivation of Science was established in Calcutta in 1876.



Bangadarshan, a Bengali literary magazine founded by Bankim Chandra Chattopadhyay in 1872. He aimed to promote scientific education and rational thinking among the Bengali intelligentsia through Bangadarshan.



Bankim Chandra also played an important role in introducing scientific ideas to a wider readership through a series of essays later collected as Vigyanrahasya in 1875

When Science Met Society in the Lecture Hall

One of the most distinctive features of the Indian Association for the Cultivation of Science during its early decades was its vibrant culture of public scientific lectures and demonstrations. These gatherings transformed science from an abstract subject confined to books into a shared intellectual experience that could be observed and discussed by a wider public.

The lecture hall itself became a theatre of discovery. Evenings often began under the soft glow of oil lamps that illuminated rows of benches and a demonstration table arranged with glass prisms, electrical coils, chemical vessels, and polished brass instruments. As the lecture progressed, scientific principles were revealed through carefully staged experiments designed to make invisible phenomena visible.

Electrical induction coils produced bright sparks that crackled across electrodes, while beams of light passing through prisms separated into vivid spectral colours. Chemical reactions generated sudden flashes of colour or heat. Such demonstrations translated theoretical ideas into observable events, allowing audiences to see for themselves how scientific explanations were grounded in experiment and evidence. For many attendees, these moments offered their first direct encounter with experimental science.

The audiences at IACS reflected the expanding intellectual community of nineteenth-century Calcutta. school teachers, lawyers, administrators, journalists, and members of the ***bhadralok*** intelligentsia gathered to hear scientific ideas explained and to observe experiments performed before them. In an era when laboratory facilities were limited and scientific journals circulated only among small academic circles, these lectures provided a rare opportunity for the public to engage with contemporary scientific knowledge.

Their influence extended far beyond the lecture hall. College students attended eagerly, often witnessing experiments unavailable in their own classrooms. School teachers observed the demonstrations so that they could reproduce simplified versions for their pupils. Journalists reported on the events in newspapers and magazines, carrying descriptions of the experiments to readers across the city.

Through these interconnected networks, lecture halls, classrooms, and print scientific ideas began to circulate more widely within society. What began as demonstrations before a curious audience gradually contributed to the growth of a broader intellectual environment in which scientific reasoning became part of public discussion. In this way, the early lecture culture of the Indian Association for the Cultivation of Science played a quiet but important role in shaping an emerging scientific outlook in India.

From Lecture Hall to Laboratory

As the Association grew, its activities gradually expanded beyond public demonstrations. Laboratories were established, instruments acquired, and facilities developed for experimental investigation.

This transition marked an important stage in the growth of modern science in India. Scientific inquiry moved from demonstration before audiences to sustained research within laboratories. Work in Physics and Chemistry began to take shape within the institution.

Yet the public spirit that characterised the early years of IACS remained central. Lectures and demonstrations continued alongside research activities, ensuring that scientific work remained connected to the intellectual life of society.

The journey from lecture hall to laboratory reflected a broader transformation taking place in India. Institutions dedicated to scientific research were beginning to emerge, shaped both by intellectual curiosity and by a growing aspiration to cultivate science within the country.

A Community of Science and Society

Over time the Association became a meeting ground for scientists, educators, and the educated public of Calcutta. Lectures and discussions created an atmosphere in which scientific ideas circulated widely.

Several leading scientists were connected directly or through the broader scientific culture of the city with the intellectual environment surrounding the Association. Scientists such as Prafulla Chandra Ray, Jagadish Chandra Bose, Nilratan Sircar, Ashutosh Mukherjee, Meghnad Saha, Debendra Mohan Bose, and K. S. Krishnan belonged to a generation that helped shape the development of modern science in India.

Within this environment, the laboratories of IACS also became a space for original research. The most celebrated example was the work of Sir C. V. Raman, whose experiments on the scattering of light–carried out with relatively modest instruments, led to the discovery of the Raman Effect. Awarded the Nobel Prize in Physics in 1930, the discovery brought global recognition to Indian science and demonstrated that path-breaking research could emerge from laboratories sustained by Indian initiative.

At the same time, the Association continued to nurture a culture in which science remained visible within public life. Lectures, demonstrations, and discussions ensured that scientific curiosity remained part of the intellectual conversation of society.

Legacy of Scientific Culture

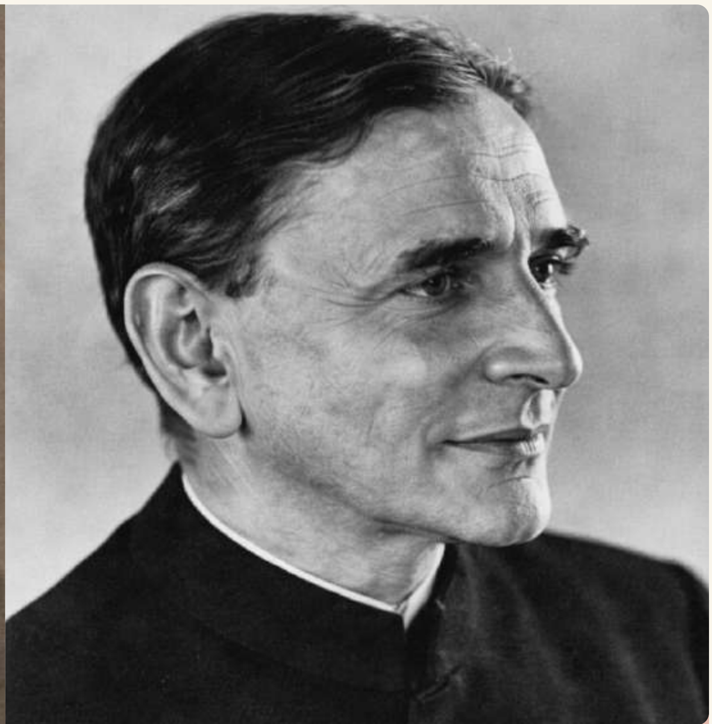
The historical significance of the IACS lies in the way it helped institutionalise scientific inquiry in India at a formative moment in the country's intellectual history. In retrospect, the institution represented far more than the establishment of a research centre, it embodied the conviction that scientific inquiry could become an integral part of India's intellectual and cultural life.

By creating spaces where experiment, discussion, and public engagement could coexist, the Association helped transform curiosity into research and learning into discovery. In those lecture halls and laboratories, the idea of a scientific Bharat began to take institutional form, an idea that would shape the country's scientific journey in the decades to follow.

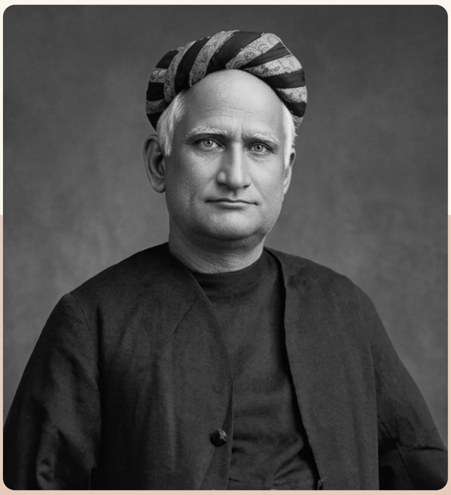
Ashutosh Dey, fondly known as Ashu Babu, was a devoted associate and right-hand man of C. V. Raman at the IACS. Serving as Assistant Secretary and living on campus, he was always available to assist Raman's late-night experiments. For over 25 years, he remained a close collaborator, even co-authoring work on acoustics, including studies on instruments like the veena and mridangam, and helping build a self-working violin.

Importantly, Dey was among the key figures who supported the environment that enabled Raman's Nobel Prize, winning work on the Raman Effect, alongside Amrita Lal Sircar, Ashutosh Mukherjee, and K. S. Krishnan. While Krishnan was the principal scientific collaborator, Dey's constant assistance and dedication made him an indispensable presence in Raman's research journey.

Sir Nilratan Sircar (1861–1943) was an medical doctor, educationist, philanthropist and swadeshi entrepreneur. He was the first Indian President of IACS, taught Physiological Chemistry.



Debendra Mohan Bose (1885–1975) was an physicist known for his work on cosmic rays, artificial radioactivity, and neutron physics. With Bibha Chowdhuri, he first discovered mesons. He served as the longest-serving Director of Bose Institute (1938–1967) and was the nephew of physicist Jagadish Chandra Bose.



Bankim Chandra and the Culture of Science

Bankim Chandra Chattopadhyay (1838–1894) is widely remembered as a pioneering novelist and nationalist thinker, celebrated for composing Vande Mataram. Yet he also played an important role in encouraging scientific thought and rational inquiry in nineteenth-century India. His engagement with science became particularly visible with the founding of the Bengali monthly Bangadarshan in 1872. At a time when modern scientific ideas circulated largely within limited intellectual circles, Bankim Chandra used the journal to bring science into the public domain and introduce readers to new ways of thinking about the natural world.

Through Bangadarshan, Bankim Chandra began writing essays on popular science aimed at intellectually curious readers, senior school students, and educated modern women, whom he believed would help shape a rational and progressive society. These essays were later collected as Vigyan Rahasya (1875), among the earliest systematic efforts to present elementary science in Bengali. Covering subjects such as astronomy, physics, biology, geology, and human evolution, the essays introduced readers not merely to scientific facts but to scientific ways of thinking.

Drawing upon the works of European scientists including Torricelli, Pascal, Lyell, Tyndall, and Huxley, Bankim adapted contemporary scientific ideas into clear and engaging Bengali prose. Essays such as ***Dhula*** (dust and disease), ***Jaibanik*** (protoplasm), and ***Koto Kaal Manushya*** (the antiquity of humankind) illustrate both the breadth of his scientific interests and his ability to communicate complex ideas with clarity.

Bankim Chandra's engagement with science also had a philosophical dimension. In The Study of Hindu Philosophy (1873), he critically examined prevailing intellectual traditions and argued that excessive reliance on deductive and aphoristic reasoning had limited the growth of experimental science, while also acknowledging early Indian achievements and emphasising the importance of sustained empirical inquiry.

His interest in science extended beyond writing to questions of institutions and intellectual culture. In his essay "Bharat Varshiya Vigyan Sabha" (1872), published in Bangadarshan, he argued that scientific progress required institutions devoted to experimentation and research. In this context he supported the efforts of Mahendralal Sircar, whose vision eventually led to the founding of the Indian Association for the Cultivation of Science (IACS).

From Calcutta to the Country

The Spread of the IACS Lecture Model

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The sesquicentenary of the Indian Association for the Cultivation of Science (IACS) in 2026 is a milestone for scientific research in India. It can also be regarded as a landmark for popularisation of science in our country. The reasons are not difficult to see. Mahendra Lal Sircar, the founder of IACS, had pronounced the very ideal for this association in an article in 1869. Under the title 'On the Desirability of Cultivation of the Sciences by the Natives of India' he wrote,

> *'We want a different institution altogether. We want an institution which shall be for the instruction of the masses, where lectures on scientific subjects will be systematically delivered and not only illustrative experiments performed by the lecturers, but the audience should be invited and taught to perform themselves …'* [1]

Sircar, like many other like-minded Indians, was disappointed with the state of scientific enquiry as well as dissemination of scientific knowledge in the country. Thus, he wrote,

'… The only scientific institute of any respect in all India is the Asiatic Society of Bengal. It has done and is doing much for the advancement of science in this country. But it does not present to humble learners any facilities for the present of scientific studies. Nor is it necessary or desirable that it should. It is well that with its higher pretensions it should engage itself in new fields of research.'[1]

Remaining true to his initial plans, Sircar designed the curriculum of IACS in such a way that it could bring science to every interested citizen of the country. This article will not seek to describe the tumultuous years that led to the establishment of the association. That history has been narrated by others in this volume. The idea here is to bring into discussion the culture of public lectures in science that was spawned by IACS. The first person to empathise with the plan of Sircar was Reverend Father Eugène Lafont (1837-1908), the Jesuit teacher and physicist at St Xavier's College. IACS was not a university that awarded degrees to candidates who passed an examination. Rather, it arranged lectures on various disciplines of science. Lafont became the first lecturer of the association in August 1876. Babu Tara Prasanna Roy and Sircar himself joined as regular lecturers in 1878. It is found from the report of the association for the year 1883 that 95 lectures were delivered by the aforesaid three scholars in general physics, acoustics, geometrical optics, chemistry, frictional electricity, magnetism, dynamic electricity and astronomy. As regards the attendees to these lectures, the report stated,

> *'The lectures are attended by students of the Calcutta Colleges, Members of the Association, and by the general public, among whom there is often a small sprinkling of Europeans. The number of audience varies from 40 to 60.'* [1]

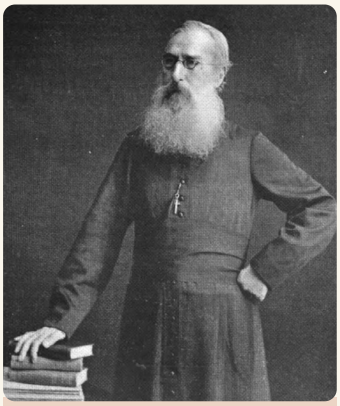
Thus, the lectures at IACS initiated general public into science apart from complementing the knowledge of the students studying in different colleges of Calcutta.

Father Lafont and his Disciples

Jesuit priest from Belgium, Father Lafont, came to teach at the St Xavier's College in Calcutta in 1865. He went on to design and implement an outstanding plan for science education for this institution. The rooftop laboratory set up by him in the college was the first of its kind in India. There, in 1887, he used a barometer to calculate the time of arrival of a devastating cyclone.

The Father Eugène Lafont developded an Observatory at St. Xavier's College, Kolkata and the same was revived after restoration

Lafont shared his prediction with the administration and immediate measures could be taken to save lives. This event turned him overnight into a reliable weather forecaster and 'The Indo-European Correspondence', a weekly published from Calcutta, didn't miss the opportunity to contract his services. He was an excellent speaker and was adept at using experiments while he lectured. Calcutta was then a city with a very small population. It was only logical that Sircar would meet Lafont and seek his support for his proposed association.



Father Eugène Lafont

Lafont had set a very high benchmark for himself. He could impress the audience with just any topic. A report appearing in 'The Statesman', published from Calcutta, is instructive in this regard. On 26 August 1887 the paper reviewed Lafont's lecture on 'Color: what it is' and paid glowing tribute to the speaker.

It commented, '… The exposition although necessarily largely scientific, was made so clear to laymen, that any person of ordinary intelligence was easily able to follow the lecture.' [1]

Lafont brought his skills to IACS and it was but natural that attendees would greatly benefit by his presentations. Ruchiram Sahni, a student hailing from Punjab and enrolled in the Presidency College, frequented IACS and Lafont made a lasting impression on him. In his memoirs we find Sahni fondly recalling the experience of listening to the Jesuit professor,'… There were other lecturers also who appeared on the platform now and again, but in making a difficult point crystal clear and, especially, in creating popular interest in science, no one could approach the Jesuit professor.' Sahni was frank to admit that these were the lectures that propelled him towards starting the Punjab Science Institute at Lahore along with Professor J C Oman. (Sehgal & Mahanti, 1997, pp. 12-13) It was an institute designed to impart scientific knowledge to the people across the province of Punjab.

The titles chosen for the lectures clearly demonstrate the popular nature of such presentations. Dr C C Caleb chose titles like Build of the Human Body, Man's Fear, Smokes: poisonous and non-poisonous. Since Sahni was employed at the Meteorological Department he spoke on the patterns of weather in India. Use of innovative lantern slides endeared him to the audience on every occasion. His lectures were in great demand at all corners of Punjab. As Sahni recalled,

> *'… From all sides there was a demand to us to send out lecturers and, in a very short time, it was even decided to charge a small fee, at the mufassil stations, to cover at least part of the expenses incurred in sending out lecturers generally accompanied by a laboratory assistant and the necessary apparatus to illustrate the lecture. …'*

Sahni had also noticed a student of Lafont taking the stage at IACS to address the audience. This illustrious student, Jagadish Chandra Bose, is regarded as the first modern scientist of India. In 1917 he set up the Bose Institute at Calcutta to make space for serious scientific research in the country. However, he still had Father Lafont's teachings with him and decided to start public lectures aimed at the lay public. His stay in England had given him a first-hand experience of the science popularisation activities undertaken by some of the reputed English scientists.

Ruchi Ram Sahni

When the opportunity arrived, he modelled his institute after the Royal Institution in London and the design of the large lecture hall of the institute best demonstrates the similarity. Bose started giving popular lectures on his research and instituted a small entry fee for the audience just on the lines of what IACS had done four decades before.[2] The culture of public lectures was also supported in the early decades of 20th century by Bangiya Sahitya Parishat. Scientific topics figured prominently among subjects for such lectures and Bose was always in demand as a speaker.[3]

The Raman Impact

Despite great efforts of Sircar, IACS could not bloom into a research institution as he had desired. There were several reasons for this. Sircar passed away in 1904 with discontent in his heart. Thereafter young C V Raman joined IACS in 1907 and as they say, the rest is history. In winning the Nobel Prize for Physics in 1930 he not only earned fame for himself but also made IACS known to the world. In his reply to the civic honour bestowed on him by the Calcutta Municipal Corporation he said,

'… Dr. Sircar devoted a life-time of labour to the institution which he created and equipped in the hope that it would someday be utilised for the advancement of science in India. Its doors were open, awaiting the arrival of someone who could utilise the resources it offered. That arrival happened to be myself. …'[4]

Raman's stay in Calcutta and his association with IACS were characterised by some splendid lectures that he delivered. His biographer A Jayaraman has put it this way,

'Raman excelled in public speaking and could give a lecture on, for instance, Egyptian History, off the cuff. His scientific lectures were a treat, for he was a superb entertainer. They were delivered in a high-pitched resonant voice which reached the entire audience, making loud-speakers unnecessary. …' [5]

C. V. Raman demonstrating an experimental apparatus

Although IACS did not cultivate the Nobel laureate's abilities, Raman's public lectures served to refresh the association's own established legacy. He founded an influential Indian School of Physics, whose members—including K. S. Krishnan, Bidhu Bhusan Roy, and D. B. Deodhar—went on to hold leading positions at institutions across the country.[4] A significant number of these accomplished academicians possessed the oratorical flair they learned from their guru. In this way, they disseminated the culture of public speaking initiated by IACS far and wide. Krishnan deserves special mention for his ability to lace lectures with lively humour. His association with IACS got a second tenure after Raman left Calcutta to take up the Directorship of the Indian Institute of Science in Bangalore. Krishnan was appointed as the first Mahendralal Sircar Professor in 1933.

Amazing Ashutosh

IACS and its founder Sircar nurtured Asutosh Mukherjee, the mathematician, in his youth. He never forgot this debt. At the Memorial meeting of Sircar in 1904 he opened his heart in saying,

'He was not only my father's friend, but after my father's death he was more than a father to me.'

Mukherjee was appointed as Honorary Lecturer of Mathematics in 1887 at IACS and till 1991 he delivered 125 lectures on mathematics and mathematical physics.[6] The sharpness and power of his lectures were of a different class altogether. As everyone knows, he kept up this standard of oration when he moved to different areas like law and educational administration. Dwelling on the initiatives of Mukherjee as the Vice-Chancellor of the University of Calcutta, Nani Palkhivala had once commented,

Sir Ashutosh Mukherjee, The Mathematician and Second Vice Chancellor of Calcutta University

> *'Asutosh was one of the integrators of modern India. He took all India to be his province. …'*[7]

Mukherjee was very impressed by the work of Raman at IACS and wasted no time in recruiting the turbaned scholar as a Professor of Physics in his university. He had also roped in the famous mathematician Ganesh Prasad to occupy the Rasbehari Ghosh Chair of Applied Mathematics.[8] In the same spirit of an integrator, Mukherjee started the Indian Science Congress Association (ISCA) in 1914. It created a national platform for leading lecturers in science in its annual sessions.[9] Thus, the Tiger of Bengal, as he is lovingly referred to in his native place, made the public speaking model developed at IACS seep into the academic and cultural life of the nation.

Living Legacy

In 1898 the famous industrialist J N Tata moved a grand proposal to start a science institute at Bombay. He pledged a large sum of money from his family savings, much more than what IACS could collect through the decades, and asked for matching grants from the government. Sircar attentively followed the course of events as the British government showed some annoyance with the proposal and raised several objections.

Since Calcutta was the capital of the country, Burjorji Padshah, emissary of Tata, had to come to Calcutta in January 1899 to knock at the doors of the relevant government departments. Padshah, warmly welcomed by Sircar, discussed the details of Tata's proposal with the founder of IACS. Sircar was apparently happy to see a wealthy gentleman of his country coming forward to establish a science institute but deep inside he felt disappointment at the neglect faced by IACS. The 1898 proposal ultimately blossomed to see the establishment of the Indian Institute of Science (IISc) at Bangalore in 1909 but neither Tata nor Sircar lived to see the day.[10] It is not possible to directly link the organisation of IISc to the ideals set forth by IACS but it is only logical to assume that the former inspired the creation of the latter. Several key features including public lectures on science remained as an essential part of both the institutions. Another science institute that resembled IACS has been already mentioned – the Bose Institute at Calcutta.

One needs to recall the ambitious plan of Sircar while elaborating on the legacy factor. He said,

> *'We shall be able to institute two series of lectures on each subject, one general for the general public, and the other special for the instruction of few who would like to form themselves into a class to learn the subject. …'* [11]

This element of eagerness to create scientific awareness among the people while trying to tackle an uphill task of constructing a research institute is of acute importance in our present discourse. In the mid-1920s Satyendra Nath Bose, then a young Professor of Physics at Dacca University, pulled together another 11 scholars in the city of Dacca to start a science society called 'Baarojana' (literally meaning twelve participants). The group published science periodicals in Bengali to disseminate scientific knowledge.

Sir Jagadish Chandra Bose demonstrating his Wireless Milimeter Range Wavelength Experiment in 1897

A student of J C Bose, the younger Bose was deeply impressed by Sircar's efforts to initiate scientific enquiry in the country.[12] He went on to establish the first major science society in free India in 1948. Named 'Bangiya Bijnan Parishad', this society reinstituted public science lectures in their full glory.[3] Bose's initiatives were preceded by four professors of Muir Central College at Allahabad (now Prayagraj) who got together to form 'Vigyan Parishad' in 1913. The Parishad initially focussed on publication of a periodical titled 'Vigyan' but later on started, among other things, series of public lectures.[13] Here again, the founder of IACS did not directly influence or inspire them but they had undoubtedly inherited Sircar's legacy.

The history of science popularisation in our country can thus never be imagined without the groundbreaking efforts of Sircar. His legacy continues to enrich our sphere of science communication and the present-day efforts at making public understanding of science more effective.

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The Raman Effect and the Making of IACS: Discovery, Legacy, and Institutional Renewal

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Kolkata

The Beginning: Making of IACS

The birth of modern science in twentieth-century India had its early roots in western scientific thoughts inspired by the Industrial Revolution in Europe. It was a period when British imperialism had firmly gripped the Indian subcontinent, reshaping its economy through legislation, such as, the Permanent Settlement in the agricultural sector during the first half of the nineteenth century. India was yet to wake up from a deep mediaeval hangover of mysticism, superstitious traits and beliefs of its caste-conflict-ridden society before making a positive drift towards a path of renaissance laid-out by the two towering figures, Raja Rammohan Roy and Pandit Iswarchandra Vidyasagar through social reform and education. As the Bengali Renaissance gathered momentum in the latter half of the twentieth century, the great visionary Dr. Mahendra Lal Sircar mooted the idea of an Institute for the pursuit of research and teaching in science as an integral component of the Indian National movement.

> *In 1875, Sircar lamented, "…There is at present a sad deficiency of scientific culture amongst our countrymen. Man must continually be at a subject, observing and experimenting before he can acquire that knowledge of it which will enable him to feel his own deficiencies and deficiencies in the branch of science he has made his speciality, before indeed he can engage with any hope of success in researches which will improve himself and his science."*

On 29 July 1876, the Indian Association for the Cultivation of Science (IACS) was founded with the primary objective of promoting scientific learning and research. As part of its mandate, Sircar declared: ***"The object of the Association is to enable the Natives of India to cultivate science in all its departments by original research and its varied applications to the arts and comforts of life."*** This modest step during the colonial era eventually proved to be a giant leap for Modern Indian science. IACS marked its presence on the global scientific map when Sir C. V. Raman discovered the phenomenon of light scattering, now known as the Raman Effect, at the Association in 1928, for which he was awarded the Nobel Prize in Physics in 1930.

Conceived as part of the nationalist movement, the Association was envisioned as an institution funded entirely by Indians. Dr. Sircar invited public subscriptions through the publication of a prospectus for a registered society in the 3 January 1870 issue of The Hindu Patriot. Several prominent personalities responded and became members of the society, including Pandit Ishwar Chandra Vidyasagar, Rajendra Lal Mitra, Kali Kissen Tagore, Maharaja Jatindra Mohan Tagore, and the Maharaja of Vizianagaram, among others. A vigorous debate arose over whether the Association should focus on pure science or technology; the matter was ultimately settled in favour of pure science at a meeting held at the Senate House of the University of Calcutta on 15 January 1876.

For nearly thirty years after its establishment, the Association functioned primarily as a centre for science teaching. Initially, physics was the only subject offered.

Dr. Sircar himself delivered lectures on heat, electricity, and magnetism, while Father Lafont of St. Xavier's College taught optics, acoustics, and general physics. Lectures in chemistry, begun by Dr. Kanai Lal Dey, were later continued by Tara Prasanna Roy, Ram Chandra Dutta, Rajani Kanta Sen, and Chuni Lal Bose. In 1887, Asutosh Mukherjee delivered a series of lectures on pure and applied mathematics. That same year, Geology was introduced by Pramath Nath Bose. In 1889, Jagadish Chandra Bose returned from Cambridge and conducted practical classes in physics. A course in botany began in 1894, and in 1895 Dr. Nil Ratan Sircar, who later became the first Indian President of IACS, taught physiological chemistry.

The Raman Effect and the Raman Era

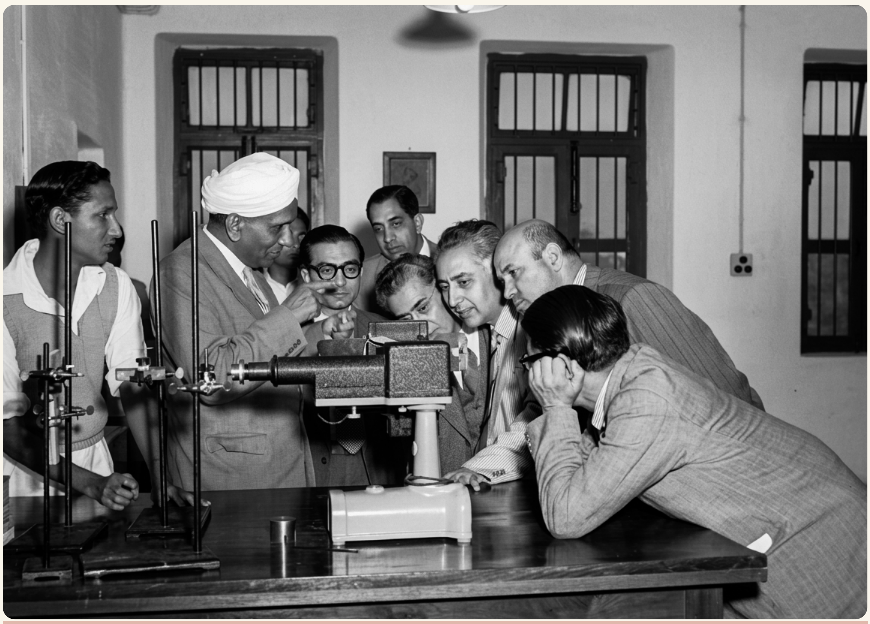
A sweeping transition took place at IACS around 1904, the year Dr. Mahendra Lal Sircar passed away and his son, Amrita Lal Sircar, assumed charge as Secretary of the Association.

A couple of years later, in 1907, the young Chandrasekhar Venkat Raman arrived in Calcutta from Madras as a senior government official in the Office of the Accountant General. By then, Raman had already published several papers in internationally reputed journals as an undergraduate student of physics and was recognized for his academic brilliance. During this period, he happened to come across the IACS, located at 210 Bow-bazar Street in central Calcutta. To pursue scientific research in his spare time after office hours, he became a member of the Association. Within a few months, Raman published an article on polarized light in Nature–the first publication from IACS in a professional scientific journal.

His primary research interests at the time were the physics of vibrations, waves, and oscillations in optics and acoustics. His research on percussion instruments, such as the tabla and mridangam, as well as string instruments like the vina, were widely appreciated by his peers. In 1917, he was offered the Palit Professorship at the University of Calcutta, and in 1924 he was elected a Fellow of the Royal Society. To ensure the regular dissemination of scientific results, Raman almost single-handedly began publishing a bulletin of the Association, which eventually evolved into the Indian Journal of Physics in 1926. Several new areas of physics–particularly the physical optics of scattering, X-ray crystallography, and colloid science–developed under his guidance. Students from beyond the province of Bengal came to join him, and IACS truly acquired the character of a national institution.

Among his students were K. S. Krishnan, D. Banerjee, S. K. Banerjee, S. Bhagavatam, L. A. Ramdas, P. Krishnamurthy, B. B. Ray, S. K. Mitra, Seshagiri Rao, and K. R. Ramanathan, among others. His collaborative work with Krishnamurthy on X-ray crystallography deserves special mention. In 1929, the method of small-angle X-ray scattering was first proposed to investigate amorphous carbon, although its extensive application began nearly twenty-five years later. During this transformative period, IACS evolved from an institution devoted primarily to science teaching into an institute dedicated to the creation of science.

The research of Raman and his co-workers on the scattering of light at IACS in the 1920s has secured a permanent place in the history of science. It was during this period that the inelastic scattering of light, later known as the Raman Effect, was conceptualized and experimentally realized in 1928.

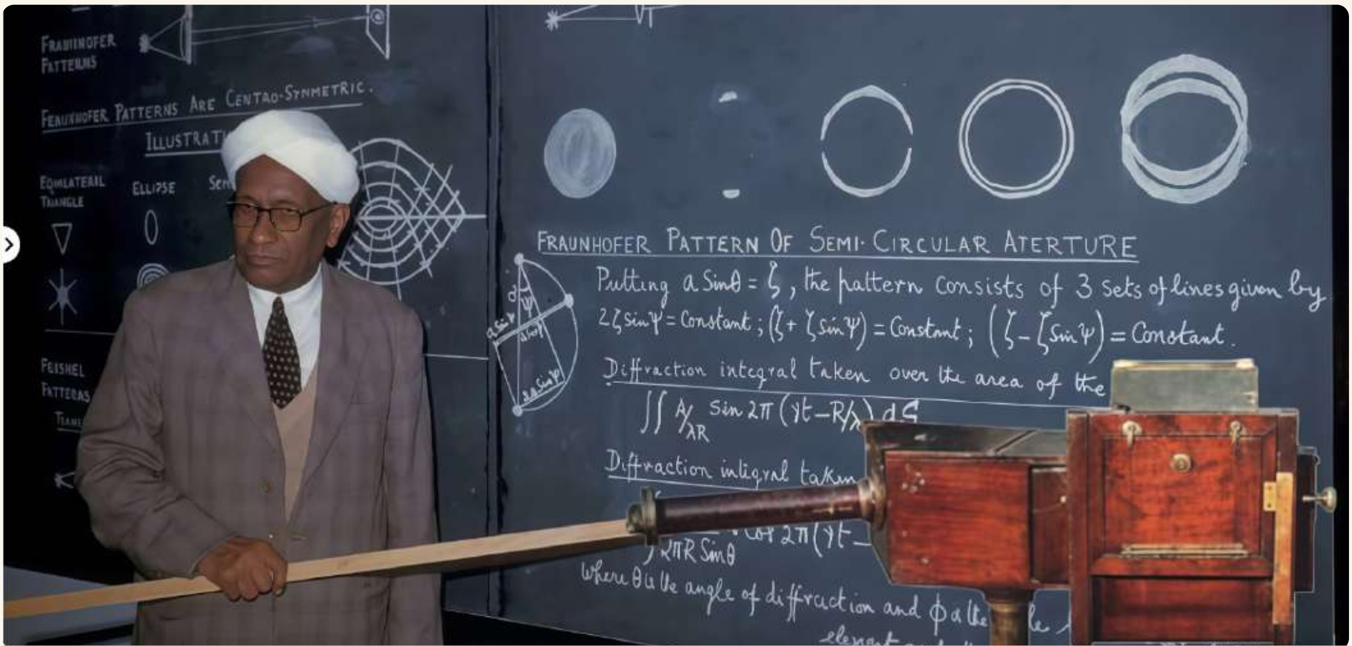

C V Raman explaining the Raman Effect to his students, in1930

The Indian Journal of Physics, the Association's flagship scientific publication

To place this development in perspective, we begin with a brief historical note.

By the end of the nineteenth century, it had been firmly established through the work of Newton, Maxwell, and Faraday that light is an electromagnetic wave. However, in 1900 Planck demonstrated that equilibrium radiation in a closed cavity exchanges energy with its walls in discrete quanta–an idea entirely foreign to classical physics.

Rayleigh had shown that when a particle (molecules or atoms) is irradiated with monochromatic light whose wavelength is much larger than the particle's dimensions, the scattered light retains the same wavelength (elastic scattering) but with reduced intensity. The intensity of the scattered light varies inversely as the fourth power of the wavelength. This phenomenon explains the blueness of the sky, as sunlight is scattered by atmospheric gas molecules, with shorter wavelengths (blue light) scattered more strongly in all directions.



C. V. Raman teaching in classroom

A few years later, Einstein showed, in his calculation of the entropy of radiation in a closed cavity, that radiation itself behaves as a collection of quanta, later called photons. The direct application of this idea to explain the ejection of electrons from a metal surface under illumination–the photoelectric effect–met with remarkable success.

The concept of the photon broke new ground again in 1923 when Compton observed the inelastic scattering of X-rays by electrons. In this process, the incident X-ray photon transfers part of its energy to an electron, causing the scattered photon to emerge with lower energy and a longer wavelength.

This discovery greatly influenced Raman, who anticipated that there must exist an optical analogue of the Compton effect. In his own words: ***"…Earlier this year, however, a powerful impetus to further research was provided when I conceived the idea that the effect was some kind of optical analogue to the type of X-ray scattering discovered by Prof. Compton…"*** A classicist at heart, Raman was also deeply influenced by the work of Lord Rayleigh and Stokes in his studies of light scattering in the optical range of the spectrum.

After careful investigations over several years, involving nearly sixty liquids, Raman and his co-workers observed a faint incoherent component in the scattered light, about an order of magnitude weaker than the primary radiation.

He identified this as a new kind of secondary radiation. The frequency of the scattered light could be either higher or lower than that of the incident light, depending on the interaction involved. Thus, if the frequency of the exciting light is $v_{excitation}$ and that for the scattered light is $v_{scattered}$ then one may write

$$h\nu_{scattered} = h\nu_{excitation} + \Delta E$$

where h is the Planck constant and E is the energy exchanged with the particle. If E is positive (blue shift) the particle drops to a lower energy state and if E is negative (red shift) the particle is shifted to a higher energy state. When the scattered frequency is less (greater) than the excitation frequency the spectral line is termed as Stokes (anti-Stokes) line. Raman effect is thus a phenomenon of inelastic scattering of light. When E is zero we have the usual Raleigh scattering (elastic).

The energy difference E contains important information about the system. One may attribute this quantity to the energy difference between two rotational or vibrational states of a molecule, or between two atomic states characteristic of the molecule or atom itself. The Raman spectrum thus serves as an important fingerprint of a molecule. From a classical standpoint, the electric field component of the incident light along a given direction polarizes the molecule, effectively distorting it into an anisotropic ellipsoid. This time-varying polarization radiates in all directions. The scattered radiation is typically collected in a direction perpendicular to the direction of excitation.

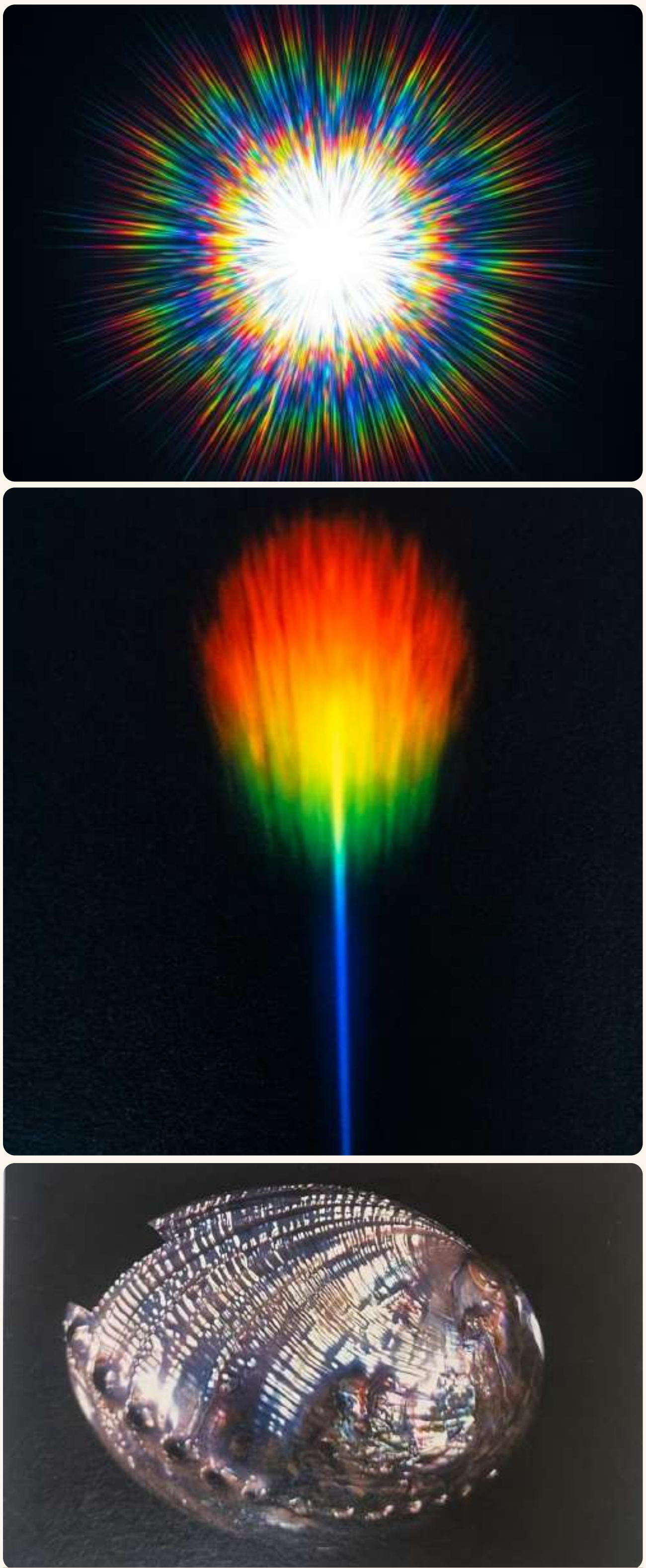
Although the Raman effect is universal, an important question arises: are all molecules Raman-active? This requires further analysis. It is well known from the theory of radiation–matter interaction that, to exhibit a pure vibrational or rotational absorption spectrum, a molecule must possess a permanent dipole moment. This stringent requirement excludes a large class of molecules, such as H_2, O_2, and Cl_2. However, these molecules are Raman-active due to induced polarization, allowing one to extract molecular parameters such as internuclear distances and vibrational frequencies. The vibrational absorption spectrum and the Raman spectrum therefore provide complementary information.

The far-reaching consequences of this discovery were immediately apparent to Raman himself. In formally announcing the result on 16 March 1928 in Bangalore, he remarked: "…We are obviously only at the fringe of a fascinating new region of experimental research which promises to throw light on diverse problems relating to radiation and wave-theory, X-ray optics, atomic and molecular spectra, fluorescence and scattering, thermodynamics and chemistry. It all remains to be worked out…"

Raman spectroscopy, as a new scientific discipline, received fresh impetus with the advent of the laser in the early 1960s and has since evolved

C. V. Raman with his apparatus used in the study of light scattering

C. V. Raman conducting a laboratory experiment tremendously over nearly a century. Its developments may broadly be categorized into advances in instrumentation–such as dispersive and Fourier-transform (FT) Raman techniques; specialized methods including surface-enhanced Raman scattering (SERS) and tip-enhanced Raman scattering (TERS); nonlinear techniques such as stimulated Raman scattering (SRS) and coherent anti-Stokes Raman scattering (CARS), which offer higher sensitivity and speed and are widely used in microscopy; resonance Raman scattering for molecule-specific enhancement; spatially offset Raman scattering (SORS) for probing opaque samples; and many others. The list continues to grow.



The Raman Effect- scattering of light observed by C. V. Raman

The Legacy as continued

Raman spent more than a quarter of a century in Calcutta before joining the Indian Institute of Science, Bangalore, in 1933 as its first Indian Director. By that time, a chair Professorship named after Dr. Mahendra Lal Sircar had been instituted at IACS from a fund created through a donation by Raja Bihari Lal Mitra, along with commemorative contributions from others in honour of the late Dr. Sircar. K. S. Krishnan, a former student and co-worker of Raman, became the first Mahendra Lal Sircar (MLS) Chair Professor (1934–1942). Krishnan was a remarkably innovative experimentalist who also possessed a deep understanding of theoretical physics, particularly quantum physics, which at that time was still in its infancy. For more than two decades, he appeared to be the lone Indian practitioner of the quantum approach to condensed matter physics, pursuing both theory and experiment as required. Apart from his collaborative work with Raman on light scattering, his research on crystal magnetism broke new ground.

We may mention two major contributions in this field. First, he developed a technique known as the method of critical torque, used to determine the magnetic anisotropy and absolute magnetic susceptibility of small diamagnetic or paramagnetic crystals. Second, he solved the theoretical problem of correlating the magnetic susceptibilities and anisotropies of crystals with those of their constituent ions and molecules. Among the students associated with this work, and who later fabricated cryogenic setups for low-temperature measurements, were B. C. Guha, S. L. Banerjee, A. Mukherjee, A. Bose, and others. Krishnan was elected a Fellow of the Royal Society in 1938.

The second MLS Professor was Kedareswar Banerjee (1943–1952). A researcher in X-ray crystallography, Banerjee pioneered the algebraic method of phase determination in the Fourier analysis of structure factors. This method was later refined by other researchers and eventually led to the development of the direct methods in X-ray crystallography, for which Karle and Hauptman were awarded the Nobel Prize in Chemistry in 1985.

From Society to Institute: A Transition

Before the Second World War, physics was the only subject pursued for research at IACS. The post-war period brought a global transformation in the practice of science. It was realized that donations from countrymen were too meagre to meet the rising costs of experimental research. Fundamental structural changes were introduced after Independence, when government funding became available on the recommendation of the Five-Year Planning Commission. The old building at 210 Bow-bazar Street was already in a dilapidated condition. In 1947, Professor Meghnad Saha undertook the reorganization of the Association to enable it to play a more significant role in scientific research in independent India. This required substantial expansion, which was not possible at the original premises. A plot of land was acquired at Jadavpur, and the foundation stone was laid by Dr. Bidhan Chandra Roy, the then Chief Minister of West Bengal, on 26 September 1948. The shift to the new premises took place in 1951, and in 1952 the new campus was visited by Prime Minister Jawaharlal Nehru.

Under the directorship of Meghnad Saha, research assumed a more practical orientation. Three new departments in chemistry and three in physics were established, along with a library and a workshop. The first Professor of Organic Chemistry was P. C. Dutta, who introduced the concept of stereo-controlled synthesis in India. P. Ray, a pioneer in elucidating the mechanisms of inorganic racemization reactions (the Ray–Dutta twist mechanism), initiated research on nickel and silver complexes in unusual oxidation states. S. R. Palit pioneered polymer research in India, while S. Basu initiated teaching and research in quantum chemistry in the country.

Meghnad Saha with L Pauling and S.N. Sen at IACS

Amid these developments, IACS also witnessed one of the most profound results in theoretical physics. In a series of papers in the mid-1950s, A. K. Raychaudhuri established what is now known as the Raychaudhuri equation, an essential ingredient in the proof of the Hawking–Penrose singularity theorems describing the origin and evolution of the universe. N. C. Sil, a pioneer of atomic collision physics in India, formulated what is known as the Sil variational principle.

Over the past few decades, research at IACS has diversified under the umbrella of six Schools: Chemical Sciences, Physical Sciences, Biological Sciences, Materials Sciences, Applied and Interdisciplinary Sciences, and Mathematical and Computational Sciences. The Institute has made significant contributions to laser spectroscopy, energy research, functional molecules and materials, biological chemistry, electronic structure and dynamics, high-energy physics, theoretical condensed matter physics, and related areas. It is almost impossible to summarize the current breadth of activity within this short account.

Since 2005, IACS has offered a post-B.Sc. Integrated Ph.D. programme, which evolved into a vibrant BS–MS programme for school-leaving students in 2018. IACS has also attained the status of a Deemed-to-be University under the University Grants Commission Act. The Indian Journal of Physics has recently completed one hundred years of its distinguished existence.

Born out of the Indian national movement during the dawn of the nineteenth-century renaissance, the Indian Association for the Cultivation of Science was founded to fulfil the hopes and aspirations of a subjugated nation despite formidable odds and indifference. It is not merely an institute; it is the cradle of modern Indian science. This brief account is a humble tribute to those whose vision and dedication have shaped its remarkable journey and made today a reality.

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From Bose Statistics to No-Go Theorems: Bharat, IACS and the Quantum Century

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Quantum mechanics emerged in the early twentieth century from the radical realization that nature, at its deepest level, is governed not by deterministic certainty but by probability, superposition, and entanglement. It revealed a universe in which particles behave as waves, measurement shapes reality, and distant systems remain mysteriously correlated across space and time. In doing so, it overturned classical notions of causality and continuity, offering instead a mathematical language of extraordinary precision to describe the subatomic world. From explaining the stability of atoms and the spectra of stars to underpinning technologies such as lasers, semiconductors, and the rapidly unfolding era of quantum computation, quantum mechanics stands as one of the most beautiful and transformative intellectual achievements in the history of human thought. India's engagement with this revolution, however, has been distinctive in both its depth and its historical trajectory, unfolding as a story of intellectual emancipation rather than mere scientific adoption.

At the center of this journey stands the Indian Association for the Cultivation of Science (IACS), founded on July 29, 1876, by Dr. Mahendra Lal Sircar as the first scientific institution in Asia to be "solely native and purely national." Conceived during the ferment of the Bengal Renaissance, the IACS embodied Sircar's conviction that political nationalism without scientific self-reliance was hollow. By creating a space where Indians could pursue experimental and theoretical science independent of colonial imperatives, the IACS transformed science from an imported craft into an indigenous intellectual enterprise, nurturing a culture in which fundamental inquiry was seen as essential to national regeneration.

This ethos achieved global resonance in the early twentieth century, when Dr. C.V. Raman began his experimental work at IACS in 1907, culminating in the 1928 discovery of the Raman Effect–one of the earliest experimental validations of quantum theory outside Europe and India's first Nobel-winning scientific contribution. Around the same period, Dr. Satyendra Nath Bose's formulation of quantum statistics fundamentally altered the conceptual foundations of quantum mechanics, introducing ideas that later enabled Bose–Einstein condensation and reshaped modern many-body physics. Together, these achievements positioned India at the heart of the first quantum revolution.

In the decades that followed, Indian scientists made influential contributions to quantum field theory, entanglement, decoherence, and open quantum systems, and in the twenty-first century have moved decisively into quantum technologies–demonstrating quantum communication, advancing quantum information theory, and developing indigenous quantum computing platforms. In the contemporary era, this tradition is carried forward by figures such as Dr. Rupamanjari Ghosh, whose pioneering work on quantum optics and coherence deepened experimental access to nonclassical light, Dr. Arun K. Pati, whose insights into quantum information, entanglement, and the no-deleting principle reshaped our understanding of quantum limits, and Dr. Lov Grover, whose quantum search algorithm revealed, with startling elegance, how quantum mechanics could outperform classical computation and redefine the very notion of algorithmic efficiency. The launch of the National Quantum Mission in 2023 marks the latest phase of this continuum.

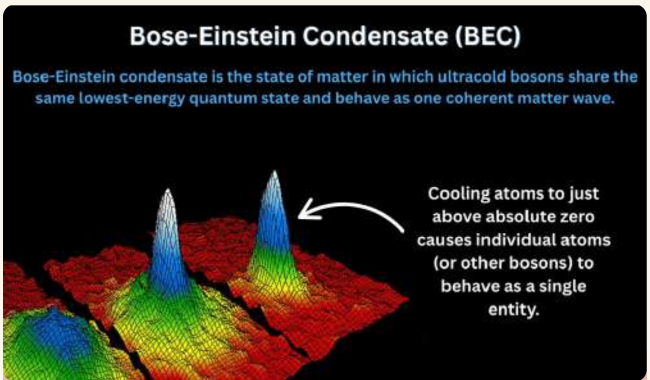
As the IACS approaches its sesquicentennial in February 2026, it stands as both an enduring institution and a powerful reminder that India's quantum future is rooted in a century-and-a-half-old commitment to the cultivation of fundamental science as a cornerstone of national selfhood and global relevance.

The Golden Decade and the Luminaries

The 1920s witnessed an unprecedented surge in Indian physics, with three extraordinary breakthroughs emerging from a land that lacked a traditional modern research infrastructure. These discoveries–the Saha Ionization Equation (1920), Bose Statistics (1924), and the Raman Effect (1928)–were all centered on the interaction between matter and radiation, which was the central theme of the burgeoning quantum revolution in Europe.

In 1924, Dr. Satyendra Nath Bose, a young physicist at the University of Dhaka, authored a paper that would change the course of physics forever. Titled "Planck's Law and the Hypothesis of Light Quanta," the work was sent to Albert Einstein after being rejected by a British journal. Bose had identified a logical flaw in Max Planck's derivation of the blackbody radiation law: it relied on classical Maxwell-Boltzmann statistics for particles while simultaneously using quantum concepts for energy. Bose's revolutionary insight was the introduction of the concept of indistinguishability.

He proposed that identical particles, such as photons, do not possess individual identities that allow them to be tracked or labeled. Instead, the statistics of these particles must be calculated based on the number of ways they can occupy available quantum states. Though his radical departure from classical logic was initially met with hesitation by the European scientific establishment, it was instantly championed by Albert Einstein, who personally translated the manuscript for Zeitschrift für Physik and generalized the theory to encompass matter. This collaboration predicted the Bose-Einstein Condensate (BEC)–an exotic state of matter formed near absolute zero where particles lose their individual character and merge into a single, collective quantum wave.



Bose-Einstein Condensate (BEC)

The impact of Bose's work is monumental. Half of the fundamental particles in the universe are now named "bosons" in his honour, including the so-called God particle – the Higg's Boson!

While Bose was building the theoretical pillars of quantum statistics, Dr. C.V. Raman was conducting systematic experimental studies on the scattering of light at the IACS. Raman's shift from acoustics (where he had studied the harmonic nature of the tabla and mridangam) to optics was driven by a fascination with the blue color of the sea. During a voyage to Europe in 1921, he realized that Lord Rayleigh's theory of light scattering by atmospheric molecules did not sufficiently explain the deep blue of the Mediterranean.

Back at 12 Bowbazar Street, Raman and his assistant K.S. Krishnan used a simple yet elegant setup consisting of sunlight, a set of filters, and a telescope to observe a "feeble fluorescence" in scattering liquids. On February 28, 1928, they confirmed that when a monochromatic beam of light passed through a transparent medium, a small fraction of the scattered light emerged with changed frequencies. This phenomenon, the Raman Effect, provided direct experimental evidence for the quantum nature of light, confirming that photons could exchange energy with molecules in discrete amounts.

The shift in frequency is characteristic of the molecular vibrations of the medium, making Raman spectroscopy one of the most powerful tools in modern chemistry and materials science. Raman's Nobel Prize in 1930 was not just a personal triumph but a vindication of Sircar's dream of an Indian institution capable of original fundamental research. Dr. Meghnad Saha, a contemporary of Bose at Calcutta University, applied quantum principles to the macroscopic world of astrophysics. His Saha Ionization Equation (1920) related the ionization state of an element in a star's atmosphere to its temperature and pressure. By treating a stellar atmosphere as a plasma in thermal equilibrium, Saha used statistical mechanics and quantum theory to show how spectral lines could be used to determine the physical conditions of distant suns.

Under the leadership of K.S. Krishnan, IACS pioneered research in modern magnetism and structural physics. Krishnan's work on the magnetic anisotropy of crystals and the behaviour of transition metal ions provided critical insights into the quantum mechanical origins of magnetism. Dr. Kedareshwar Banerjee, a successor to this tradition, pioneered the "direct method" of crystallography, which used mathematical relationships between the intensities of X-ray reflections to determine the structure of crystals. This was a precursor to the computational structural biology that would later flourish in India. An interesting aspect, when we talk of quantum mechanics and Bharat, is that of interdisciplinarity, which has been such an important part of modern science.

The legacy of Raman's experimental rigor found a unique application in the work of G.N. Ramachandran, who studied under Raman at the Indian Institute of Science (IISc). Ramachandran applied the principles of crystal physics and optics to biological macromolecules, effectively founding the field of molecular biophysics in India. In the early 1950s, Ramachandran and Gopinath Kartha proposed the triple-helical model of collagen, the most abundant protein in mammals. This was followed by the 1963 publication of the Ramachandran Plot, which mapped the sterically allowed conformations of amino acids in a protein structure. This plot remains a cornerstone of structural biology, providing a geometric and energetic basis for understanding protein folding–a process governed by quantum-scale non-bonded interactions. Ramachandran's work also extended to medical imaging; his development of the convolution-backprojection algorithms in 1971 greatly improved the quality of X-ray tomography, laying the foundation for modern CT scans.

The March Ahead

The historical trajectory of Indian quantum science is a century-long arc that connects the foundational statistical formulations of the 1920s to a sophisticated 21st-century technological ecosystem. In its early decades, Indian physicists engaged primarily with the mathematical and conceptual underpinnings of quantum mechanics, often working in parallel with European developments while navigating limited institutional resources.

Between the 1950s and the 1990s, the focus broadened to high-level theoretical groundwork and "quantum-adjacent" breakthroughs in biophysics, optics, and condensed matter physics, establishing India as a significant intellectual node in the global quantum community. E.C. George Sudarshan emerged as a towering figure during this period; his 1963 development of the Sudarshan-Glauber P representation not only proved the equivalence of classical and quantum optics but also provided a rigorous framework that underpins much of modern quantum optics, inspiring generations of physicists worldwide.

In parallel, the Majumdar-Ghosh model (1969), introduced by Chanchal Kumar Majumdar and Dipan Ghosh, became a global benchmark in condensed matter physics as the first exactly solvable frustrated quantum spin system, offering deep insights into quantum magnetism that continue to influence both theoretical and experimental research. Contributions in biophysics, such as G.N. Ramachandran's application of quantum principles to protein structure at Madras University, cemented India's leadership in structural biology long before "quantum biology" entered mainstream discourse, demonstrating a uniquely interdisciplinary vision that combined quantum theory with life sciences.

The 1990s marked a decisive pivot toward information theory and computational paradigms, catalyzed by the global rise of algorithmic thinking and the Indian diaspora's contributions in cutting-edge research institutions. Lov Grover's 1996 discovery of the quantum search algorithm, which provided the first quadratic speedup ($O(\sqrt{N})$) for unstructured data, exemplified this shift and laid a cornerstone for what is now recognized as quantum information science (QIS).

As India entered the new millennium, the focus progressively shifted from theoretical exploration to experimental verification and hardware development. By the 2010s, initiatives such as the QuEST (Quantum-Enabled Science and Technology) program formalized systematic research into superconducting qubits, ion

QpiAI

traps, and photonic systems. Indian experimentalists, particularly those at IISER Mohali, RRI Bengaluru, and TIFR, moved from merely observing quantum phenomena to actively manipulating them, producing the country's first indigenous 3-qubit and 6-qubit superconducting processors and demonstrating capabilities comparable to smaller-scale global labs. These efforts were complemented by growing attention to foundational infrastructure, including low-temperature physics, ultra-stable laser systems, and precision fabrication techniques, ensuring that theoretical breakthroughs could be translated into functioning devices.

By 2026, India's quantum landscape has matured into a "product-first" phase under the National Quantum Mission (NQM), which emphasizes end-to-end technological sovereignty. The recent unveiling of Kaveri, a 64-qubit superconducting quantum processor by the startup QpiAI in late 2025, represents the most powerful indigenous hardware to date, signaling a credible pathway toward the NQM's 1000-qubit target by 2031.

On the communications front, ISRO and the Raman Research Institute have successfully demonstrated free-space quantum key distribution (QKD) over 500 km, and the planned Quantum Communication Satellite in 2026 is expected to extend secure quantum links across the subcontinent. This technological sovereignty is underpinned by an integrated ecosystem spanning the entire stack–from indigenous liquid helium facilities at IIT Bombay for cryogenic cooling to research in post-quantum cryptography at IIT Kanpur–ensuring resilience against both classical and quantum threats. The convergence of decades of theoretical insight, experimental rigor, and industrial innovation underscores India's distinctive model: a nation capable of producing both the intellectual foundations and the tangible technologies of a truly quantum future. Today, India aims to be among the top three global quantum economies, capture over 50% of the quantum software market, and achieve self-reliance in hardware and solutions.

IBM Quantum System Two

Demonstrating tangible progress, India has successfully executed fiber-based quantum key distribution over 380 km and plans to host an IBM Quantum System Two by 2026. The mission supports indigenous startups, research hubs, and talent development, targeting the deployment of 120,000–150,000 quantum professionals by 2040. However, challenges such as import dependency in critical hardware, limited private investment, and the need for enhanced R&D quality remain. With a focus on inclusive and secure development, India is integrating quantum advancements into sectors like logistics, healthcare, defence, and digital public infrastructure, ensuring that its quantum journey aligns with the broader goal of Viksit Bharat by 2047.

The 150-year odyssey from the gas-lit corridors of the Indian Association for the Cultivation of Science (IACS) on Bowbazar Street to the modern advanced laboratories funded by the National Quantum Mission is more than a timeline; it is the definitive biography of the Indian scientific spirit. When Dr. Mahendra Lal Sircar envisioned a space where Indians would "cultivate" science with their own hands, he was not merely seeking academic parity–he was demanding intellectual sovereignty. That seed of self-reliance, nurtured by the likes of C.V. Raman and S.N. Bose, has matured into a forest of innovation. Today, the Indian physicist does not just observe the universe; they interrogate it.

The story of India's contribution to quantum physics and computing is a beautiful illustration of how interdisciplinary and basic scientific research can be synthesized into something truly meaningful for humanity. As we march towards our dream of Viksit Bharat 2047, Bharat stands poised as a primary architect of the quantum age, proving that the pursuit of the quirks of the quanta–the 'smallest' of particles can lead to the 'grandest' of national destinies: that of Atmanirbharata and sustainability.

Building IACS

Patrons, Benefactors, and Early Supporters

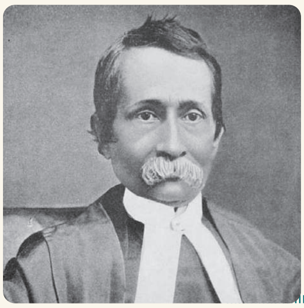
The establishment and early growth of the Indian Association for the Cultivation of Science (IACS) were shaped not only by scientific vision but also by the encouragement and support of distinguished public figures who recognised the importance of creating an indigenous scientific institution in India. As patrons, benefactors, trustees, and advocates, they lent moral authority, social influence, and institutional strength at a crucial formative stage. Their involvement helped build public confidence in IACS and sustained its mission to promote scientific research and the wider appreciation of science in India.

Pandit Ishwar Chandra Vidyasagar stands among nineteenth-century India's most influential educators and social reformers, and an important yet often overlooked aspect of his legacy was his early support for scientific education. At a time when scientific activity in India remained largely within colonial institutions, Vidyasagar recognised that modern science, shaped by reason, observation, and critical inquiry, was essential for social progress, rational thought, and national advancement.

This outlook resonated deeply with Dr. Mahendra Lal Sircar's vision of establishing the Indian Association for the Cultivation of Science (IACS) in 1876 as an independent Indian centre for scientific research and public lectures. Vidyasagar's endorsement lent moral authority and public confidence to the new institution. As a member of the first Trustee Board, he embodied the close connection between educational reform and the growth of scientific culture in India. His lifelong commitment to rationalism and accessible education complemented the mission of IACS to popularise science, illustrating how social reform and scientific awakening together shaped the intellectual foundations of modern India.

Keshab Chandra Sen

A leading social reformer and influential intellectual of nineteenth-century Bengal, served as an early trustee and supporter of the Indian Association for the Cultivation of Science (IACS) during its formative years. As a prominent leader of the Brahmo Samaj movement, Sen advocated rationalism, modern education, and the harmonization of scientific thought with ethical and social progress. His association with IACS reflected his belief that scientific inquiry should be accessible to Indians and integrated into public life. By supporting the institution's founding vision, he helped strengthen its social credibility at a time when independent scientific initiatives required endorsement from respected public figures. As a trustee, his role lay primarily in intellectual and moral advocacy rather than direct scientific work. His support contributed to the early acceptance of IACS as a national institution dedicated to experimentation, public lectures, and the cultivation of scientific temper among Indians.



Gooroodas Banerjee

was an eminent scholar, jurist, and educationist of nineteenth-century Bengal, respected for his intellectual leadership and public service. As an early patron of the Indian Association for the Cultivation of Science (IACS), he lent moral authority and academic credibility, supporting its vision of promoting scientific education and research among Indians.

Rajendralal Mitra

Raja Rajendralal Mitra, distinguished historian, orientalist, and scholar, was among Bengal's leading intellectuals. A strong advocate of modern knowledge, he supported IACS as an early patron, encouraging scientific inquiry and helping bridge traditional scholarship with modern science, thereby strengthening public acceptance of the institution during its formative years.

Surendranath Banerjee

Sir Surendranath Banerjee, nationalist leader, educationist, and influential public speaker, supported IACS as an early patron. Believing education and science were essential to national progress, he endorsed the institution's establishment, helping mobilize intellectual and public support for an indigenous scientific centre dedicated to research and scientific awareness.

Raja Peary Mohan Mukherjee, noted philanthropist and public figure of Bengal, was a major benefactor of IACS. Through financial support and leadership, he contributed significantly to its early stability and later became the first Indian President of the institution, helping guide its growth as a national centre for scientific research.

Akshoy Kumar Datta was a leading Bengali intellectual, rationalist thinker, and advocate of scientific education associated with the Bengal Renaissance. Though not wealthy, he supported the Indian Association for the Cultivation of Science (IACS) through meaningful financial contributions relative to his means, reflecting his deep commitment to rational inquiry, modern science, and public intellectual advancement.

The Maharaja of Vizianagram, a prominent princely ruler and patron of education and culture, provided significant financial support during the early years of the Indian Association for the Cultivation of Science (IACS). His contribution helped strengthen the institution's financial foundation, enabling the establishment of laboratories and public scientific activities envisioned by its founder, Dr. Mahendra Lal Sircar.

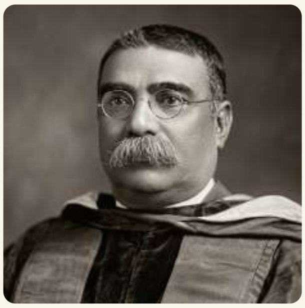
Kali Krishna Tagore, a distinguished member of the Tagore family and noted philanthropist, was an important early benefactor of the Indian Association for the Cultivation of Science (IACS). Known for supporting education and public institutions in Bengal, his financial assistance contributed to the stability and early development of IACS, helping advance scientific learning among Indians.

Eugène Lafont (Father Lafont)

Father Eugène Lafont, Jesuit scientist and educator at St. Xavier's College, was an early scientific influence supporting the establishment of IACS. A pioneer in experimental science teaching in Bengal, he promoted public scientific lectures and demonstrations. His encouragement and participation helped shape the Association's early culture of experimental inquiry and popularization of science among Indians.

Jagadish Chandra Bose

Sir Jagadish Chandra Bose, pioneering physicist and biologist, contributed to the early scientific activities of IACS through lectures and experimental demonstrations. His engagement strengthened the Association's academic profile and inspired public interest in scientific research. Bose's presence linked IACS with emerging indigenous scientific excellence and reinforced its role as a centre for modern experimental science.



Sir Ashutosh Mukherjee, renowned jurist, educationist, and Vice-Chancellor of the University of Calcutta, played an important role as a patron of scientific advancement in India. Deeply committed to the growth of higher education and original research, he believed that the progress of the nation depended on strong scientific institutions that could nurture independent inquiry and intellectual excellence.

His support for the Indian Association for the Cultivation of Science (IACS) reflected this larger vision. At a time when scientific research in India faced institutional and financial constraints, Ashutosh Mukherjee's encouragement helped strengthen the public and academic standing of organisations devoted to scientific work. He recognised IACS as a pioneering space where research, lectures, and public engagement could together cultivate scientific temper beyond the walls of the colonial university system.

As a distinguished public figure and influential patron of education, Ashutosh Mukherjee helped bridge the worlds of academia and scientific research, reinforcing the idea that universities and independent scientific institutions must work in harmony for the advancement of knowledge. His association with IACS forms part of his broader legacy of fostering a modern intellectual culture in India, one that valued scholarship, scientific inquiry, and national self-confidence.

Rai Bahadur Chunilal Bose, noted chemist and educator, played an important role in early scientific teaching and demonstrations associated with IACS. His participation in lectures and academic activities supported the Association's mission of promoting scientific understanding among Indians. Through education and public engagement, he contributed to building IACS as a centre for practical scientific learning.

Contemporary Research at IACS

Physics Research at the IACS

Legacy, Evolution and Future Directions

Prof. Sourov Roy

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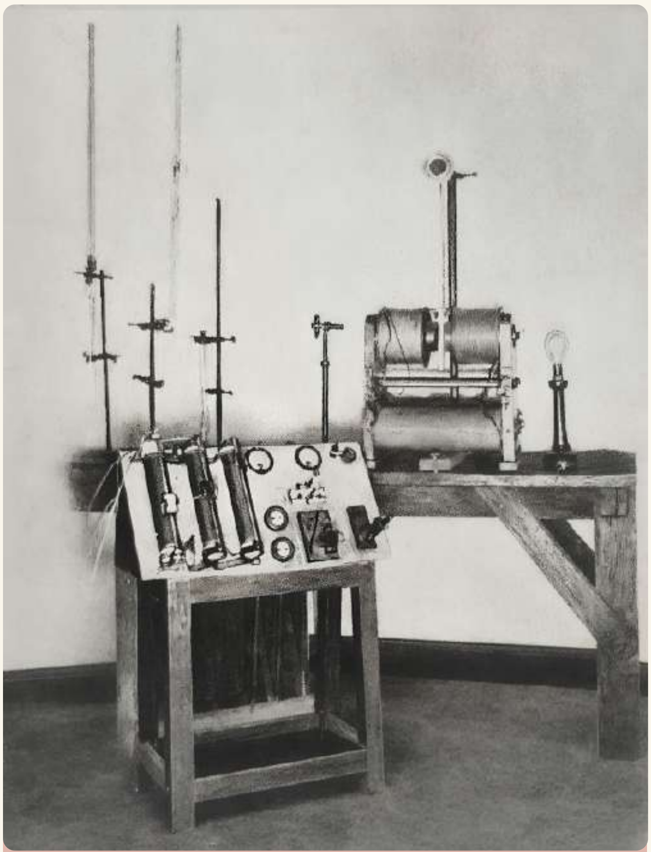
As Asia's oldest research institute, Indian Association for the Cultivation of Science (IACS) was conceived with the explicit mission of fostering indigenous scientific research and cultivating a scientific temper in colonial India. Over nearly a century and a half, the institute has evolved from a pioneering centre of experimental science into a modern, mul tidisciplinary research university, while maintaining a strong emphasis on fundamental physics. Its trajectory mirrors the broader evolution of physics research in India, from early experimental discoveries to participation in global big-science collaborations.

Historical Legacy and Foundational Contributions

The most celebrated landmark in the history of IACS is the discovery of the Raman Effect in 1928 by Sir C. V. Raman, an achievement that brought India's first Nobel Prize in Physics in 1930. The discovery of inelastic light scattering revolutionised molecular spectroscopy and laid enduring foundations for the study of light-matter interactions. This work established IACS as a global hub for physical optics and spectroscopy, disciplines that continue to influence contemporary condensed matter and materials research.

Equally significant were early contributions to crystal magnetism and solid-state physics by K. S. Krishnan, the first M. L. Sircar Professor at IACS. Research on magnetic susceptibility, lattice dynamics, and crystallography helped seed the development of condensed matter physics in India. The institute also served as an intellectual home to luminaries such as Meghnad Saha and Satyendra Nath Bose, whose theoretical insights shaped modern physics nationally and internationally. The founding of the Indian Journal of Physics at IACS in 1926 further reinforced its role as a nucleus for disseminating cutting-edge research.

C.V. Raman's Spectrograph in 1928



K.S. Krishnan's Apparatus at IACS

Evolution of Research in Physical Sciences

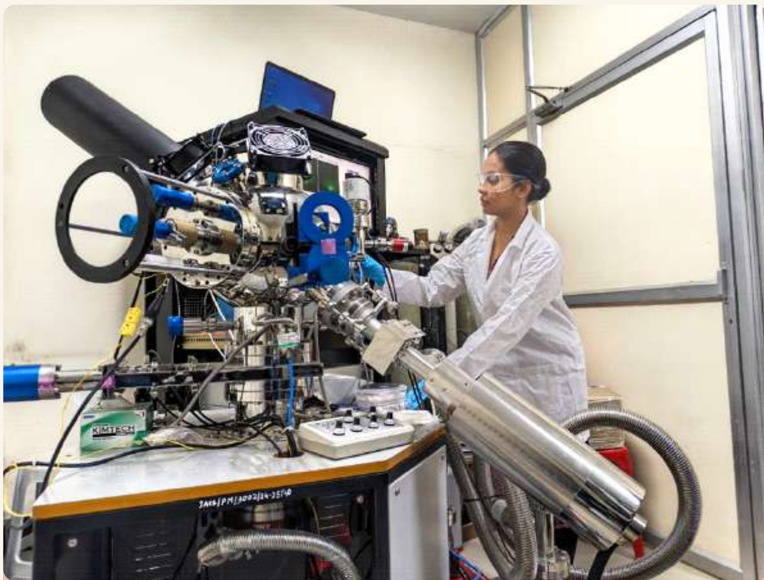
Over the decades, physics research at IACS diversified in response to emerging scientific frontiers. From early emphases on optics and spectroscopy, the institute expanded into atomic and molecular physics, solid-state physics, statistical mechanics, and quantum field theory. By the first two decades of this century, the School of Physical Sciences (SPS) had consolidated research activities into three broad thrust areas: condensed matter physics, high-energy physics, and gravitational physics, supported by strong programs in atomic and molecular physics.

A defining feature of this evolution has been the sustained interplay between theory and experiment. Methodological advances in spectroscopy, scattering theory, and many-body physics provided a common intellectual foundation that later facilitated the growth of both condensed matter physics and high-energy physics at the institute.

Condensed Matter Physics: From Solids to Quantum Matter

Condensed matter physics remains one of the strongest pillars of research at IACS. Building on its historical expertise in solid-state physics and spectroscopy, contemporary research ad dresses quantum and functional materials, strongly correlated systems, and nonequilibrium phe nomena. Experimental programs at the institute investigate crystalline solids, low-dimensional systems, oxides, nanostructures, and functional materials using a broad suite of techniques, including electrical and thermal transport measurements, magnetometry, neutron and X-ray scattering, ultrafast optical spectroscopy, and advanced spectroscopic probes. These efforts address fundamental questions related to electronic correlations, magnetism, lattice dynamics, and phase transitions, while also engaging with materials relevant for energy, sensing, and device applications.

Theoretical condensed matter research at IACS focuses on quantum phase transitions, topo logical matter, unconventional superconductivity, and non-equilibrium dynamics, including Floquet driven systems. Concepts such as quantum scars, Hilbert space fragmentation, and violations of conventional thermalisation paradigms are actively explored, reflecting global trends in many body physics. These studies intersect directly with national priorities in quantum technologies, spintronics, energy-efficient devices, and beyond-CMOS electronics.



Pulsed Laser Deposition (PLD) system equipped with in-situ Reflection High-Energy Electron Diffraction (RHEED) for precise monitoring and control of high-quality single-crystalline thin film growth (IACS)

Theoretical work at IACS increasingly engages with realistic material descriptions and ex perimentally relevant parameter regimes. This includes studies of spin-orbit coupling, disorder, and electron-phonon interactions, which play critical roles in modern quantum materials. Such efforts reinforce a feedback loop between theory and experiment, enabling predictive understand ing and interpretation of complex condensed matter phenomena.

An important and closely related frontier area at IACS is the physics of ultracold atoms and molecules, which occupies a distinctive position at the interface of condensed matter physics, atomic physics, and quantum information science. Research at IACS has contributed theoret ical insights into ultracold collisions, scattering resonances, and controlled formation of cold molecules, complementing experimental advances worldwide in laser cooling and trapping techniques.

High-Energy Physics: From Field Theory to the Early Universe

High-Energy Physics (HEP) at IACS is anchored in a sustained, theory-driven program that connects quantum field theory, particle physics phenomenology, cosmology, and astroparticle physics. Over the past two decades, research has increasingly emphasised building coherent links between fundamental theoretical structures and experimentally testable observables, in line with global developments in particle physics with broader ambits.

Ultra-High Vacuum (UHV) system enabling in-situ, real-time Magneto-Optical Kerr Effect (MOKE) investigations of ultra-thin magnetic films and multilayers at IACS

A major thrust of HEP research at IACS concerns physics beyond the Standard Model. Significant efforts have been devoted to neutrino mass generation mechanisms, including seesaw frameworks, and their phenomenological implications at high-energy colliders such as the Large Hadron Collider (LHC).

Studies of extended scalar sectors and supersymmetric models have explored theoretical consistency, naturalness, and distinctive collider signatures, contributing to the interpretation of data from the Higgs boson era. These investigations place IACS in sync with the national effort supporting India's participation in LHC experiments, particularly through close interactions with various groups engaged in dedicated detector simulation, calibration, and phenomenological studies.

Dark Matter Physics constitutes another central pillar of high-energy research at IACS. Theoretical work spans thermal and non-thermal production mechanisms, portal models linking dark sectors to the Standard Model, and ultra-light dark matter candidates. Particular attention has been paid to the cosmological history of dark matter, including scenarios involving partial or complete thermalisation within hidden sectors.

Using fundamental principles such as unitarity and consistency of quantum field theory, IACS researchers have derived robust bounds on dark matter properties, directly linking microscopic theory to cosmological observables. These studies connect collider physics, indirect detection experiments, and astrophysical data within a unified framework.

Astroparticle Physics and Early-Universe Cosmology further broaden the scope of HEP at IACS. Research on electroweak phase transitions, baryogenesis, and associated gravitational wave signatures exemplifies the convergence of particle physics and cosmology. Multi-messenger approaches, combining collider constraints with observations from cosmic rays, gamma rays, x-rays and gravitational waves, reflect a growing emphasis on interdisciplinary strategies to un cover new physics.

In the Indian context, such efforts resonate with national space and planetary missions. ISRO's Chandrayaan-2 Mission, for example, is closely aligned with astroparticle and high-energy research. Formal developments in conformal field theory, scattering amplitudes, string theory, holography, and categorical methods complement phenomenological studies, situ ating IACS within international efforts at the interface of physics and mathematics.

Gravitational Physics and Frontier Interfaces

Gravitational Physics at IACS provides an important interface between high-energy theory, cosmology, and observational astrophysics, rooted in a distinguished Indian tradition shaped in part by the work of Amal Kumar Raychaudhuri, whose famous equation remains foundational to the modern understanding of spacetime singularities. Research activities focus on both classical and semi-classical aspects of gravity, with particular emphasis on testing general relativity and exploring its extensions in strong-field and cosmological regimes. These efforts align with India's expanding engagement in gravitational wave astronomy, including participation in the LIGO India initiative.

Key research directions include theoretical studies of compact objects such as black holes and neutron stars, especially in binary systems relevant for gravitational wave detection. In vestigations of orbital dynamics, tidal effects, and waveform modelling aim to identify potential imprints of new physics or deviations from general relativity in high-precision observational data. Complementary work on modified gravity theories, including scalar-tensor and f(R) models, explores their consistency and possible observational signatures in astrophysical and cosmological contexts. Studies of signatures of extra dimensions connect theoretical models to observations by current and future gravitational wave detectors.

Quantum and Thermodynamic aspects of gravity form a smaller but conceptually significant component of this program, linking gravitational dynamics to principles of quantum field theory and statistical physics. By engaging with collider experiments, cosmological surveys, and grav itational wave detectors, these programs reinforce IACS's role as a key contributor to frontier physics within India and the global scientific community.

These activities underscore a broader trend in contemporary physics: the convergence of particle physics, cosmology, and gravity into a unified exploration of the early universe and extreme astrophysical environments.

IACS within the Indian Physics Ecosystem

Within the national landscape, IACS functions as a hub for fundamental physics research, complementing mission-oriented programs at institutions supported by the Department of Science and Technology and the Department of Atomic Energy. Strong collaborative ties with HRI, TIFR, SINP, IISc, IISERs, IITs, and international laboratories enable IACS researchers to contribute to large-scale national and global initiatives while retaining institutional autonomy in research directions.

Equally significant is the institute's role in human resource development. Through its un dergraduate, postgraduate, doctoral and postdoctoral programs, IACS has trained generations of physicists who now populate universities, national laboratories, and high-technology sectors across India. This circulation of talent has been central to building national capacity in both condensed matter and high-energy physics.

In addition to theory-driven programs, IACS has steadily strengthened its experimental in frastructure and detector capabilities. Advanced spectroscopic instrumentation, low-temperature measurement facilities, high-field magnet systems, and precision electronic transport setups support cutting-edge condensed matter research. Engagement with Particle and Astroparticle Physics has also fostered expertise in detector simulation, data analysis frameworks, and radiation-matter interaction studies. Such developments not only enhance in-house research but also position IACS to contribute meaningfully to national and international large-scale experi mental collaborations.

Outlook and Future Directions

As India approaches the centenary of its independence in 2047, the legacy and contemporary strengths of physics research at IACS position it as a key contributor to the nation's scientific future. The coming decades are expected to witness deeper integration of high-energy physics, condensed matter physics, and gravitational physics, driven by shared theoretical frameworks, advanced computational tools, and increasingly sophisticated experimental platforms. At IACS, this convergence is already visible in research themes that span quantum field theory, topology, nonequilibrium dynamics, and cosmology.

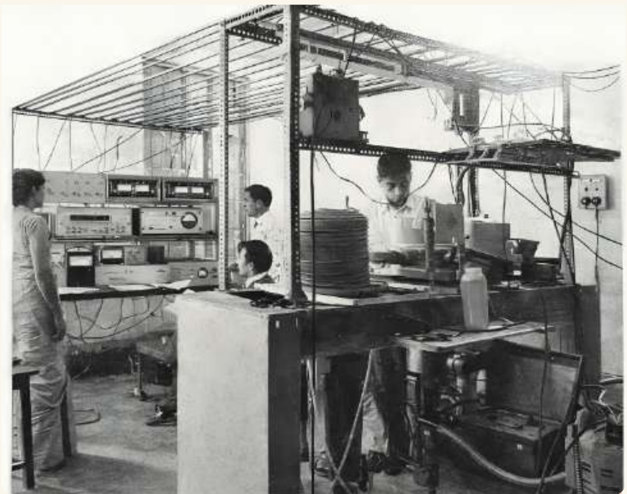
In High-Energy Physics, future directions will be shaped by next-generation collider experi ments, precision neutrino facilities, and the growing impact of multi-messenger astronomy. The Oretical efforts at IACS are well-positioned to contribute to physics beyond the Standard Model, particularly through studies of dark matter, CP violation, and Early-Universe phase transitions. Close engagement with gravitational wave astronomy, including the LIGO-India initiative, is expected to further strengthen links between particle physics, cosmology, and gravity.

In Condensed Matter Physics, the emphasis is likely to shift increasingly toward quantum materials and devices that exploit topology, strong correlations, and coherent control. Research on quantum spin liquids, topological phases, ultrafast dynamics, and hybrid excitations such as magnons and phonons aligns naturally with national missions in quantum science and advanced materials. At the same time, IACS's historical strength in spectroscopy and materials character isation provides a strong foundation for translating fundamental discoveries into device-relevant platforms.

Taken together, the legacy, evolution, and contemporary strengths of physics research at IACS illustrate how a century-and-a-half-old institution can remain scientifically vibrant while adapting to new frontiers. From foundational advances in spectroscopy and solid-state physics to current work in quantum matter, particle phenomenology, and gravitational physics, IACS has sustained a coherent commitment to fundamental inquiry and demonstrated that long-term investment in basic science yields enduring intellectual and societal dividends. Its ability to integrate historical strengths with emerging frontier areas-such as ultracold atoms, topological materials, dark matter, and gravitational wave physics-positions it uniquely within the Indian research ecosystem.

As India aspires to a leadership role in global science and technology, institutions like IACS will continue to play a critical role in shaping both knowledge production and human capital. By nurturing curiosity-driven research with emphasis on fundamental inquiry, fostering national and international collaboration of interdisciplinary nature, and training future generations of physicists through its integrated programs, IACS continues to serve as a cornerstone of India's physics enterprise, thus ensuring that future generations of researchers are equipped to address both foundational questions and societal challenges. In doing so, it not only honours its remark able legacy but also contributes decisively to the country's scientific ambitions in the decades leading up to and beyond 2047.

Archival Images of Early Instruments and the Physics Laboratory at IACS



Molecular Beam Laboratory

Anisotropy Susceptibility

Thin Film Laboratory

Physics at IACS: From Classical Roots to Frontier Science

Prof. Indra Dasgupta

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Molecules and materials are key ingredients in designing a variety of objects ranging from drugs to devices that shape our lives. These systems therefore form an important component of global and national research, and the Indian Association for the Cultivation of Science (IACS) is no exception. Several active research groups at IACS are working to understand novel molecules and materials for a variety of applications using diverse experimental methods as well as theoretical techniques.

From a theoretical perspective, the properties of molecules and materials are governed by the laws of quantum mechanics. At present, ab initio electronic structure calculations based on methods such as density functional theory (DFT) and highly accurate quantum chemical approaches are ideal tools for the investigation and prediction of electronic, magnetic, and optical properties of these systems. However, for the analysis and prediction of many material properties, such as mechanical behaviour, the use of ab initio quantum mechanics is often too ambitious, even with state-of-the-art computational resources. In this respect, atomistic simulations at larger length scales using effective models are very useful for understanding material properties.

Hence, a practical alternative approach is to view materials through windows of different length scales and develop theoretical modelling in three broad domains, namely microscopic, mesoscopic, and macroscopic regimes, covering the length scales of 0.1–1 nm, 1–100 nm, and larger than 100 nm, respectively.

It is also recognised that to understand material properties at a given length scale, it is crucial to simulate properties and mechanisms at all shorter length scales down to the fundamental electronic and atomistic domain. Therefore, it is becoming increasingly important to design simulation tools that bridge different length scales–from macroscopic to mesoscopic to microscopic–using the multiscale method. Researchers at IACS are engaged in developing methods based on multiscale synthesis and simulation approaches to understand, design, innovate, and create novel materials with useful functions and properties. While first-principles electronic structure calculations are employed to understand the ground- and excited-state properties of molecules and materials, the study of larger biological systems relies on molecular dynamics and coarse-graining approaches. Hybrid Quantum Mechanics/Molecular Mechanics (QM/MM) techniques are also used to study biological systems.

Of particular interest in this context are quantum materials that exhibit quantum mechanical phenomena on a macroscopic scale in our classical world. Although the properties of all materials ultimately require quantum mechanics for their description, not all materials are quantum materials. Quantum materials are characterised by real, observable quantum effects.

A new class of materials, namely Topological Insulators, has been discovered in which the geometry (topology) of the quantum mechanical wavefunction leads to dissipationless metallic edge states in an otherwise insulating material. These materials are expected to be crucial for the development of low-power electronics. Superconductors are materials that exhibit zero electrical resistance and expel magnetic fields from their interior due to their inherent quantum mechanical properties. The superconducting ground state displays quantum coherence with no classical analogue. The spin of an electron originates from quantum mechanics. Spintronics, or spin-transport electronics, is an emerging area that utilizes the intrinsic spin of electrons and their associated magnetic moment, in addition to their charge, to process and store data. The inclusion of the spin degree of freedom leads to enhanced functionalities such as increased data storage capacity, faster data processing, non-volatile memory, and improved energy efficiency.

A class of magnetic materials known as Quantum Spin Liquids (QSLs) lacks magnetic order even at very low temperatures. Highly entangled spin states distinguish them from usual paramagnets. Quantum fluctuations and quantum entanglement are two key ingredients of spin liquids. QSLs are characterised by non-local spin correlations and fractional quantum numbers. They provide a rich platform for hosting entangled states that can potentially be utilised as qubits for quantum computing. Owing to the presence of topological order in their ground state, QSLs are tolerant to small concentrations of defects and therefore represent promising resource materials for robust and fault-tolerant quantum computing.

Another class of materials, namely nanomaterials, exhibits quantum effects that offer the possibility of tailoring properties by tuning size. A well-known consequence is band-gap tunability in semiconducting nanomaterials, leading to novel optical properties not observed in their bulk counterparts.

Active research on quantum materials is being carried out at IACS in line with the mandate of the National Quantum Mission (NQM). Topological properties have been investigated in two-dimensional insulating ferromagnetic systems known as Chern insulators, which are characterised by non-zero Chern numbers and exhibit the integral quantum Hall effect. Furthermore, it has been shown that these systems can undergo a topological phase transition in which the sign of the Chern number changes with the orientation of the magnetic moment, with potential applications in topological transistors. Superconductivity has been investigated in nickelates ($NdNiO_2$, $LaNiO_2$) and compared with their cuprate counterpart ($CaCuO_2$). Theoretical analysis revealed that while superconductivity in cuprates is driven by a single band, in nickelates two bands are involved in superconductivity, a result corroborated by experiments.

In recent times, understanding and identifying spin-liquid candidates has been an active area of research worldwide. In this regard, at IACS, low-dimensional frustrated quantum spin systems and spin–orbit-coupled strongly correlated systems exhibiting bond-dependent Kitaev exchange interactions are investigated theoretically in collaboration with experimentalists to identify and understand suitable spin-liquid candidates.

In recent years, there has been considerable interest in a new class of materials known as multifunctional materials, in which two or more distinct physical properties are realised within the same material. Multifunctional materials are important not only because of their potential applications but also from the perspective of fundamental research. Magnetic multiferroics are a class of materials in which magnetism and ferroelectricity not only coexist but are also strongly coupled. As a consequence, magnetisation can be controlled by an electric field and electric polarisation by a magnetic field, opening up possibilities for four-state devices. Theoretical and computational research in this direction has not only identified the microscopic mechanisms of the coupling but also predicted materials that can host such properties.

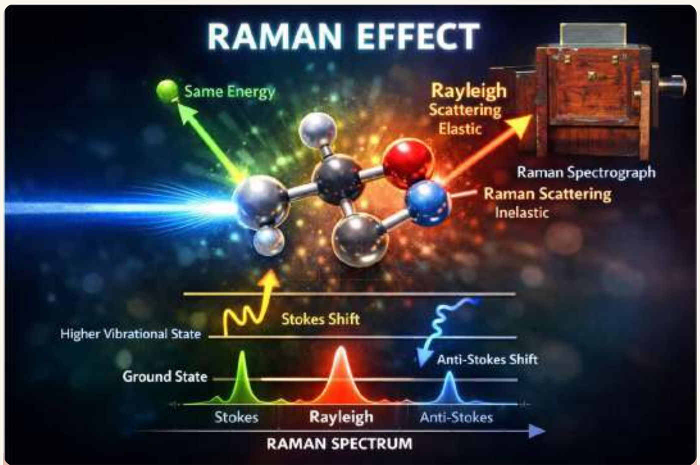
Another direction of research pursued is spintronics, which plays a vital role in several emerging quantum technologies due to its advantages over conventional electronics. The inclusion of the spin degree of freedom leads to enhanced functionalities such as increased data storage capacity, faster data processing, non-volatile memory, and improved energy efficiency. Spin splitting of bands is usually induced by a magnetic field. Of particular importance in spintronics is spin splitting induced by an electric field. In materials lacking inversion symmetry, a non-vanishing potential gradient can give rise to spin splitting of electronic bands in an otherwise non-magnetic system, known as the Rashba–Dresselhaus effect, characterised by unique spin textures. It has been demonstrated that when such spin textures are realized in ferroelectric systems, they can be reversed by an applied electric field. This controllability makes them promising candidates for spin transistors and other potential spintronic devices.

Tailoring both the dimension and size of materials has a crucial impact on tuning their properties and enabling novel functionalities. A novel route to designing multifunctional materials is the use of nanoparticles, where additional functionalisation may be achieved as a result of size-dependent properties. Novel nanoparticles have been investigated for applications in LEDs and for harvesting solar energy.

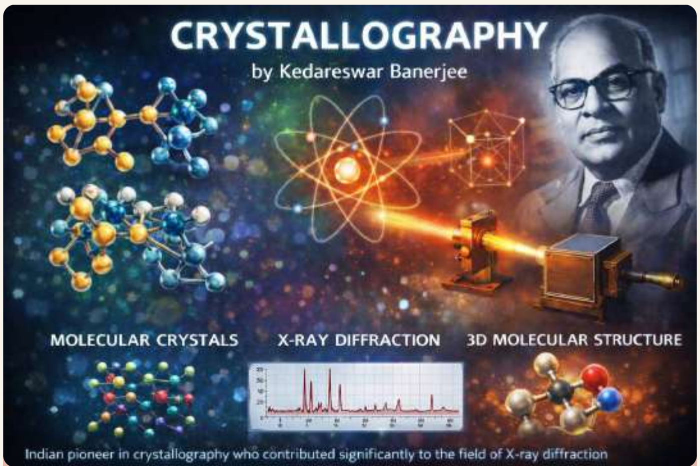
Semiconductor Heterostructures are a promising class of systems that have already found widespread applications in optoelectronic devices, high-electron-mobility transistors, solar cells, and light-emitting diodes. The functionality of such heterostructures can be further controlled at the nanoscale. The quantum confinement in individual nanoparticles, combined with the fact that the electronic properties of heterostructures are determined by a unique balance of the properties of the parent semiconductors, provides additional functionalization at the nanoscale. It has been shown that semiconductor heterostructures at the nanoscale offer tunability of the band gap through band-offset engineering at the interface over a wide range due to the quantum confinement of electrons.Of particular interest are type-II coupled quantum dots with staggered band alignment, where the lowest-energy states for electrons and holes are located in different semiconductors. At the interface, electrons and holes tend to remain spatially separated due to the energy gradient. Thus, type-II alignment is beneficial for photovoltaic applications, as excited electrons and holes are located in spatially distinct regions of the semiconductor, reducing the probability of recombination.

Recently, it has been shown that coupled quantum dots can capture photons and be integrated as active components within quantum-dot-sensitized solar cells, highlighting their importance in translational research. In addition, type-II coupled quantum dots may provide an alternative route for designing nanoscale diode and transistor devices if the system is overall asymmetric such that occupied and unoccupied states are spatially separated. These systems may exhibit rectification or switching phenomena and could serve as alternatives to molecular electronics with improved performance characteristics.

In conclusion, computational research on quantum materials at IACS has significantly advanced the understanding of fundamental quantum phenomena and their practical implications. By integrating first-principles calculations, multiscale modelling, and close collaboration with experimental investigations, researchers are not only uncovering the microscopic origins of complex material behaviour but also predicting and designing materials with transformative technological potential. From topological phases and unconventional superconductivity to spintronics, multiferroics, and nanoscale heterostructures, these efforts align strongly with national initiatives such as the NQM. The continued synergy between theory and experiment is expected to accelerate the development of next-generation quantum materials and devices, positioning IACS at the forefront of cutting-edge materials research.



Schematic of Raman effect discovered by C. V. Raman. Inset shows the Raman spectrograph



Schematic of structure determination by X-ray invented by Kedareswar Banerjee

Evolution of Chemical Sciences at IACS

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Research at the Indian Association for the Cultivation of Science (IACS), though largely dominated by physics in its early decades, also witnessed the first contributions to Chemistry during 1914–1917. These early studies were carried out at IACS's original campus at 210 Bowbazar Street, Kolkata, then the centre of scientific activity.

During the early emergence of Chemical Research (1914-1917), under the mentorship of Rasik Lal Dutta, two research scholars, Manindra Nath Banerjee and Jagadindra Nath Lahiri, conducted pioneering chemical studies. In 1914, Banerjee presented his work entitled "The phenomenon of chemical induction" at a scientific meeting of the Association. This was followed in 1917 by two research papers presented by Dutta and Lahiri at the annual science convention: "Iodination of mercury by means of nitrogen iodide or by means of iodine solution in the presence of ammonia" and "Replacement of iodine atoms by nitro-groups in phenolic bodies."

Foundations of Chemical Research at IACS (1940–1960)

Following the early phase of isolated chemical investigations in the 1910s, the next major advance in chemical sciences at IACS came decades later in a physics-dominated research environment. Influenced by eminent physicists such as C. V. Raman and K. S. Krishnan, early chemical research was driven by experimental rigour and spectroscopic approaches grounded in fundamental science.

A landmark contribution during this period came from Priyadaranjan Ray, a pioneer of modern inorganic chemistry in India. His seminal 1944 monograph, The Theory of Valency and the Structure of Inorganic Compounds, significantly advanced contemporary understanding of valency, oxidation states, and coordination chemistry, and brought early international recognition to chemical research associated with IACS.

The late 1940s' marked a turning point, when chemistry at IACS began to emerge as an independent discipline. In 1947, Ray joined IACS as Honorary Director, at a time when the institute was actively expanding its scientific scope beyond physics. His leadership and academic stature played a key role in shaping the institutional foundations of Inorganic Chemistry at IACS.

The same year also saw the establishment of the Department of Physical Chemistry, the first dedicated chemistry department at the institute. Under the founding leadership of Santi Ranjan Palit, the department quickly gained national recognition through research in polymer science, solution chemistry, electrochemistry, and photochemistry. The program was further strengthened in 1948 by Sadhan Basu, whose work connected polymer kinetics with biological function. The establishment of the first dedicated chemistry laboratory in 1947 marked a major turning point, initiating an era of structured chemical research that steadily grew in scope, depth, and impact over the years.

In 1949, the Department of Organic Chemistry was established, with early research focused on heterocycles and natural products. A major expansion followed in 1953 under Phanindra Chandra Dutta, whose leadership brought international recognition through stereocontrolled synthesis of terpenoids and complex natural products.

The Department of Inorganic Chemistry, formally established in 1951 under Priyadaranjan Ray, rapidly developed strengths in coordination chemistry, analytical methods, and magnetic studies. By the mid-1950s, Inorganic Chemistry at IACS was firmly established, providing a strong foundation for its sustained growth and long-term impact.

Modernization of Chemical Sciences at IACS (1960–2018)

The 1960s and 1970s marked a major phase of expansion and modernisation of chemical sciences at the IACS.

A lasting legacy in chemical sciences was built under the Directorship of Sadhan Basu (1981–1982) and Usha Ranjan Ghatak (1989–1993), during whose tenures core areas of chemical research were significantly strengthened. The institute's scientific profile was further reinforced under the Directorship of Debashis Mukherjee (1999–2008) and Kankan Bhattacharyya (2009–2013), both eminent chemists, strengthening the visibility of chemistry in academic landscape.

Department of Physical Chemistry

Following Palit's retirement in 1975, Mihir Chowdhury assumed leadership of the department and ushered in a new phase of modernisation. Between 1975 and 1990, chemical research at IACS expanded significantly in both instrumentation and methodology, with the introduction of laser spectroscopy, ESR, photochemistry, chemical dynamics, and quantum-mechanical interpretations of molecular processes.

Chowdhury's pioneering research on the structure and dynamics of isolated jet-cooled molecules advanced cryogenic matrix isolation spectroscopy to elucidate intermolecular interactions in weakly bound complexes, thereby laying a strong foundation for molecular cluster spectroscopy at IACS. In 2005, Tapas Chakraborty extended these investigations to gas-phase photochemistry and atmospheric kinetics, particularly reactions of NO_3 radicals with volatile organic compounds, significantly advancing understanding of atmospheric chemistry and oxidative processes.

During early 2000, Kankan Bhattacharyya led transformative work in laser spectroscopy and ultrafast solvation dynamics, time-resolved studies in live cells and biomolecular systems. His group extensively applied single-molecule fluorescence resonance energy transfer (Sm-FRET) and related techniques to probe protein folding and microtubule dynamics, establishing a strong interface between physical chemistry and biology.

Theoretical Chemistry at the School of Chemical Sciences (SCS) has flourished through the pioneering contributions of three distinguished groups. Under Debasish Mukherjee, quantum many-body theory and coupled cluster methods reached international prominence, with a variant recognized globally as the "Gold Standard" in molecular electronic structure calculations, alongside major advances in multireference approaches. Shankar Prasad Bhattacharyya bridged structure and dynamics through innovative reaction descriptors and introduced stochastic, evolution-inspired algorithms such as simulated annealing and genetic algorithms, anticipating modern machine learning strategies. Complementing these efforts, D. S. Ray made seminal contributions to non-equilibrium statistical mechanics and chaotic dynamics, establishing fluctuation–dissipation–like relations in low-dimensional systems and revealing deep connections between chaotic diffusion, entropy production, and flux. These advances positioned IACS at the forefront of Modern Physical and Theoretical Chemistry in India.

Department of Organic Chemistry

Parallel growth occurred in the Department of Organic Chemistry. In 1977, Professor Usha Ranjan Ghatak, a distinguished student of Professor P. C. Dutta, assumed leadership of the department and significantly expanded its academic profile. From modest beginnings with only two faculty members, the department evolved into one of India's leading centres for synthetic organic chemistry.

Between the early 1980s and 2000, organic chemistry at IACS was further strengthened by notable contributions from R. V. Venkateswaran, Debabrata Mukherjee, N. G. Kundu, and Subhas Chandra Roy ranging from synthetic methodologies to natural product synthesis. During this period, Saswati Lahiri, who obtained her Ph.D. from IIT Kanpur, was the only woman faculty member of organic chemistry at IACS. Brindaban Chandra Ranu, who served as Head of the Department (2003–2008) brought international recognition through his contributions to selective and green organic synthesis, particularly in catalytic methodologies and mechanochemistry, significantly advanced modern synthetic practice.

In parallel, Subrata Ghosh, established a strong research programme focused on the total synthesis of bioactive natural products and the development of advanced synthetic methodologies, including cycloaddition reactions, olefin metathesis, and chiral pool–based asymmetric synthesis. Together, these collective efforts, high-impact publications, and national and international recognition played a central role in establishing IACS as a leading centre for advanced organic synthesis and methodological innovation.

Department of Inorganic Chemistry

The growth of inorganic chemistry at IACS was shaped by several distinguished faculty members. Animesh Chakravorty brought international recognition to IACS through his seminal contributions to coordination chemistry and transition metal complexes. His visionary guidance as the leader of the Inorganic Chemistry department, strengthened the department's research culture. Through dedicated mentorship, he trained a large number of successful researchers, and his work earned several prestigious recognitions and honours, further enhancing the institute's scientific stature. Kamalaksha Nag strengthened research in macrocyclic ligands and multinuclear metal complexes, contributing significantly to structural and supramolecular inorganic chemistry. Saktiprasad Ghosh expanded studies in transition metal reactivity, particularly involving osmium, iridium, and platinum complexes. Nirmalendu Ray Chaudhuri advanced supramolecular coordination networks, polymeric metal assemblies, and magnetic properties of complexes, linking structure with functionality. Muktimoy Chaudhury contributed to transition metal chemistry and magnetic studies, reinforcing physical inorganic approaches. Sreebrata Goswami further diversified the field through functional coordination systems and molecular design. Together, their contributions strengthened and modernised inorganic chemistry at IACS, establishing it as a nationally and internationally recognized centre of excellence.

From Departments to a Unified Vision (2018–Present)

A defining milestone was reached in 2018, when the previously independent Departments of Organic, Inorganic, and Physical Chemistry were formally integrated into the School of Chemical Sciences (SCS) at IACS. This institutional reorganisation, carried out during the directorship of eminent chemist Santanu Bhattacharya, created a unified academic and research framework that promoted interdisciplinary collaboration, shared infrastructure, and coordinated teaching, while preserving the depth and rigor of individual chemical traditions.

Pradyut Ghosh served as the first Chair of the SCS, followed by Abhishek Dey. In 2025, the Chairmanship was assumed by Jyotirmayee Dash, who currently chairs the School.

Current Structure and Research Landscape of the School of Chemical Sciences

Physical and Theoretical Chemistry: From Classical Foundations to Quantum and Dynamic Frontiers

Early pioneering work established national leadership in laser spectroscopy, ultrafast dynamics, magnetic field effects, and quantum theory, laying a strong conceptual and methodological foundation.

Continuing on earlier advances in spectroscopy and nonlinear optics, Prof. Prasant Singh is currently applying advanced spectroscopic tools to probe protein folding, microtubule dynamics, and nucleic acid and membrane-associated interactions at the molecular level. Continuing the legacy of supersonic jet and cold chemistry, Dr. Nabanita Deb is presently establishing an ultra-cold reaction dynamics facility at SCS to explore how atoms and molecules interact at ultralow temperatures.

IACS also played a pioneering role in ultrafast photodynamics and confined chemical systems, revealing how solvation and charge-transfer dynamics are dramatically altered in restricted environments such as micelles, hydrogels, and lipid assemblies. Complementing these efforts, long-standing research on confined media and solvation dynamics has evolved into modern soft-matter and materials chemistry. Prof. Tarun Kumar Mandal continues this trajectory through work on controlled polymerization, peptide-polymer hybrids, stimuli-responsive polymers, ionic liquids, and mesostructured materials.

Theoretical Chemistry at IACS is vibrant and diverse, spanning multiscale quantum chemical method development, catalysis, biomolecular dynamics, and non-adiabatic quantum dynamics. Prof. Ayan Datta advances multiscale approaches for complex materials and catalytic systems, while Prof. Avisek Das and Prof. Biman Jana explore peptide self-assembly, protein–protein interactions, protein folding dynamics, and mechanochemistry of intrinsically disordered proteins using atomistic simulations. Prof. Ankan Paul integrates quantum chemistry with machine learning to address challenges in small-molecule activation and catalysis, and Prof. Debashree focuses on ML-driven wavefunction optimization and inverse spectral problems. Complementing these efforts, Prof. Satrajit Adhikary leads cutting-edge work beyond the adiabatic approximation, developing sophisticated non-adiabatic methodologies for photoexcited dynamics and advancing surface-hopping frameworks. Together, these groups position theoretical chemistry at IACS at the forefront of modern computational and quantum chemical research.

Inorganic Chemistry: From Classical Coordination to Functional Metal Systems

Inorganic Chemistry at IACS has evolved over several decades from foundational studies in coordination chemistry to modern, function-driven metal-based systems. Early research established fundamental insights into electronic structure, redox behaviour, spin states, mixed valency, and metal–metal interactions across transition and noble metals, with landmark contributions ranging from mononuclear and polynuclear complexes to macrocyclic and extended frameworks. These efforts shaped understanding of molecular architecture, reactivity, and cooperative phenomena in metal-centered chemistry.

Building on this legacy, contemporary research at SCS advances bioinspired catalysis, supramolecular chemistry, and functional materials. Prof. Abhishek Dey integrates synthetic design with electronic-structure theory to develop metallo-porphyrins for small-molecule activation relevant to clean energy and environmental remediation, while Prof. Harapriya Rath designs electronically tunable porphyrinoids for optoelectronic applications. The tradition of polynuclear and extended metal assemblies continues through Prof. Raju Mondal, whose work on coordination polymers, metallogels, and MOFs targets proton conductivity, magnetic coupling, luminescence switching, and photoresponsive dynamics.

Macrocyclic and multimetallic chemistry remains a core strength, with Prof. Amit Majumdar developing multinuclear metal architectures that model nitric oxide reductase activity and biological NO conversion. In bioinorganic chemistry, Prof. Somdatta Ghosh Dey investigates metal–peptide interactions linked to neurodegenerative disorders, while Prof. Tapan Kanti Paine develops functional mimics of non-heme iron enzymes. Extending earlier interests in ligand design and extended solids, Prof. Pradyut Ghosh advances supramolecular anion recognition and noncovalent catalysis for sensing and environmental applications. These efforts reflect a gradual progression from classical inorganic chemistry at IACS to contemporary research addressing energy, environment, and human health.

Organic Chemistry at IACS: From Natural Product Synthesis to Molecular Function

Organic Chemistry at IACS represents a sustained trajectory of innovation, evolving from classical natural product synthesis to modern reaction design, supramolecular chemistry, green catalysis, and therapeutic discovery. Early work established IACS as a national leader in stereocontrolled synthesis of biologically active natural products, particularly terpenoids and complex architectures, laying a strong foundation in molecular construction and functional design.

This continues through Prof. Rajib Kumar Goswami, whose research focuses on the total synthesis of complex macrolides and lipopeptides, development of medicinally relevant scaffolds, and evaluation of anticancer and antibacterial activities, reinforcing IACS's long-standing strength in natural product chemistry. Methodological innovation, a defining feature of organic chemistry at IACS, is carried forward by Prof. Joyram Guin, whose work in radical chemistry, organo- and transition-metal catalysis, and oxygen-based green oxidations advances sustainable and efficient synthetic strategies for pharmaceuticals and materials.
Extending early contributions to heterocyclic and nucleoside chemistry, contemporary research now spans chemical biology and therapeutic design.

Prof. Jyotirmayee Dash leads efforts in designing anticancer and antimicrobial small-molecule therapeutics to address major global health challenges, while also developing nucleic-acid-based supramolecular systems, including DNA/RNA ion channels and hydrogels that bridge molecular design with biomedical applications. Extending earlier interests in noncovalent interactions and solid-state chemistry, Prof. Parthasarathi Dastidar advances crystal-engineered supramolecular systems and self-assembled molecular gels for drug delivery, soft materials, and stimuli-responsive platforms. The evolution of organic chemistry at IACS from molecular synthesis to function-driven chemistry addresses health, materials, and sustainability.

Research Highlights of SCS

A theoretical study from IACS provided compelling molecular orbital–based evidence that diatomic carbon (C_2) possesses a latent quadruple bond, revealed through analysis of high-spin excited-state potential energy curves. By identifying a purely dissociative nonet state and deep septet minima, the work reframed the long-standing C_2 bond order debate and proposed pathways for experimental verification. (https://www.chemistryworld.com/news/excited-state-potential-energy-curves-reignite-diatomic-carbons-bond-order-conundrum/4012109.article) (by Prof. Ankan Paul)

An iron-based molecular electrocatalyst capable of selectively converting CO_2 into either formate or methanol by simply tuning reaction conditions. It advances sustainable carbon recycling and provides key design insights for multi-electron CO_2 reduction to energy-rich fuels. (https://www.chemistryviews.org/iron-porphyrinoid-for-the-electrochemical-reduction-of-co2/ (by Prof. Abhishek Dey)

A thiazole-based synthetic peptide that self-assembles into ion channels, disrupts ion homeostasis, and targets G-quadruplex DNA in cervical cancer cells. The peptide selectively induces cancer cell death while sparing normal cells, offering a promising new therapeutic strategy (https://www.nature.com/articles/d44151-024-00164-x) (by Prof. Jyotirmayee Dash)

The software ANNCI, developed at IACS, has been deployed on the national PARAM supercomputers, enabling thousands of users nationwide to access advanced quantum chemistry tools. (by Prof. Debashree Ghosh)

A cyanide-trapping supramolecular cage produced at kilogram scale and supplied to Tata Steel for wastewater remediation. This shows how fundamental supramolecular chemistry can be translated into practical, large-scale solutions for industrial environmental cleanup. (by Prof. Pradyut Ghosh).

Research Infrastructure: The School of Chemical Sciences (SCS) is supported by a strong and diverse research infrastructure that enables cutting-edge work across experimental and theoretical chemistry. Facilities include advanced electrochemical workstations, EPR spectroscopy, continuous-flow reactors, and a Mössbauer spectroscopy facility; the only one of its kind in Eastern India. The School also houses single-crystal X-ray diffraction, AFM, ITC instrumentation, a DNA synthesizer, and advanced fluorescence imaging systems.

At the Chemistry–Biology interface, SCS maintains a patch-clamp electrophysiology setup, available in only a few laboratories in India. Complementing these experimental capabilities is

High Resolution Mass Spectrometry (HRMS), an analytical technique used to measure molecular masses with very high precision at IACS

Nuclear Magnetic Resonance (NMR) Spectrometers (300, 400, 500, and 600 MHz) at IACS, used for non-destructive, high-resolution analysis of molecular structure, dynamics, and composition a high-performance computing (HPC) cluster that supports theoretical chemistry, quantum chemical calculations, molecular simulations, and data-driven research.These facilities serve as national resources, supporting researchers and students from across the country.

Honours and Recognitions

Since the establishment of dedicated chemistry departments in the late 1940s, IACS has consistently produced nationally and internationally recognized chemical scientists. This enduring legacy of excellence, now carried forward by the School of Chemical Sciences (SCS). The faculty members of SCS have also been recipients of Swarna-Jayanti Fellowships, J. C. Bose Fellowships, and major national research grants. Many have been elected Fellows of the Indian National Science Academy (INSA), Indian Academy of Sciences (IAS), and other prestigious academies and numerous invited lectureships and global honours.

In addition to conducting high quality research and teaching SCS faculty members are also serving as editors, associate editors, and editorial advisory board members of leading international journals. They contribute to national evaluation panels and PAC members of major funding bodies. The sustained efforts of SCS have played a major role in keeping IACS consistently ranked among the Top 10 in the Nature Index for chemistry in each of the last five years.

The alumni of SCS have excelled across diverse career paths, they hold postdoctoral positions abroad through highly competitive and prestigious international fellowships such as Marie Curie and Newton, work in leading industries including Syngene, Dr. Reddy's, IOCL, HPCL, and major pharmaceutical centres, and serve as faculty members at IITs, IISERs, national laboratories, as well as top universities in the US and Europe. This continued success reflects the strong academic culture and enduring legacy of excellence that has defined chemistry at IACS since its inception, sustaining its tradition of recognition across generations.

Broader Scientific and Societal Impact of Chemical Research at IACS

Rooted in a strong tradition of curiosity-driven research, SCS functions as an integrative hub where chemistry interfaces seamlessly with areas of national relevance including health, environment, energy, and computation-domains that closely align with India's national missions and global sustainability goals.

In the health sector, SCS contributes to the National Health Mission through research spanning antimicrobial and anticancer drug discovery, gene modulation, metallo-peptide systems, and molecular strategies targeting complex diseases such as Alzheimer's and Type-2 diabetes. Expertise in natural products, optically pure molecules, hydrogels, and functional polymers enables the development of advanced therapeutics, biomaterials, and delivery platforms, demonstrating the translational power of molecular-level chemistry.

Environmental sustainability forms another major pillar of impact. Research being carried out in green chemistry, sustainable synthesis, pollutant sensing, water purification, and industrial waste management addresses challenges related to clean water, pollution control, and ecosystem resilience. These efforts align with the National Water Mission and clean energy initiatives.

In the energy domain, SCS addresses climate and energy-transition challenges through work on CO_2 capture and conversion, hydrogen generation, NOx reduction, photochemical and electrochemical processes, and catalytic reaction networks. By integrating catalysis, electrochemistry, and reaction engineering, the school advances scalable chemical solutions for clean energy and emissions mitigation.

Complementing experimental research, strong capabilities in computational chemistry, AI/ML-enabled modeling, and quantum dynamical simulations support national efforts under the National Supercomputing Mission and the National Quantum Mission. These approaches accelerate materials discovery, catalyst design, and reaction optimization, ensuring predictive and data-driven innovation.

Beyond research, SCS plays a vital role in human resource development, educator training, and science outreach, democratizing access to advanced research infrastructure and fostering scientific temper across diverse sections of society.

Dream 2047: IACS at 150 Years

As IACS commemorates 150 years of scientific excellence in 2026, its vision is firmly aligned with India's aspiration for Viksit Bharat 2047. Under the leadership of the current Director, Prof. Kalobaran Maiti, IACS continues to promote a culture of scientific excellence across disciplines, with strong encouragement for chemistry as a foundational and enabling science for national development.

Building on its historic legacy as India's oldest research institution, the School of Chemical Sciences articulates a forward-looking roadmap that integrates mission-driven research, capacity building, and global engagement.

A key component of this vision is to conceptualise and establish interdisciplinary Centres of Excellence, aligned with national priorities that will be developed in a phased manner to address antimicrobial resistance, clean energy, environmental sustainability, and catalysis-driven innovation through advanced molecular design, emerging technologies, and translational research.

Looking ahead, SCS envisions the strengthening of strategic academic programs in synthetic, analytical, and molecular sciences, alongside enhanced student and faculty exchange with leading global institutions. These initiatives will foster interdisciplinary research, train globally competitive scientists, and enable the translation of fundamental chemical science into technologies of national importance.

Together, these efforts reflect IACS's evolution from a historic cradle of Indian science to a future-ready institution shaping solutions for health, sustainability, and technological self-reliance.

At 150 years, IACS stands poised to continue its founding mandate– advancing world-class science on Indian soil– while actively contributing to India's scientific, societal, and economic transformation by 2047.

References:

1. A Century: IACS
2. 125 Years, Indian Association for the Cultivation of Science
3. National Symposium on Perspective and Challenges in Organic Chemistry, Department of Organic Chemistry, 18 October 2014
4. 5th Convocation, Indian Association for the Cultivation of Science, 4 August 2024
5. Annual Report 2024-2025, Indian Association for the Cultivation of Science

Research Now

Compound purification by column chromatography

Solvent evaporation using rotary evaporator

Setting up Atomic force microscopy sample

Working in cell culture laminar hood

Photo irradiation guided reaction

Binding affinity assessment by ITC experiment

Fluorescence microscopy image acquisition

Biophysical experimental preparation

Research Then

A setup for low temperature susceptibility measurement

Differential scanning calorimeter

Pulsed high magnetic field setup

Research Facilities in the Laboratory Prof Jyotirmayee Dash at IACS

Acknowledgement

Valuable suggestions and insights provided by Prof. Satrajit Adhikari and Prof. Subhas Chandra Roy are gratefully acknowledged.

Biological Sciences at IACS: Emergence, Integration, and Innovation

Prof. Prasanta Kumar Das

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Indian Association for the Cultivation of Science
Kolkata

The Indian Association for the Cultivation of Science (IACS) founded in Kolkata in the year 1876 continues to hold its historic legacy through out in the field of scientific research and teaching. In 2026, as IACS approaches to its milestone of 150th anniversary, it has become the symbol of excellence in the development of modern science and education, carrying a legacy built over a century and a half. Throughout its historic journey, IACS has provided a great platform to the young minds for the growth and development of research in the frontier research across various disciplines with encouraging curiosity and excitement. IACS has produced many renowned scientists, and they have made significant contribution towards the ground breaking research, leaving a strong footprint globally. And the most eminent was one is in 1928, C.V. Raman discovered the Raman Effect, for which he was awarded the Nobel Prize in Physics in 1930. Altogether IACS, with its motivation and commitment towards research, innovation, knowledge and mentorship, plays crucial role in shaping the scientific landscape and become a vibrant hub for pioneering research.

Biological Sciences primarily nurtured and pursued in School of Biological Sciences (SBS) at IACS has shown a consistent and significant growth in the field of biological and interdisciplinary sciences, maintaining the remarkable legacy of IACS. The origin of SBS can be traced back to year 1986, when the former department of biological chemistry was formed by the reorganisation of department of macromolecules. From the very beginning, the department has served as an innovative platform where both chemistry and biology overlaps, breaking all traditional boundaries in research to established a unified approach to life sciences. Initially, the department mainly focuses on the chemistry of biological systems, and over time, the growing demand for research to overcome societal problem and improvement in healthcare led the department to extend its grab across the domain of Biological Sciences that include Microbiology, Disease Biology, Cell Biology, Molecular Biology, Cancer Biology, Chemical Biology, Biophysics, Drug Delivery, Biomedical Research, Nanoscience, and Theranostics. This broadened vision along with the aim of disseminating knowledge through main course teaching activities led to the transformation of department into School of Biological Sciences SBS in the year of 2018, the same year when IACS was granted as Deemed-to-be-University status under de-novo category.

Research activities in Biological Sciences encourage collaborations across various field including chemistry, physics, materials science, and nanotechnology, bringing modern insights into fundamental biological processes and significant advancements in biomaterials, cancer biology, and targeted drug delivery. Over the past few decades, the institute has organised various biological research programmes, worked on the development of advance infrastructure and instrumentation facilities for research, blending molecular biology, chemical biology, biophysics, and nanobiotechnology. Altogether, SBS with its dedicated faculties, involvement of young researchers with brilliant mind, better instrument facilities, advanced infrastructure and external funding, has become a distinguished centre of research and training. Today, it stands as a leading department in IACS focused on advancing knowledge across various disciplines while significantly contributing to both basic and applied biosciences.

Beginning to the early 2000s, SBS has lengthened its remarkable research in the field of cancer biology. At that time, researchers recognised various metabolic defects in tumor cells, including key enzymes as promising drug target and the tumour-suppressing immune effects of methylglyoxal. These discoveries bridged basic biochemistry and biomedicine. At the same time, the school enhanced its multidisciplinary profile, spreading research into glycobiology, synthetic carbohydrate chemistry, plant sciences, and microbiology. Detailed studies on lectins, carbohydrate-binding proteins from plants, fungi, and animals, highlighted their specific sugar recognition and potential uses in diagnostics, imaging, and therapy. SBS also pursued microbial biochemistry, studying how microorganisms adapt to extreme and polluted environments, including dairy waste and contaminated soils. These efforts collectively illustrate holistic approach biological sciences to tackle human health challenges while promoting environmental sustainability.

Recent research at SBS includes in- depth understanding of cancer biology, cell biology, molecular biology and allied activities encompassing wide range of fields integrating chemistry, biology, materials science, and molecular medicine and its useful applications. A major focus is on engineering peptide and carbon-based self-assembling systems to create soft functional materials. Peptide-derived hydrogels have proven to be biocompatible platforms for sustained drug release, antibacterial treatments, and three-dimensional cell culture. Complementary projects involve applications in bioimaging, catalysis, chemical sensing, photoswitching, and antibacterial technologies.

Building on these foundations, research activities in SBS also focused on developing membrane-inspired soft nanocomposites for theranostic applications that integrate diagnostic and therapeutic functions. Research includes developing state of the art cellular transporters for intracellular delivery of drugs, nucleic acids, and proteins, as well as applications in biosensing, bioimaging, and antibiotic therapy. These multifunctional systems are also adapted into tissue-engineering scaffolds with embedded therapeutic and diagnostic capabilities.

Ongoing studies aim to improve enzyme performance by placing biocatalysts within soft, membrane-like environments for better catalytic efficiency under physiological conditions. Research into DNA and protein interactions with these amphiphilic systems, along with developing functionaliszed organic particles and carbon dots, expands opportunities for advanced sensing, imaging, and therapeutic strategies partiularly in cancer treatement.

At the Bio-Nano Interface, SBS is building innovative platforms that connect biological systems with nanoscale technologies for molecular sensing, bioelectronics, and structural biology. Research on nucleic acid detection uses bioactive films of Xeno Nucleic Acids (XNAs), allowing sensitive and selective DNA/RNA detection without PCR amplification or fluorescent labeling. Additionally, metalloproteins from humans are being examined as components for nanoscale electron transport, paving the way for sustainable bioelectronic devices. These efforts are supported by single-molecule structural studies using scanning probe microscopy to visualize protein assemblies and characterize drug-induced changes in DNA, advancing high-resolution biophysical analysis and molecular electronics.

In Cellular and Molecular biology, in- depth understanding is being pursued towards the regulatory mechanisms behind cell adhesion, division, migration, and mechanotransduction. A central focus is on Nonmuscle Myosin II (NM II) and how its regulation by microRNAs, long non-coding RNAs, and alternative splicing of heavy chain pre-mRNAs occurs in neuronal systems. It is being examined the signaling networks that control cellular transformation, mechanosensing, vesicle transport, and migration using integrated in vitro models and in vivo mouse systems. This comprehensive approach offers insights into how molecular regulation influences cellular behavior, impacting disease progression and therapy development.

Another significant research area addresses the connection between coagulation biology and cancer, focusing on how coagulation factors, bioactive lipids, hypoxia, and mechanical forces contribute to immune evasion and drug resistance. Researchers combine molecular biology with computational techniques, such as molecular dynamics simulations and computer-aided drug design, to identify key signaling pathways in tumor growth. These studies are backed by developing fluorescent probes, small-molecule inhibitors, drug conjugates, and targeted delivery systems aimed at modifying immune-evasion pathways, informing the design of precision cancer therapies.

Investigations are also making major strides in genome stability research, investigating DNA damage and repair mechanisms relevant to cancer, neurodegeneration, and mitochondrial dysfunction. Special attention is given to DNA topoisomerase I (Top1), which forms trapped cleavage complexes (Top1cc) caused by camptothecin or oxidative stress, and how TDP1 repairs these complexes. Disruptions in this repair process, observed in spinocerebellar ataxia with axonal neuropathy (SCAN1), are actively studied.

Additional efforts examine DNA damage response signaling, PARP1-mediated repair mechanisms, action of PARP inhibitors, and new mitochondrial DNA repair pathways, illuminating how mtDNA damage contributes to human diseases.

In Developmental Biology and Immuno-metabolism, Research in SBS Biological Sciences has revealed the important roles of lipid droplets in early development and immune regulation. Using zebrafish embryos enriched in lipid droplets, researchers show how these organelles aid early development and provide pre-immune defense by recruiting lipases for lipid metabolism. Broader studies explore how cells interpret biochemical and mechanical signals from their surroundings, delving into the regulation of monocyte differentiation, macrophage diversity, phagocytosis, and migration through receptor-ligand interactions and extracellular mechanics. This integrated framework combines cell biology, developmental biology, and biophysics to uncover how metabolic and mechanical signals influence immune function.

One of the other important domain in Biological Sciences is Microbiology that has been focused on bacterial pathogenesis, particularly how Escherichia coli takes advantage of host systems through complex regulatory networks and specialized secretion systems like injectisomes. A significant discovery includes bacterial nanotubes, structures enabling communication and nutrient sharing between cells. Alongside components from injectisomes, these nanotubes represent strategies supporting microbial survival and virulence. By merging genetic, structural, and cellular methods, this research reveals new insights into host-pathogen interactions and microbial cooperation, allowing opportunities for therapies aimed at disrupting bacterial communication and nutrient acquisition.

Overall, these interconnected research efforts in biological sciences at IACS showcase an integrated approach to understand biological complexity, drawing on expertise in molecular engineering, soft matter assembly, bio-nano interfaces, cellular regulation, genome maintenance, microbial survival strategies, and developmental processes. By seamlessly combining basic research with real-world applications, this body of work stimulates innovation in medicine, nanoscience, environmental sustainability, and biotechnology, reinforcing a comprehensive vision of science with societal benefits.

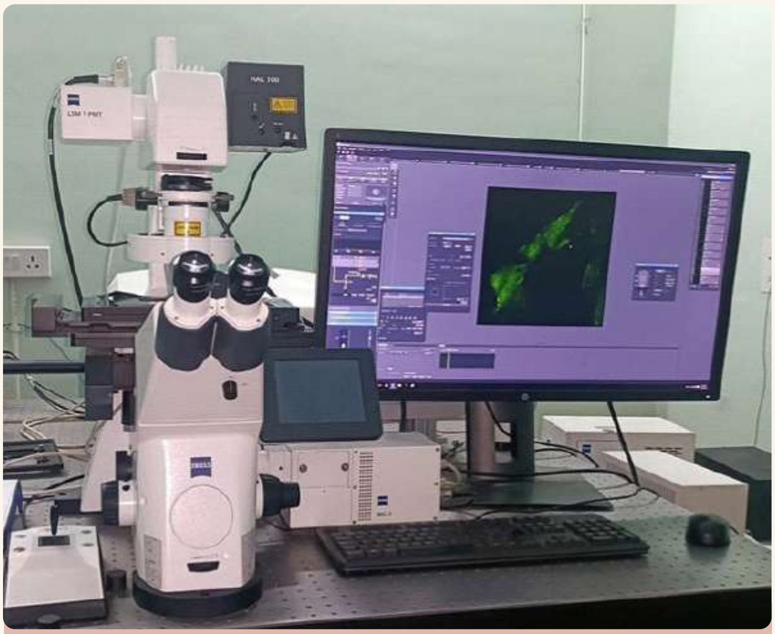
Biological Sciences at IACS plays a pivotal role in translating scientific innovation into societal benefit by addressing critical challenges in health, environment, and technology. Its research has led to practical advances in targeted therapeutics, antimicrobial strategies, tissue engineering, and disease diagnostics through the development of advanced biomaterials, soft nanocomposites, and theranostic platforms. Foundational discoveries in cancer biology, genome stability, and immunometabolism are shaping precision medicine approaches, while progress in biosensing and bio-nano technologies is enabling cost-effective molecular diagnostics. Equally impactful are SBS contributions to microbial science, which inform strategies against infectious diseases and antimicrobial resistance, alongside sustainable solutions for environmental remediation.

Beyond research, SBS has built a strong educational framework that empowers future scientists. The launch of the BS-MS program introduced an interdisciplinary undergraduate pathway combining rigorous coursework with hands-on laboratory training, fostering adaptable and creative researchers. This was further strengthened by the Integrated PhD programme, which provides a seamless transition from foundational learning to advanced research, cultivating scientific leadership and innovation. Together, these efforts highlight SBS's evolution into a dynamic academic and research ecosystem, one that not only advances scientific frontiers but also delivers meaningful societal impact, aligning IACS's historic legacy with contemporary global needs. These achievements chart the remarkable transformation of SBS from a focused academic unit into a vibrant interdisciplinary hub at the forefront of modern biological research. Rooted in IACS's distinguished heritage yet coordinated to the demands of contemporary science, SBS has emerged as a centre of excellence at the convergence of chemistry, biology, and medicine.

As IACS commemorates its 150-year legacy, Biological Sciences SBS exemplifies this enduring tradition of innovation, building upon early foundations in enzymology and cancer metabolism while advancing frontiers in therapy, genomics, cell biology, cancer biology, nanomedicine, biomaterials, and infectious disease biology. Defined by scientific rigour, adaptability, and creative inquiry, biological science has fostered a culture that values both discovery and mentorship, preparing successive generations of researchers to lead with insight and purpose. Looking ahead, the SBS is poised to strengthen international partnerships, broaden its academic programmes, and pursue transformative research directions, reaffirming its commitment to scientific excellence and societal progress in keeping with IACS's enduring mission of advancing knowledge for the betterment of humanity.

Advanced Microscopy and Cell Analysis Facilities at IACS

STED Microscope

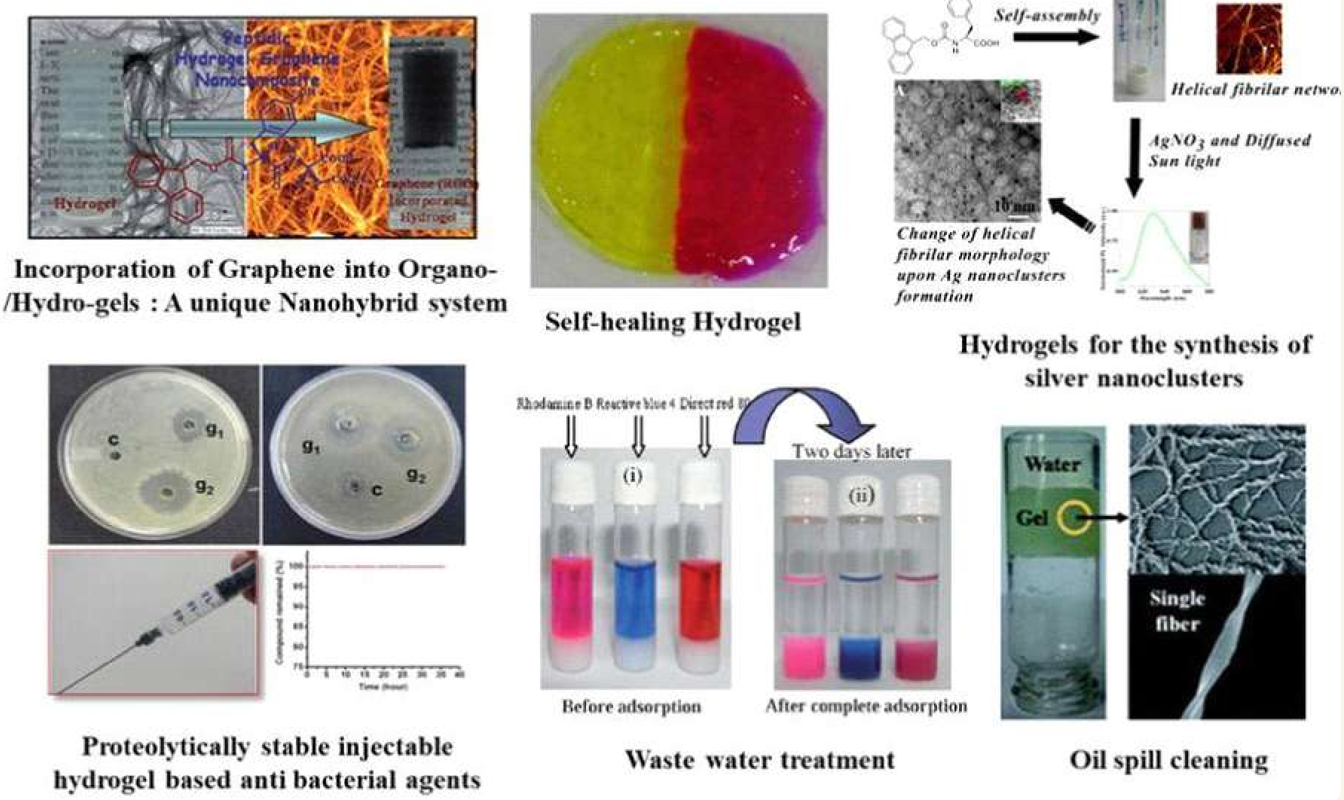


Confocal Microscope

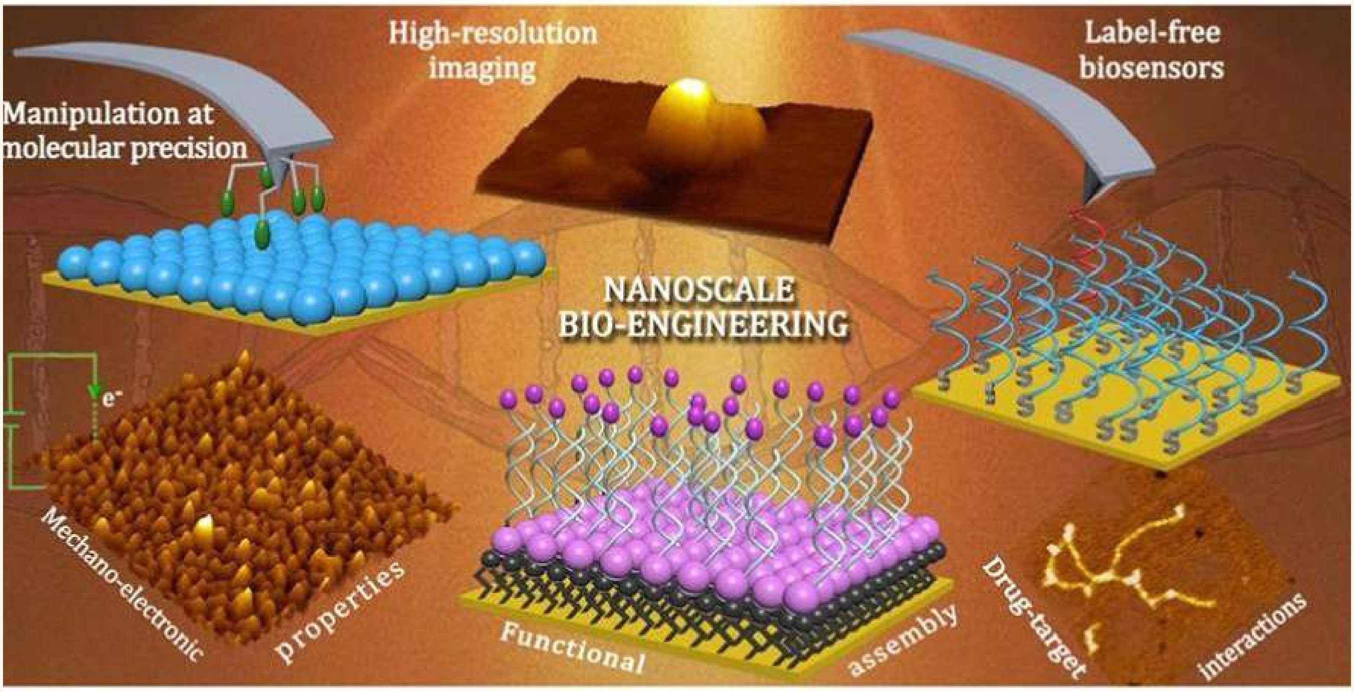
FACS-CELL Sorter

Stimulated Emission Depletion (STED) microscope, Fluorescence-Activated Cell Sorting (FACS) and Confocal microscope

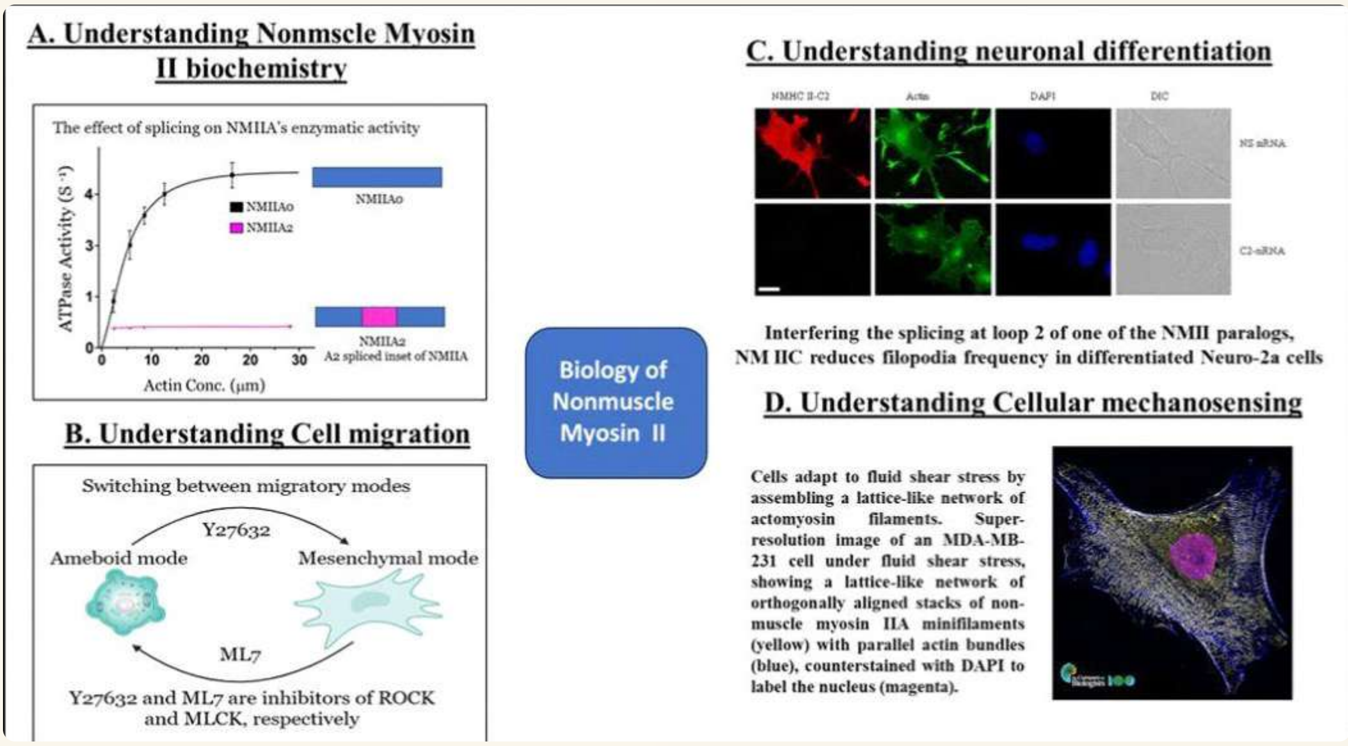
Applications of peptide/amino acid based soft materials

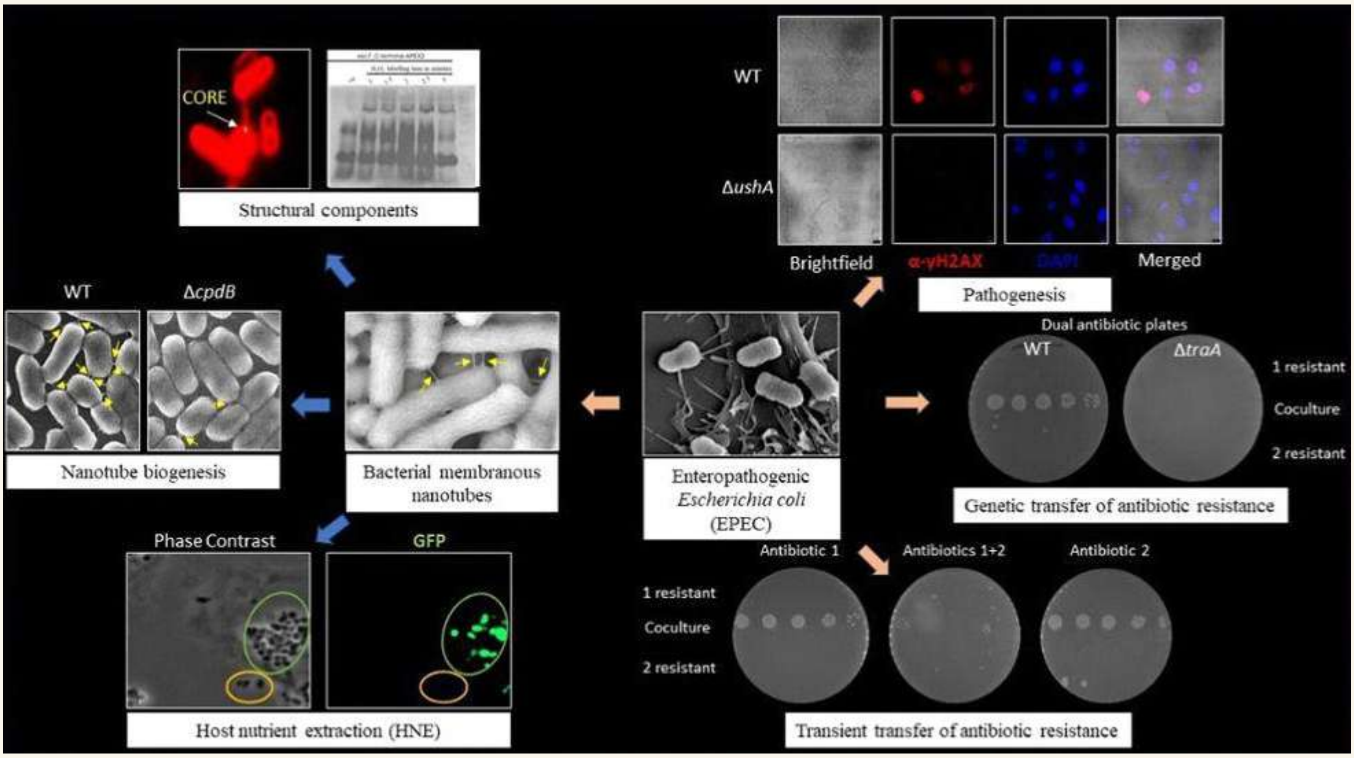


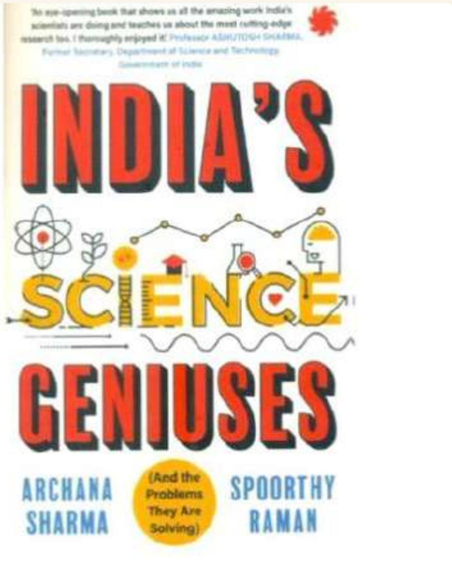
Nanoscale Biosensing/Bioelectronics, Single Molecule Structural Biology
(Working for transition from Fundamental to Translational)

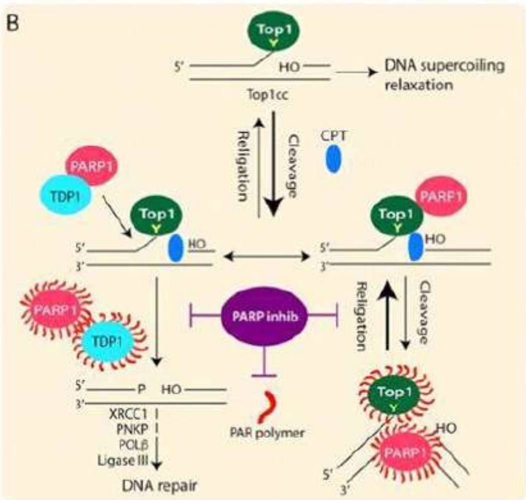


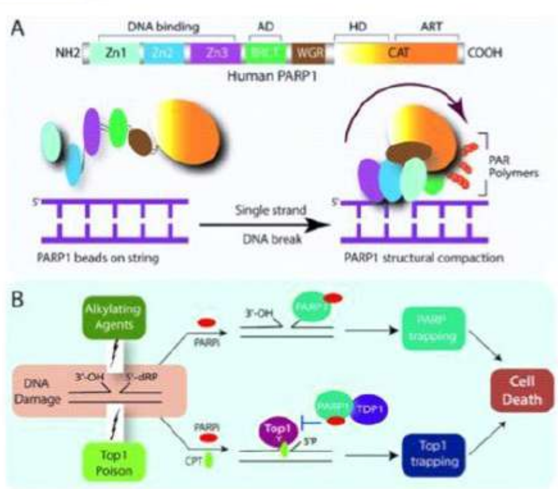
Major success: Development of a PCR-independent, fluorescent label-free method for gene mutation (oncogenic driver mutations) screening for early detection of cancer.


A. Understanding Nonmscle Myosin II biochemistry
The effect of splicing on NMIIA's enzymatic activity
ATPase Activity (S⁻¹)
NMIIA0
NMIIA2
Actin Conc. (µm)
A2 spliced inset of NMIIA
B. Understanding Cell migration
Switching between migratory modes
Y27632
Ameboid mode
Mesenchymal mode
ML7
Y27632 and ML7 are inhibitors of ROCK and MLCK, respectively
Biology of Nonmuscle Myosin II
C. Understanding neuronal differentiation
Interfering the splicing at loop 2 of one of the NMII paralogs, NM IIC reduces filopodia frequency in differentiated Neuro-2a cells
D. Understanding Cellular mechanosensing
Cells adapt to fluid shear stress by assembling a lattice-like network of actomyosin filaments. Super-resolution image of an MDA-MB-231 cell under fluid shear stress, showing a lattice-like network of orthogonally aligned stacks of non-muscle myosin IIA minifilaments (yellow) with parallel actin bundles (blue), counterstained with DAPI to label the nucleus (magenta).

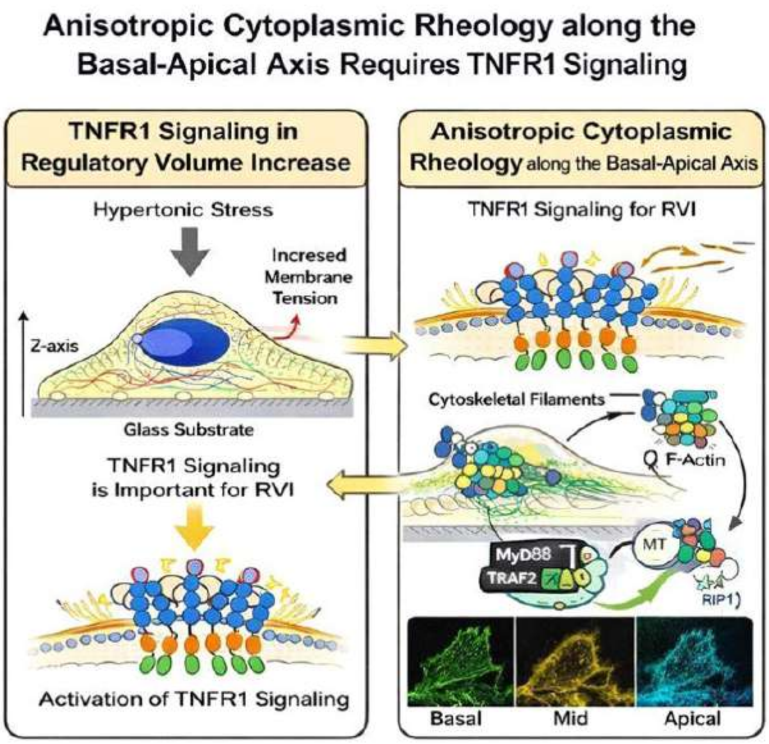

CORE
Structural components
WT
ΔushA
Brightfield
α-γH2AX
DAPI
Merged
Pathogenesis
WT
ΔcpdB
Nanotube biogenesis
Bacterial membranous nanotubes
Enteropathogenic Escherichia coli (EPEC)
Dual antibiotic plates
ΔtraA
1 resistant
Coculture
2 resistant
Genetic transfer of antibiotic resistance
Phase Contrast
GFP
Host nutrient extraction (HNE)
Antibiotic 1
Antibiotics 1+2
Antibiotic 2
Transient transfer of antibiotic resistance







Synergistic cancer cell killing through the combined therapeutic strategy of trapping topoisomerase–DNA adducts and PARP1 inhibition.



The cytoplasm exhibits anisotropic rheological properties arising from the polarized organization of cytoskeletal filaments along the basal–apical axis. Under hypertonic stress, cells achieve volume regulation through TNFR1 activation, triggered by reduced membrane tension–mediated increases in intra-cluster receptor density (IRD).

Materials & Interdisciplinary Research at IACS

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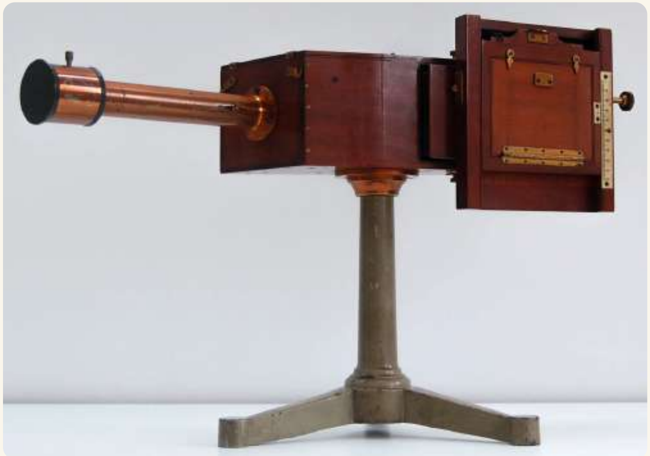
The founding of the Indian Association for the Cultivation of Science in 1876 was a milestone in the history of renaissance of modern India. Mahendra Lal Sircar perceived the important role that science can play in building modern Indian society. The general activities of the Association started in the field of teaching physics, chemistry, mathematics and life sciences.

In this early period, while the institute didn't have a formal Materials Science discipline, however, materials-related research–such as crystallography, solid state materials, X-ray studies, and magnetic properties of materials–were integral parts of investigations undertaken by its scientists.

A new era of scientific research activity started with the discovery by C. V. Raman that light scattering by molecules shifts in wavelength–known as the Raman Effect.

The scattered radiations were photographed with a portable Hilger quartz spectrograph and the spectrogram revealed the presence of a number of lines or bands, not contained in the spectrum of the incident radiation.[1]


Adam Hilger Quartz Spectrograph at IACS

This new light effect came to be known as "the Raman Effect" which led to Raman receiving the Nobel Prize in Physics in the year 1930. This discovery fundamentally changed spectroscopy and opened tools used extensively in materials characterisation and put India quite prominently in the world map of science. India celebrates National Science Day on 28 February every year to mark the discovery of the Raman Effect. The optical properties of naturally occurring crystals were also the subject of many investigations by Raman and his co-workers. Raman discovered the properties of smoky quartz and the phenomenon of conical refraction in biaxial crystals, which revealed a new optical property of biaxial crystals.[2-4]

The works on crystal magnetism and magnetic anisotropy by K. S. Krishnan in the thirties and forties made great impact on the scientists who were studying the crystalline state of matter. The work by Krishnan laid the foundation of solid-state materials research in India, which later evolved into modern materials science. Crystallography and solid-state properties of materials became scientifically prominent through the works of Kedareswar Banerjee, who contributed to early crystal structure determination and helped embed materials understanding in the unit cell from the observed intensities of the X-ray diffraction spots.[5] The X-ray crystallography, enormously contributed to early methods of crystal structure determination -- work foundational to materials science long before the field was formally defined.

Meghnad Saha transformed astrophysics into a quantitative science and helped build India's scientific infrastructure after independence. Saha's ionisation theory remained fundamental in understanding composition of stars and high–temperature plasmas.

Under the leadership of Saha, a new expansion plan was put through for the study of molecular structures by physicists and chemists.

The creation of four Departments of Physics and Chemistry each was designed to enable the Association to tackle problems of Material Science which required multidisciplinary approach. The plan envisaged the important role that science would play in the economic resurgence of the country.[6,7]

By the late 1970s and 1980s, advances in solid-state research and experimental instrumentation, further strengthened these activities. This period represented a transitional phase at IACS–moving from classical physics and chemistry toward an integrated understanding of materials–setting the stage for the formal development of materials science as an interdisciplinary field in the decades that followed. Various problems of solid-state physics related to crystal structure, semicrystalline nature of solids, phase transition in solids, lattice dynamics, defects in solids, transport static properties of conducting solids and solid-state spectroscopy etc. were investigated by various departments of the Association. Transparent conducting oxides like indium tin oxide, tin oxide and zinc oxide, which are widely used for device fabrication presently, were developed by the magnetron sputtering technique. The development materials and fabrication technology for advanced solar photovoltaic solar cells created generous interest in the technological research. Synthesis of binary and ternary semiconductors for the fabrication of thin film solar cells and fabrication technology for the single and multijunction silicon solar cells were developed.

By the 1980s, advances in experimental techniques and theoretical understanding began to shift attention from bulk materials to reduced-dimensional systems. Researchers increasingly explored size-dependent physical and chemical phenomena, recognising that materials exhibited fundamentally new behaviour when their dimensions were reduced to the nanometre scale. This period marked a conceptual transition -- from traditional bulk solid-state studies to nanoscale science, even before the term “nanoscience” became widely popular. Glass-metal and glass-semiconductor nanocomposites were developed. Some of the significant observations were: fractal growth of metallic phase under the influence of electric filed, assembly of interconnected nanosized metal particles, quantum confinement effect as evidenced by the electrical transport and optical properties, core-shell structure effect on the magnetic behavior of nanosized ferromagnetic-ferrimagnetic composites.

On the technology front, a fully automated Langmuir-Blodgett film deposition instrument was designed and the technology was transferred to NRDC, Govt. of India. These studies highlighted phenomena unique to the nanoscale, such as quantum confinement, enhanced surface reactivity, and tunable optical and magnetic responses. Although nanoscience emerged globally as a distinct field only in the late 20th century, the intellectual foundations for nanoscale materials research at the Association were laid much earlier through studies on crystal growth, surfaces, defects, spectroscopy, and structure–property relationships.

In the early 21st century, nanoscience and nanomaterials became a clearly defined and strategically important research area. Research expanded rapidly into the synthesis, characterisation, and functional understanding of nanomaterials, emphasising the interplay between size, shape, surface effects, and physical properties. Key areas of nanoscience research at the Association included metal and semiconductor nanoparticles, nanostructured oxides and magnetic nanomaterials, low-dimensional systems such as quantum dots, nanorods and nanowires. Today, nanoscience stands as one of the most dynamic and visible research domains at the Association. From early solid-state investigations to contemporary nanoscale research, the Association’s journey in nanoscience underscores its enduring commitment to fundamental understanding of matter and its transformation into functional materials. It exemplifies how the Institute has continuously evolved–adapting its classical strengths to address frontier areas of modern materials science.

Nanoscience is inherently interdisciplinary, drawing expertise from physics, chemistry, and materials science. Chemistry acted as a bridge between physics and materials science at IACS, enabling interdisciplinary collaboration. Chemical researchers have worked closely with physicists and materials scientists to advance in areas such as energy materials, magnetic materials, photonic materials, and nanostructured systems. Collaborative efforts have enabled research that spans fundamental science to application-oriented studies in energy materials, sensors, catalysis, photonics, and nanoelectronics.

This interdisciplinary approach reflects IACS’s historical ethos of integrating basic research with emerging technological relevance. Materials research at IACS spans a broad range of topics, including nanomaterials and quantum materials for next-generation electronics and photonics. Materials for energy and environment is also a key research topic. Materials are designed for energy conversion and storage such as battery, supercapacitor, and solar materials, and environmental applications like water pollution control. Strongly correlated and functional materials exhibiting complex behavior like magnetism, superconductivity, and other collective electronic states are developed. Polymers, soft materials, and biomaterials played crucial role for various applications including healthcare and diagnostics.

Research spans over the perovskite solar cells, light emitting diodes, strongly correlated electron systems, spintronics, 2D materials, molecular electronic devices, flexible electronics and wearable sensors. It has transformed materials research from a descriptive science into a design-oriented discipline, aligning fundamental studies with emerging technological applications.

magnetics strengthen India's scientific ecosystem and feed into high-impact global research. Materials research in advanced battery materials, hydrogen production and storage materials, photocatalysts and electrocatalysts for water splitting and CO_2 reduction, solar energy harvesting materials supports India's renewable energy goals and aligns with national missions.

Centre for Advanced Materials at IACS

The research activity pursued at the Association continue to receive national and international recognition. Its position is characterised by high publication volume, growing citation impact, and strong theoretical–experimental integration, with continued room for improvement in breakthrough innovation and technological potentiality.

With a background experience of 150 years, IACS is in a fit position to scale new and emerging frontiers in research. IACS's current research landscape reflects deep expertise in Materials, Chemistry, Physics, and Biological Sciences, woven together by interdisciplinary platforms. The broader impact of materials research at the IACS extends across science, technology, industry, sustainability, and human capacity building. As India's oldest research institution, IACS integrates fundamental discoveries with translational possibilities that influence national and global priorities.

The fundamental insights of quantum materials, 2D materials, strongly correlated systems, exploring nanoscale structure–property relationships, designing functional materials for electronics, photonics, and

IACS stands poised between its vibrant present evolving from its past with rich heritage and future pregnant with possibilities in a rapidly changing global scenario. An important strength of IACS is the confluence and synergy of the activity across various wings. IACS is thus in a unique position not only to consolidate and expand its current materials activity but also to venture in the emerging interdisciplinary areas.

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6. A Century, Indian Association for the Cultivation of Science
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CO2 Fixation Reactions Catalyzed by Porous Nanomaterials for a Sustainable Future

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Carbon dioxide (CO_2) is a major greenhouse gas, and its increasing accumulation in the atmosphere is a serious concern for achieving a sustainable future. Consequently, scientists worldwide are focusing on carbon capture and utilization (CCU) as a key strategy to achieve net-zero carbon emissions from industrial activities. In this context, we report the use of CO_2 as a C_1 source for the synthesis of a wide range of valuable chemicals such as methanol, formic acid, N-formylated amines, benzimidazoles, carbazoles, and poly(hydroxy) urethanes by exploiting the catalytic potential of porous nanomaterials. Successful large-scale implementation of these catalytic processes in the future would not only reduce our dependence on fossil-fuel-based technologies for the synthesis of these chemicals but also contribute significantly to carbon recycling.

Microporous and mesoporous materials—including zeolites, metal–organic frameworks (MOFs), covalent organic frameworks (COFs), porous organic polymers (POPs), periodic mesoporous silicas, and hierarchically porous metal oxides—have attracted considerable attention in recent years as heterogeneous catalysts. This is primarily due to their exceptionally high specific surface areas, nanoscale pore structures, high thermal and chemical stability, and the ease with which their surface functional groups or heteroelements can be tuned within their frameworks.[1–5]

At present, fossil-fuel-based feedstocks remain the primary sources of global energy and bulk chemical production. However, the accelerated combustion of these resources generates large amounts of anthropogenic CO_2 emissions, disrupting the natural carbon cycle and contributing to significant global environmental changes. Such trends pose serious challenges for a sustainable future. Although fossil resources are currently abundant, they are finite and will eventually be depleted. Therefore, the direct fixation of CO_2 into fuels and chemicals offers a promising route toward a sustainable energy landscape, enabling CO_2 to be used as an abundant and inexpensive renewable carbon resource. However, CO_2 is thermodynamically stable, with carbon in its highest oxidation state, and is therefore kinetically inert. To enable efficient CCU processes, catalysts are required to reduce the activation energy barriers associated with CO_2 conversion reactions, often in combination with suitable reducing agents.[6]

High Pressure High Temperature fixed-bed Reactor of IACS for carrying out the CO2 hydrogenation reaction

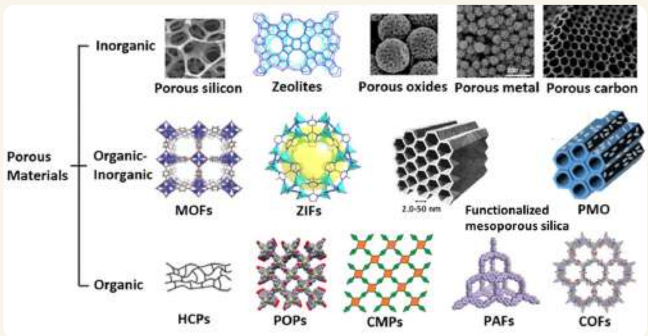
In this context, porous nanomaterials possessing CO_2-philic surface properties—particularly those exhibiting surface basicity, given that CO_2 behaves as a Lewis acid—are highly promising candidates for heterogeneous catalysis in CO_2 fixation reactions.[7] Conventional polyurethane synthesis, widely used for producing foams and other industrial materials, typically involves toxic phosgene, which is converted into hazardous bis-isocyanate intermediates. As a greener alternative, we report the synthesis of poly(hydroxy) urethane, a polyurethane derivative with improved mechanical properties, via an environmentally benign route. In this process, CO_2 undergoes cycloaddition with bis-epoxides to produce bis-cyclic carbonates, which subsequently react with diamines in the presence of a MOF-based catalyst.[8]

In another approach, nitrogen-rich porous organic polymers containing N-heterocyclic carbene (NHC) moieties, characterized by high surface areas and strong surface basicity, can be utilized for the catalytic reduction of CO_2 to methanol under atmospheric pressure. These NHC-containing porous organic polymers also exhibit excellent catalytic activity for the fixation of CO_2 with amines to form N-formylated amines, as well as for the cyclization of o-phenylenediamine to benzimidazole using hydrosilanes as reducing agents.[9] Furthermore, we have designed novel donor–acceptor-type conjugated microporous polymers (CMPs) containing triazine units and extended π-conjugation, which demonstrate promising catalytic performance in the selective photoreduction of CO_2 to methanol.[10]

Selective electroreduction of CO_2 to methanol (CO_2RR) remains a challenging task, with only a limited number of effective catalysts reported in the literature. By pyrolyzing metal–organic frameworks synthesized from mixed ligands, we generated nickel nanoparticles (NiNPs) anchored on zero-dimensional porous hollow carbon superstructures (Pyr-CP-800 and Pyr-CP-600). This unique morphology provides high specific surface area and surface roughness, which synergistically facilitate the selective electroreduction of CO_2 to CH_3OH.[11] In contrast to most previously reported Ni-based electrocatalysts that predominantly produce CO, Pyr-CP-800 selectively yielded CH_3OH with a Faradaic efficiency of 32.46% at −0.60 V versus RHE in 1.0 M KOH solution—the highest reported among Ni-based electrocatalysts to date.

Additionally, NiO nanoparticles immobilized on ZrO_2 via the incipient wetness impregnation method were employed as catalysts for the simultaneous conversion of CO_2 and glycerol in an alkaline medium to produce value-added formate and lactate. In this process, transfer hydrogenation from glycerol facilitates the reduction reaction.[12]

Porous nanomaterials can broadly be classified into inorganic, organic–inorganic hybrid, and purely organic porous materials based on their chemical composition. Classical examples of inorganic porous materials include porous silicon, zeolites, porous metal oxides, porous metals, and porous carbons (Figure 1). Organic–inorganic hybrid materials include metal–organic frameworks (MOFs), zeolitic imidazolate frameworks (ZIFs), functionalized mesoporous materials synthesized through surfactant-templated supramolecular assembly,[13] and periodic mesoporous organosilicas (PMOs) prepared using bridging organosilanes as precursors and ionic or non-ionic surfactants as templates.[14]



Classification of porous nanomaterials based on their chemical compositions

Purely organic porous materials include hypercrosslinked polymers (HCPs), porous organic polymers (POPs), conjugated microporous polymers (CMPs), porous aromatic frameworks (PAFs), and covalent organic frameworks (COFs), typically synthesized through reticular chemistry using organic monomeric building blocks.[3] The presence of nanoscale pores in these materials facilitates efficient diffusion of reactants to catalytic sites and rapid diffusion of products from the internal pore structure to the bulk phase.

CO2 fixation reactions catalyzed by porous organic polymer bearing N-heterocyclic carbene (NHC) moieties at the pore surfaces

We synthesized N-heterocyclic carbene-containing porous organic polymers, NHC-01 and NHC-02, through a Friedel–Crafts reaction between imidazolium salts and biphenyl. Among these materials, NHC-01 exhibited excellent stability, high flexibility, and a high BET surface area of 1298 $m^2\ g^{-1}$. It also demonstrated a significant CO_2 uptake capacity of 2.85 mmol g^{-1} at 273 K under 1 bar pressure.

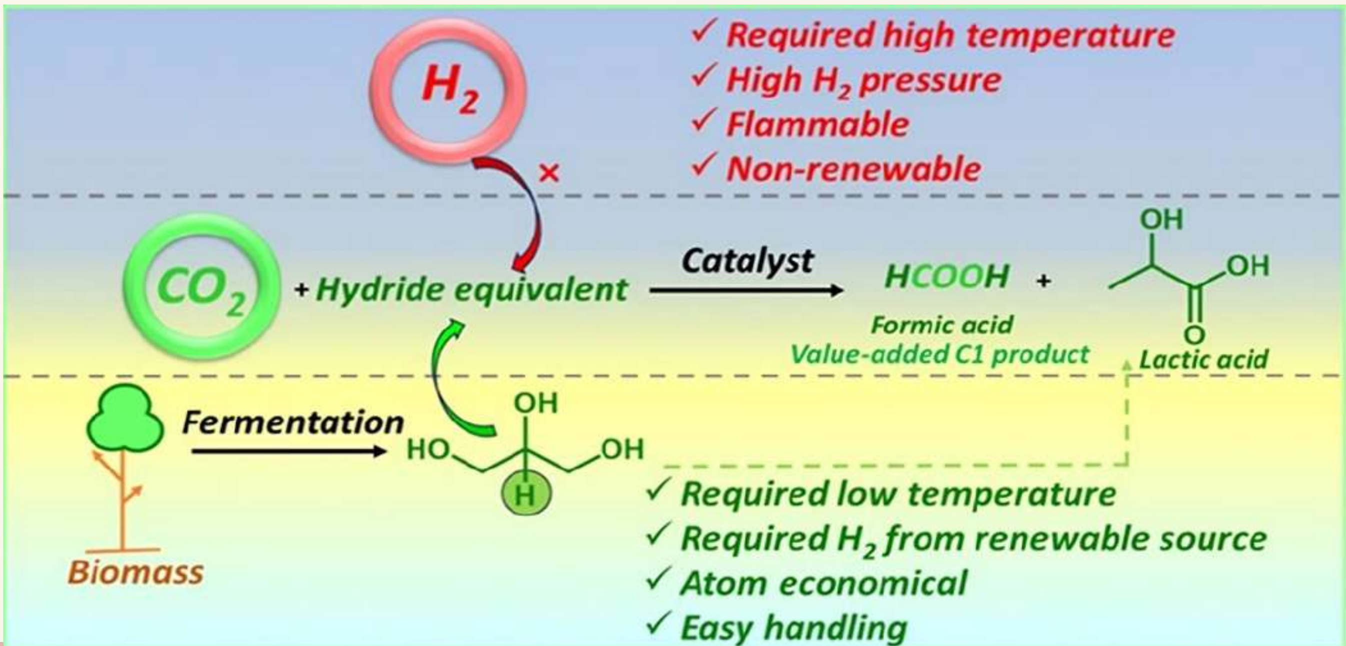
Due to its high surface area, strong CO_2 adsorption capability, and the presence of catalytically active NHC moieties, NHC-01/02 functions as an efficient metal-free organocatalyst for CO_2 conversion reactions. NHC-01 selectively reduced CO_2 to methanol through hydrosilylation under atmospheric CO_2 pressure with complete silane conversion.[9] Additionally, the catalyst showed excellent activity for N-formylation and reductive cyclization reactions, maintaining high yields for at least four catalytic cycles.

The NiO–ZrO_2 catalyst synthesized via incipient wetness impregnation enabled the simultaneous conversion of CO_2 and glycerol in an alkaline medium. Comprehensive characterization using PXRD, Raman spectroscopy, XPS, BET surface analysis, CO_2/NH_3-TPD, H_2-TPR, and UHR-TEM revealed unique properties, including weak Lewis acid sites that are critical to catalytic performance.

Under optimal conditions (200 °C, 40 bar CO_2, KOH base), the catalyst achieved yields of 3.26 mmol formate and 11.20 mmol lactate.[12] The synergistic interaction between NiO and ZrO_2, along with the in situ formation of carbonate salts, contributes to the high catalytic efficiency. Economic assessment indicates the commercial potential of co-producing formic and lactic acids, with glycerol price and the efficiency of converting formate and lactate salts into their corresponding acids being key economic factors.

We also synthesized a series of acetylene-linked donor–acceptor-type conjugated microporous polymers (CMPs) with tailored electronic structures to investigate their photocatalytic performance in CO_2 reduction to methanol in aqueous NaOH under visible light irradiation. Among them, the optimized porous polymer TTT-DEBP, featuring a strong electron-accepting triazine unit and an extended π-conjugated diethynyl biphenyl system, achieved a methanol production rate of 30.8 μmol $g^{-1}\ h^{-1}$ with 90.3% selectivity and excellent recyclability.[10] Experimental and theoretical studies revealed that the synergistic interaction between triazine, biphenyl, and acetylene units lowers exciton binding energy, enhances charge separation and transfer, and reduces charge recombination, thereby improving photocatalytic performance.

In summary, we have developed a range of porous nanomaterials possessing high specific surface areas and abundant basic sites suitable for CO_2 capture and utilization. These materials have been successfully employed as heterogeneous catalysts for the reduction of CO_2 to methanol and formic acid with high selectivity, as well as for the synthesis of N-formylated amines, carbamates, poly(hydroxy)urethanes, and benzimidazoles through reductive cyclization of o-phenylenediamine using CO_2 as a C_1 building block.



Catalytic transfer hydrogenation for the synthesis of formic and lactic acids from CO2 and glycerol in the autoclave reactor

The fixation of CO_2 into fuels and chemicals offers clear environmental and economic advantages. As a renewable carbon source, CO_2-based chemical transformations provide a sustainable pathway for industrial processes while reducing reliance on fossil-derived feedstocks.

High Pressure Gas Adsorption Instrument of IACS procured in the Indo-German project of IGSTC

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Life Inside the Laboratories and the Evolving Research Environment

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> *Indian Association for the Cultivation of Science sets itself apart as an esteemed Institution of Science, as it not only offers world-class laboratories as the oldest research institution in India, but also serves as the crucible for encounters of a lifetime.*

Experiences are etched moments of discovery, and these moments are eternally etched into our lives. This is true for everyone. Perhaps, most profoundly, for those students who embark on a new journey at IACS as they acquaint themselves not only with their scientific curiosity and passion but also with the day-to-day life of a scientist in the making. Hence, the first such experience takes place inside the laboratory.

Life inside and outside the lab has defined differences in terms of approach, rhythm, and relationships -- and perhaps the closest relationship that the students come to foster is with their research itself. They become acquainted with the research they will carry out, the scientific gaps, the questions, the experimental designs, the instruments that will aid their investigations, and the process of approaching scientific questions to seek answers rather than merely reading facts from academic books.

In doing so, they become part of the fact-making phenomenon. They also face what may be their greatest challenge -- the inevitable failures. But nothing keeps one afloat more than successful experiments and the achievement of "good results" as one always finds the strength to try again. Such are the lessons that the students learn inside their laboratories.

Over time, the laboratory becomes a space of belonging, a niche that the student can call an integral part of their lives. The members of the laboratory and the eminent research guide gradually become akin to family, as they navigate failures and successes together. This fosters a sense of camaraderie that would otherwise be difficult to achieve, as they regularly engage in scientific discussions and brainstorming sessions in the laboratories. Life inside the laboratories eases the students and creates an environment where scientific discussions flow naturally, often extending beyond formal meetings into corridors, instrument rooms, and lunch tables. Beyond the laboratory lies the wider research environment of IACS, which is no less than an extended family in its own regard for whenever required everyone puts a lot of effort to support the research students. Such an environment makes it easier for young researchers to thrive, encouraging confidence, collaboration, and immense intellectual growth.

Students from diverse backgrounds, cultural outlooks, and corners of the country come to IACS to build a small world of their own for the years they spend in their respective laboratories. The ecosystem of IACS always reinforces a positive attitude, complemented by access to world-class research infrastructure in all areas of STEM, lecture series and international exposure to encourage scientific exchange and growth.

As the research environment of IACS constantly evolves, generations of students continue to pass through the gates of IACS to enter into this research environment full of new experiences and discoveries. Although the people, instruments, and even areas of research may evolve over time, the spirit of scientific inquiry and the passion of these budding scientists will remain undiminished. Life outside IACS may transform in many ways, but some encounters will always remain special, and life inside the laboratories of IACS will forever tell the tales of these encounters. After all, these encounters at IACS become cherished chapters of growth, resilience, and scientific discovery for every past, present and future student of IACS.

Perspectives of Young Scientists

IACS provides huge opportunities filled with advanced infrastructure, a vibrant atmosphere for thinking in open mind and highly intellectual and energetic students. The vibrant present, evolving with the rich heritage of IACS and filled with enormous possibilities puts the new generation in a unique position to invent and innovate. IACS aims to contribute in areas of national priorities based on its strength in fundamental research. An interdisciplinary environment, shared facilities, and support for young scientists will enable collaborative work and translation of research into technologies that benefit society. Some perspectives envisioned for dream 2047 are briefed below.

Cold Chemistry and Astrochemical Physics: Despite its extreme dilution and low temperatures, the interstellar medium (ISM) sustains rich chemical complexity through cold atom - and ion - molecule reactions, where long-range interactions and barrierless pathways enable efficient chemistry at a few K. In this quantum regime, reaction dynamics are governed by state specificity, tunnelling, and scattering resonances, rendering temperature-averaged rate coefficients insufficient for non-equilibrium environments. While ion–molecule reactions dominate due to pervasive ionization, atom–molecule reactions involving H, C, N, and O control key formation and destruction pathways. Looking ahead, integrating precision cold chemistry experiments with quantum scattering theory will enable predictive astrochemical models linking microscopic dynamics to interstellar evolution. Bridging molecular-scale dynamics with emergent collective behavior, insights from quantum-controlled reactions in dilute, nonequilibrium environments naturally motivate broader questions about how coherence, topology, and stability arise and persist in complex many-body systems.

Topological and Nonequilibrium Quantum Matter: In this spirit, understanding topological phases represents one of the outstanding questions in modern condensed matter physics. While such phases are stable in two dimensions at zero temperature, their fate at finite temperatures remains unresolved. Central challenges include stabilizing topology in fermionic systems and identifying whether topological features survive in nonequilibrium steady states. Related efforts focus on classifying driven quantum phases and mechanisms of ergodicity breaking in isolated interacting matter.

Quantum Materials and Emergent Phenomena: Experimental efforts to uncover emergent quantum phenomena in low-dimensional and topological materials by exploring how topology, symmetry breaking, and collective order interact in reduced dimensions. By revealing unconventional phase transitions and slow critical dynamics, it aims to link fundamental quantum physics with future quantum sensing and coherent electronic technologies.

Beyond-CMOS Logic and Quantum Platforms: Future logic circuits can integrate charge, spin, phonons, and ions as information carriers. Electron - magnon coupling enables low-loss magnon transistors, phonons modulate nanoscale transport, and ionic-liquid gating induces extreme carrier densities in 2D materials. Together, these effects define a beyond-CMOS paradigm. In coherent regimes, the same couplings support hybrid quantum platforms linking magnons, phonons, and photons for quantum communication and transduction. Together, these efforts reflect a broader vision of understanding how structure, interactions, and organization across length scales give rise to novel functionality.

Polymer Science, OLEDs, and Soft Functional Materials: In this context, polymer science at IACS focuses on biodegradable, stimuli-responsive, and supramolecular polymers for drug delivery, bioimaging, antibacterial materials, OLEDs, energy harvesting, and storage. Precision control through non-covalent interactions enables functional materials whose properties are encoded in hierarchical organization, earning IACS strong international recognition.

Natural Product Chemistry and Drug Discovery: Finally, natural products remain a central pillar of new drug discovery. IACS has a strong tradition in total synthesis, functional modification, and mechanistic understanding of complex natural molecules with anticancer, antibacterial, and neuroactive potential. Future directions emphasize sustainable synthesis, rational design, and integration with chemical biology and translational research, strengthening both societal impact and foundational organic chemistry.

Inputs for the section "Perspectives of Young Scientists" were contributed by Profs. Nabanita Deb, Arnab Sen, Mintu Mondal, Subhadeep Datta, Anindita Das, Rajib Goswami, and K. D. M. Rao of IACS

Pratap Paul, Senior Research Fellow performing experiments with high-pressure liquid chromatography (HPLC)

Dr. Semantee Bhattacharya culturing mammalian cancer cells

Syed Ramizul Kabir, Senior Research Fellow using DFT for theoretical calculations

Syed Ramizul Kabir, Senior Research Fellow using DFT for theoretical calculations

Tathagata Naskar, Junior Research Fellow performing experiments in the lab

IACS@200 – An Avenue for Self-reliant India

Prof. Kalobaran Maiti
Director
Indian Association for the Cultivation of Science (IACS)
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Indian Association for the Cultivation of Science (IACS), the oldest research institute in India was established with a vision to cultivate the culture of science led by Indians for self-reliant India. To begin with, Dr. Mahendra Lal Sircar published an article in August 1869 issue of the Calcutta Journal of Medicine, stating that "...

We want an Institution which will combine the character, the scope, and objects of the Royal Institution of London and of the British Association for the Advancement of Science. We want an Institution which shall be for the instruction of the masses, where lectures on scientific subjects will be systematically delivered and not only illustrative experiments performed by the lecturers, but the audience should be invited and taught to perform them themselves. And we wish that the Institution be entirely under native management and control.

The Association was established on 15th January 1876 in a meeting in the Senate House of the Calcutta University. A Committee of Management was appointed with the Lieutenant Governor, Sir Richard Temple as the President, Dr. Rajendra Lal Mitra as Vice-President and Dr. Mahendra Lal Sircar as Secretary. In February 21, 1876, the Lt. Governor offered a building at 210 Bow Bazar Street at the junction of College Street and Bowbazar free of charge with a condition that at least Rs. 70,000/- should be collected via donations, of which Rs. 50,000/- was to be invested in Government securities and a monthly subscription of at least Rs. 100/- should be promised for two years. The Association was formally inaugurated on 29th July, 1876 with an objective "*to cultivate science in all its departments by original research and to its varied applications to the arts and comforts of life*".

Breeding scientific priorities: While the major activities involved classroom teaching, Dr. Sircar stressed on experimental science as the most important aspect for capacity building. Father Lafont helped set up laboratories in optics, meteorology, and spectro-telescopic setups. Sir Jagadish Chandra Bose introduced students to electromagnetic wave propagation and his home-built crescograph. Efforts were made to bring global inventions to India. Dr. Sircar procured Rontgen tubes soon after its discovery in November 1895 and produced the first x-ray image in India in June 1896 – within few months of its discovery despite much inferior communication system available at that time.

Visitor program is another key ingredient of training program where leading researchers from around the globe visited to offer prize lectures or lecture courses. For dissemination of knowledge to the mass, there used to be periodic scientific discussions. In 1915, the Association started printing the papers discussed in the Association as *Proceedings of the Indian Association for the Cultivation of Science;* the first volume appeared in 1917. In 1926, this became The Indian Journal of Physics, where more than sixty papers were published between 1928 – 1933 dealing with Raman effect. In 1933, a whole-time research Professorship, named Mahendra Lal Sircar Professor of Physics, was created by combining donations from Raja Veharilal Mitra with the Mahendra Lal Sircar Memorial Fund and other funds with full power of administration over Research Laboratories, Library and Workshop.

This partially fulfilled the long-cherished desire of the Founder, to establish full time research Professorships. Dr. K. S. Krishnan was the first Mahendra Lal Sircar Professor.

After the foundation of IACS, the next major step was taken at the time of platinum jubilee of IACS by a great architect of scientific reform and institution builder, Prof. Meghnad Saha. He set out a new development plan for IACS and the Foundation Stone of the laboratory building at Jadavpur was laid on 26th September, 1948, by Dr. Bidhan Chandra Roy. In fact, Prof. Saha began to take interest in the affairs of IACS soon after his return from Allahabad as Palit Professor of Physics at the University College of Science. He envisioned establishing activities in nuclear physics (now Saha Institute of Nuclear Physics), radio-physics (a department in Science College) and material science and spectroscopy at IACS. He served as honorary secretary, Vice-President, and President (1946) at IACS. By hard work and dedication, he completed the development plans of IACS. He became the first full-time Director of IACS in 1953 and served ceaselessly to build IACS till the day of his death.

In June, 1968, the Union Education Ministry appointed a Reviewing Committee to review the activities of the Association for the period 1958-68. Subsequently, the Department of Science and Technology (DST) was established and the Government of India started funding IACS as an autonomous institute under DST.

Meghnad Saha, first full-time Director of IACS in 1953

At the juncture of 125 years of IACS (2001), the then Director, Prof. Debashis Mukherjee proposed an expansion plan, a land was identified at Baruipur, and an activity in material science started at the Jadavpur campus by Prof. D. D. Sarma (Mahendra Lal Sircar Professor) with an aim to setup a center for nano-mission. However, the land was procured in 2017 by the then director, Prof. Santanu Bhattacharya with an aim to setup a Syamaprasad Mookerjee Advanced Research and Teaching (SMART) campus. In 2018, IACS became a Deemed to be University under de novo category.

Evidently, the scientific priorities spanning over classroom teaching and setting up of state-of-the-art experiments to cultivate science for the societal benefit continue to be the main motto of IACS. Prof. Meghnad Saha expanded the horizon to establish active interdisciplinary research activity near the platinum jubilee year. IACS completed another 75 years and its time to leap frog to a new paradigm filled with opportunities for the next generation as resonated in the messages of Dr. Sircar such as,

> *"To you, my dear colleagues, from whom I have received the heartiest sympathy and support, and to all our educated young men who have not yet come forward as they should have, I leave this Science Association of ours as a legacy which, calculated to regenerate our country, you will, I dare say, try your best to improve and develop to its utmost capacity ..."*

Emerging Research Directions and Infrastructure – A plan for IACS@200

Creation of modern academic infrastructure: IACS is blessed with unique blend of experience for one and half century. It is now necessary to create a space for young minds to dwell and brainstorm over issues threatening the very existence of human civilization. For example, the problems of drug-resistant diseases, air- and water-borne diseases leading to Pandemic, bleak future of fossil fuel derived energy resources, global warming, and the growing needs of the modern information age involving quantum science, data science, and artificial intelligence. This is impossible in the present campus which is too congested to run the existing programs and has no scope of expansion to address the needs of the nation as envisaged by the Government of India

Unification of diverse expertise is paramount for game changing innovations. This requires the creation of a well-equipped centers of excellence to embark on research into the emerging areas of Biotechnology and Bio-informatics, Advanced Materials (quantum and functional materials), Renewable Energy including Hydrogen Energy, Battery, Robotics, etc. IACS plans to establish a center of excellence in line of the National Education Policy, wherein there will be scope to implement *Research, Development, and Innovation (RDI) Policy* of the Government and train the young minds with the latest advances in Science & Technology. In addition, IACS will facilitate a trendsetting initiative to bring together premier institutes under a common academic platform in the form of a city cluster to breed research across disciplines adding complementary strengths

A Syamaprasad Mookerjee Advanced Research and Teaching (SMART) center of excellence will be established on a 32.45-acre land at Baruipur. **(i)** It will facilitate to setup undergraduate and graduate program of global standard with multifarious outreach activities for serving society at large. **(ii)** An *International Cell for Innovation and Research for Technology (ICIRT),* a multi-disciplinary center to promote cutting edge research in science and engineering including medical sciences.

The cell will organize public lectures by eminent scientists, workshops, and meetings in basic and applied sciences to enthuse young minds for research.
(iii) *A Science Park for Advanced Research and Creativity for Society (SPARCS)* will be setup to translate invention to innovation and catalyse technology transfer. Primary aim would be a cross fertilization of basic and applied research, and venture into the realms of technology transfer, public-private partnership, etc. IACS will take initiative, to make freely available to all interested, the proceedings of its activities in various formats and will maintain a service informatique.

Creation of Centers of Excellence

The vibrant present evolving with rich heritage of IACS and filled with enormous possibilities puts the new generation in a unique position to invent and innovate. IACS aims to contribute in areas of national priorities based on its strength in fundamental research. An interdisciplinary environment, shared facilities, and support for young scientists will enable collaborative work and translation of research into technologies that benefit society. Some of the areas identified are outlined below.

(a) *Energy Research involving activities* in battery, green energy, and carbon dioxide capture.
(b) *Advanced materials* including quantum and functional materials.

IACS-Baruipur, A SMART Center of Excellence, Kolkata

(c) ***Sustainable Environment*** via development of catalytic and supramolecular technologies for clean water, anion removal, pollutant capture, and environmental remediation, advance homogeneous, heterogeneous, nano- and enzymatic catalysis using experimental, computational, and AI/ML approaches for green chemical synthesis.
(d) ***Therapeutic Development and Antimicrobial Resistance*** to combat antimicrobial resistance through molecular design, pathogen profiling, and therapeutic development, identification of diseased cell and drug delivery, etc. IACS faculty has been working extensively on cancer cell detection and drug delivery which is integral part of this. (e) Spectroscopy and microscopy: IACS is known for its outstanding contribution in spectroscopy. Starting from first x-ray imaging by the founder Mahendra Lal Sircar to discovery of Raman effect, expansion of spectroscopy effort by Meghnad Saha, ultra-fast spectroscopy by Mihir Choudhuri, etc. IACS has not embarked on electron spectroscopy yet which is a necessary probe for advanced materials. We plan to initiate a new paradigm in this direction by setting up various forms of electron spectroscopy to reveal microscopic details of material properties and for the first time in India, a time-resolved electron spectroscopy and microscopy to study dynamics in materials with highest degree of accuracy.

Research areas of immediate focus involve, Cold Chemistry and Astrochemical Physics bridging molecular-scale dynamics with emergent collective behavior, insights from quantum-controlled reactions in dilute, nonequilibrium environments naturally motivate broader questions about how coherence, topology, and stability arise and persist in complex many-body systems. Nonequilibrium and Topological Quantum Matter to uncover emergent quantum phenomena in at different dimensions and topological materials by exploring how topology, symmetry breaking, and collective order interact.

By revealing unconventional phase transitions and slow critical dynamics, it aims to link fundamental quantum physics with future quantum sensing and coherent electronic technologies. Beyond-CMOS Logic and Quantum Platforms to integrate charge, spin, phonons, and ions as information carriers. Polymer Science, OLEDs, and Soft Functional Materials with a focus on biodegradable, stimuli-responsive, and supramolecular polymers for drug delivery, bioimaging, antibacterial materials, OLEDs, energy harvesting, and storage. Natural Product Chemistry and Drug Discovery; IACS has a strong tradition in total synthesis, functional modification, and mechanistic understanding of complex natural molecules with anticancer, antibacterial, and neuroactive potential. Future directions emphasize sustainable synthesis, rational design, and integration with chemical biology and translational research, strengthening both societal impact and foundational organic chemistry.

Challenges and Opportunities

Research ecosystem is going through a revolutionary change at present in India. It is important to realize the necessity of ***inventions for technological advances***. For example, one could not think about MRI machines, levitation, SQUID, etc. before superconductivity was discovered. Even quantum-based devices dreamt today requires superconductors.

Data storage got a revolutionary change after the discovery of giant magnetoresistance. Lasers have applications in almost every field involving medical applications, to defence. The major challenge is to realign research fraternity with the changed ecosystem which requires significant change in mindset. We need to create expertise in the fields for mission-based programs and link industry to research ecosystem.In addition to academic challenges noted above, a major bottleneck is appropriate administration to facilitate such initiatives. One needs to be ready to accept failures as any new initiative has its teething time. A balanced approach will lead to huge opportunities. IACS has been putting efforts to devise progressive plans and capacity building with the help of both Governmental support and industry involvements.

> *Swami Vivekananda,The rain drops from the sky, if it is caught in hands is pure enough for drinking. If it falls in gutter, it's value drops so much that it can't be used even for washing the feet. If it falls on hot surface, it perishes. If it falls on lotus leaf, it shines like a pearl and finally, if it falls on oyster, it becomes a pearl. The drop is same, but it's existence & worth depends on with whom it associates.*

The future role of IACS in India's Science and Innovation Ecosystem

IACS, the cradle that brought in renaissance in the culture of science in India continues to provide an oyster platform to indulge in science and create history that no other Institute in India has done so far. IACS is evolving with time taking many new steps in line with the country's mission and societal needs.

We continue to have excellent visitor program; leading scientists visit and interact with students to disseminate knowledge. As a part of ***science outreach***, an archive museum is being created to showcase how science evolved in the country and the role IACS played. This will encourage younger generation starting from school level to get inspired in science. A regular public outreach program called 'SciCafe' is initiated to interact with students and encourage scientific thinking. IACS goes to remote areas including SC/ST populated regions with a mobile experiment van to demonstrate the wonders of science. For the interaction of students with industries, a placement cell is created and students already started interacting with industries in the field of artificial intelligence. A special intern program will be established to encourage women students to take up science as career.

IACS is developing a center, **RETINA (Research Entrepreneurship for Translation Innovation and NAvigation)** as a part of ***incubation of invention to innovation***. This will help to navigate research findings to product via interaction with industry. This will grow to SPARCS proposed at SMART campus. In addition, support will be given to students for startups, ***students' entrepreneurship***. Their creative mind will get nurtured to transform into a matured entrepreneurship.

Thus, powered by curiosity driven research and a modern outlook, IACS, is poised to define new frontiers of science and allow buds to bloom with its own color. In doing so, it will inspire generations of scientists and translate laboratory-based results to field-deployable prototypes, which is the evolving science and innovation ecosystem growing in the country.

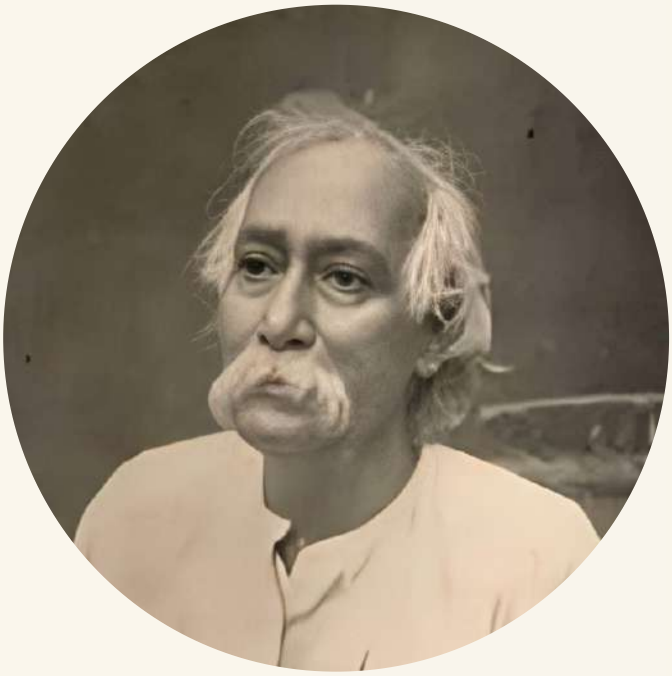
High-Performance Computer Cluster at IACS, Kolkata

Resonance Raman Spectroscopy

Biographies
Architects of **IACS**

Dr. Mahendra Lal Sircar

1833-1904



Father of Modern Science in India

Dr. Mahendra Lal Sircar stands among the earliest visionaries who imagined an intellectually self-reliant India. A physician of distinction, a public intellectual, and above all an institution builder, he founded the Indian Association for the Cultivation of Science (IACS) on 29 July 1876. At a time when scientific research in India was almost entirely dependent on colonial structures, Sircar dared to ask a simple but radical question: why should Indians not create, support, and pursue science on their own terms? His life was a sustained answer to that question.

Born on 2 November 1833 in Paikpara, Howrah, Sircar's early years were marked by loss. He was only five when his father, Taraknath Sircar, passed away. Brought up by his maternal uncles in Calcutta (Now Kolkata), the young Mahendra Lal grew up in modest circumstances but with an enduring love for learning. He began his education in Bengali and English before joining Hare School in 1840 as a free student. His brilliance soon became evident, earning him a place at Hindu College, where his curiosity for science deepened and matured.

Drawn to medicine as both a science and a service, Sircar enrolled at Calcutta Medical College. He qualified in medicine, surgery, and midwifery in 1860, obtained the Licentiate in Medicine and Surgery (LMS) degree in 1861, and went on to earn his MD in 1863, making him one of the earliest Indians to receive this degree from the University of Calcutta. These achievements placed him firmly among the intellectual elite of his time, yet he never viewed personal success as an end in itself.

As a physician, Sircar was widely respected for his skill and independence of thought. He treated many prominent contemporaries, including Bankim Chandra Chattopadhyay, and later attended Sri Ramakrishna during his final illness. Known for questioning accepted wisdom, he initially opposed homeopathy but later embraced it after careful personal study, an example of his commitment to evidence and conviction over dogma. Still, his deepest concern lay beyond clinical practice. He believed that without institutions dedicated to original research, India would remain intellectually dependent, regardless of individual brilliance.

This belief found clear expression in 1869, when he published a seminal article, “The Desirability of a National Institution for the Cultivation of the Physical Sciences by the Natives of India,” in the Calcutta Journal of Medicine. In it, Sircar argued that science must be cultivated in India, by Indians, and for India. Scientific research, he insisted, was not merely a technical pursuit but a matter of national self-respect and cultural confidence.

Years before the article appeared, Sircar had already begun working toward this goal. From 1867 onward, he tirelessly campaigned for a national scientific association, writing, speaking, persuading, and appealing to Indian patrons for support. His vision finally took shape in 1876 with the establishment of the Indian Association for the Cultivation of Science at 210 Bowbazar Street, Calcutta. Conceived as a “solely native and purely national” institution, IACS was funded, governed, and sustained by Indians, a bold and unprecedented step in colonial India.

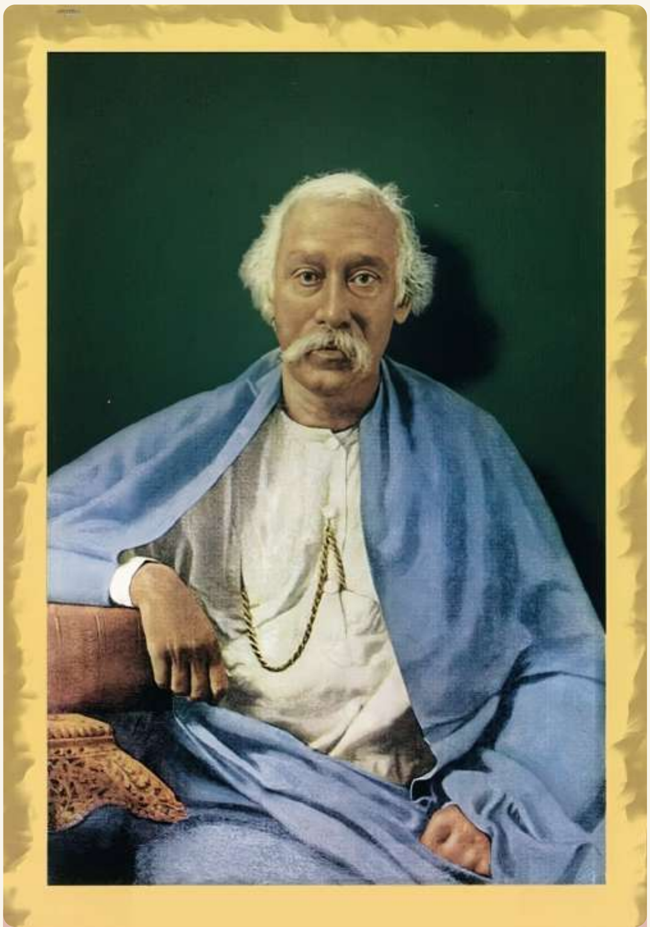
Bangadarshan

One of Sircar’s most enduring contributions was his emphasis on public scientific lectures. He believed that before a nation could produce scientists, it had to nurture scientific curiosity. Under his guidance, IACS began a systematic lecture programme that opened the world of modern science to students, teachers, and the wider public. Physics, chemistry, mathematics, and the natural sciences were discussed not as distant European achievements, but as living fields open to Indian participation. Distinguished figures such as Jagadish Chandra Bose, Ashutosh Mukherjee, Father Lafont, Chunilal Bose, and Pramathanath Bose were among those who enriched this intellectual space. In an era with few laboratories or research facilities, these lectures became the heartbeat of an emerging Indian scientific community.

Sircar’s nationalism was quiet, practical, and deeply rooted in institutions. He understood that political subordination was sustained by intellectual dependence, and that scientific capability was essential to national renewal. His work anticipated later calls for self-reliance in science and industry, long before such ideas entered popular discourse.

The global significance of Sircar’s vision became unmistakable in the early twentieth century, when a young C. V. Raman began conducting research at IACS in 1907. Working initially while holding a government post, Raman developed his experimental practice within the Association’s modest facilities. In 1928, it was here that he discovered the Raman Effect, a discovery that earned him the Nobel Prize in Physics in 1930. Though Sircar did not live to see this triumph, it stood as a powerful validation of his faith in indigenous scientific institutions.

For decades, IACS remained virtually the only place in India where advanced research in the physical sciences could be pursued seriously. Scientists

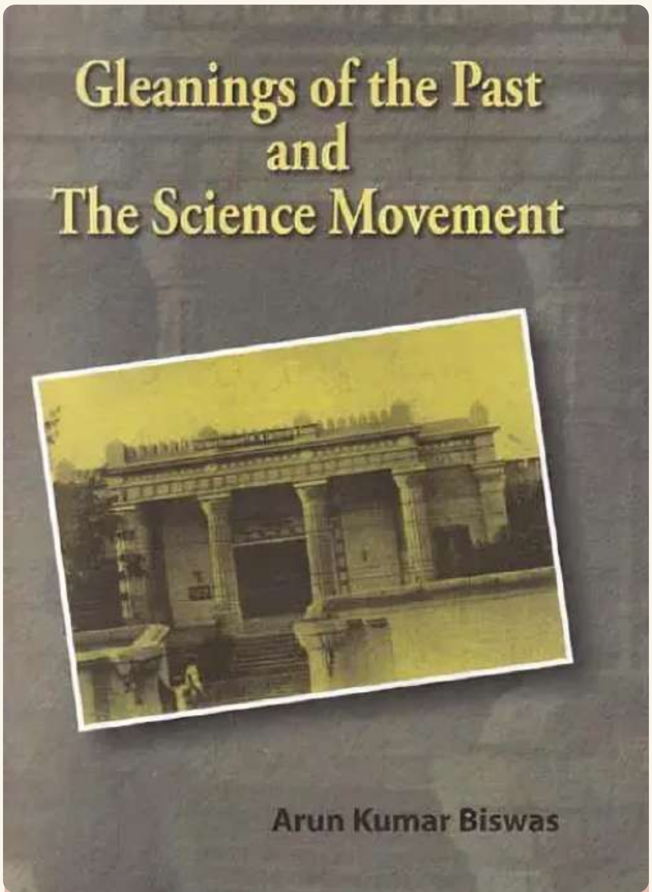


Mahendra Lal Sircar

such as Satyendra Nath Bose, Meghnad Saha, and K. S. Krishnan were shaped by the intellectual culture it nurtured. The Association bridged the gap between colonial education and Indian scientific creativity, turning aspiration into sustained practice.

Sircar's humanism extended beyond science. At a time when women's access to higher education was sharply limited, he supported Abala Bose's medical studies and enabled Sarala Devi to attend scientific lectures at IACS. These gestures reflected his belief that science must be inclusive and socially transformative.

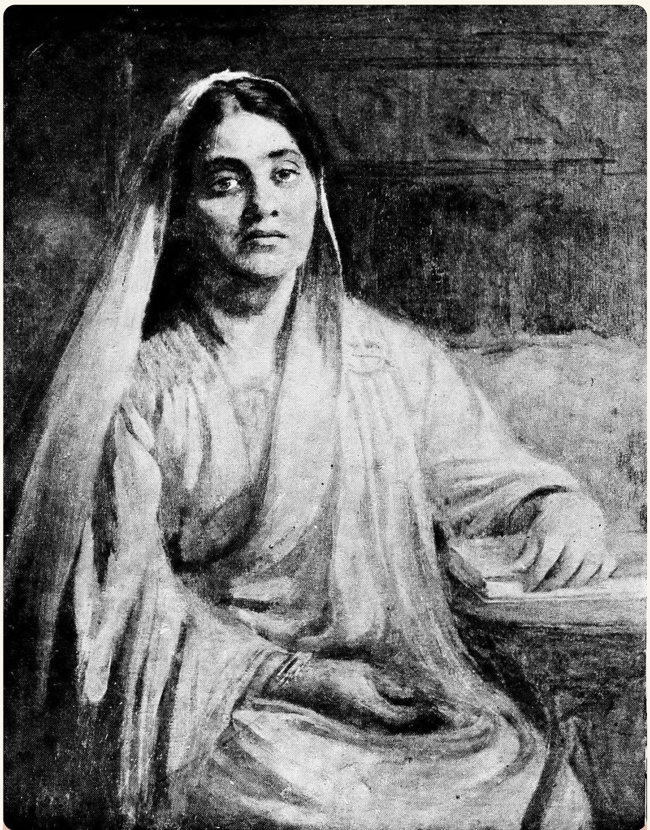
Dr. Mahendra Lal Sircar passed away on 23 February 1904, but the institution he built continued to grow, evolve, and inspire. His insistence that science be cultivated "by the natives of India" resonates strongly even today, as India reflects on scientific self-reliance, innovation ecosystems, and national research capacity.



Gleanings of the Past and the Science Movement, a monograph derived from the diaries of Mahendra Lal and Amrit Lal Sircar

Sircar's true legacy lies not merely in bricks and mortar, but in the culture he nurtured, a culture of questioning, public engagement, and institutional continuity. When Raman received the Nobel Prize in 1930, it was not only a celebration of individual genius, but also a quiet tribute to the foresight of a man who understood that nations rise through the institutions they patiently build. Dr. Mahendra Lal Sircar remains, therefore, one of the earliest architects of Indian scientific nationalism, a visionary who transformed hope into enduring scientific life.

It was the late Dr. Mahendra Lal Sircar who, by founding the Indian Association for the Cultivation of Science, made it possible for the scientific aspirations of my early years to continue burning brightly.It was the late Dr. Mahendra Lal Sircar who, by founding the Indian Association for the Cultivation of Science, made it possible for the scientific aspirations of my early years to continue burning brightly.



Lady Abala Bose, who worked extensively for women's education and the upliftment of widows

Authored by Dr Kinkini Dasgupta Misra

Amrita Lal Sircar

1860-1919

Institutional Continuity and the Growth of IACS

Amrita Lal Sircar, the son of Mahendra Lal Sircar, played an important role in sustaining and strengthening the Indian Association for the Cultivation of Science (IACS) during a critical phase in its development. While the founding vision of IACS is associated with his father, its continuity and gradual consolidation in the early twentieth century owe much to Amrit Lal Sircar's sustained efforts.

Born in August 1860 in Calcutta (now Kolkata), Amrita Lal Sircar received his education in Calcutta and later trained in medicine at the Calcutta Medical College. After completing the required examinations, he qualified with the Licentiate in Medicine and Surgery (L.M.S.) in 1894, which enabled him to practise medicine. Alongside his professional training, he remained closely associated with the scientific activities of IACS. His formal association with IACS strengthened in 1894, when he was elected Honorary Assistant Secretary of the Association. This marked his entry into the organisational and administrative framework of one of India's earliest scientific institutions. In this role, he contributed to the conduct of scientific lectures, demonstrations, and the maintenance of laboratory activities, which were central to the Association's mission.

Following the death of Mahendra Lal Sircar in 1904, Amrit Lal Sircar assumed the position of Secretary of IACS. He held this responsibility until his death in 1919, providing continuity at a time when the institution faced significant financial and organisational challenges. His tenure coincided with a transitional period in Indian science, when institutional support for research remained limited and much of the scientific activity depended on individual initiative and voluntary effort.

As Secretary, Amrita Lal Sircar worked to sustain the core functions of IACS. He ensured the regular organisation of public lectures and scientific demonstrations, maintained laboratory facilities, and supported the participation of emerging Indian scientists in the Association's activities. His efforts helped preserve IACS as a functioning centre for scientific inquiry outside the formal university system.

During his tenure, IACS continued to attract a growing number of Indian scientists. Among those associated with the institution in the later years of his leadership was C. V. Raman, whose work at IACS would later lead to the discovery of the Raman Effect in 1928. Although this development occurred after Amrit Lal Sircar's lifetime, the institutional continuity maintained during his tenure formed an important foundation for such scientific achievements.

Amrita Lal Sircar also remained engaged with the broader question of scientific development in India. He recognised the importance of creating infrastructure for research and expressed the need for dedicated laboratories that could support sustained experimental work. His perspective reflected an emerging understanding that scientific progress required not only individual effort but also institutional support.

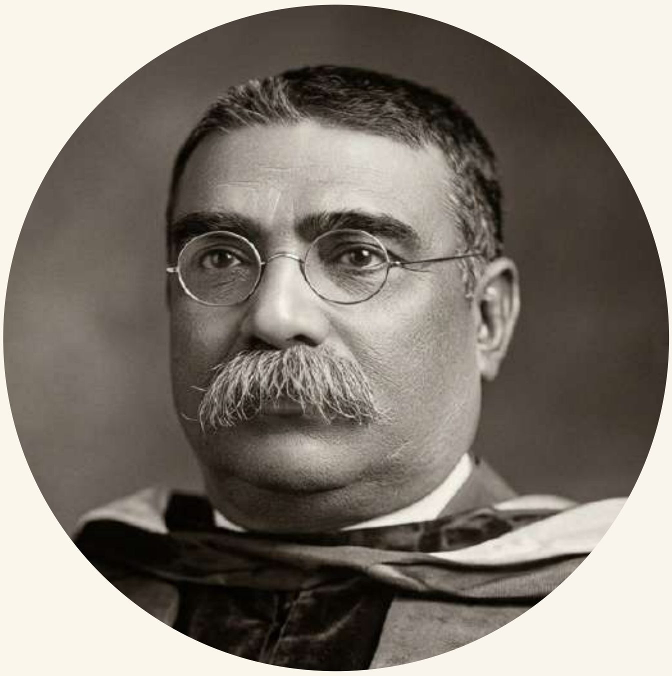
He passed away in 1919, after serving IACS for nearly fifteen years as Secretary. His contribution to Indian science lies not in a specific scientific discovery, but in ensuring the survival and functioning of an institution that would later become central to the development of modern scientific research in India.

IACS Old Campus, 210 Bowbazar Street, Kolkata

Authored by Anupama Kaushal

Sir Asutosh Mookerjee

1864-1924



The Architect of Modern Indian Science

Sir Asutosh Mookerjee (1864–1924) was a towering educationist and mathematician who reshaped Indian higher education. He combined Western scientific methods with pride in India's cultural heritage. Often called the "Tiger of Bengal," he helped establish universities, societies and research institutes as nationalist institutions. Importantly, he ensured that even the struggling Indian Association for the Cultivation of Science (IACS) in Kolkata remained vibrant during colonial neglect.

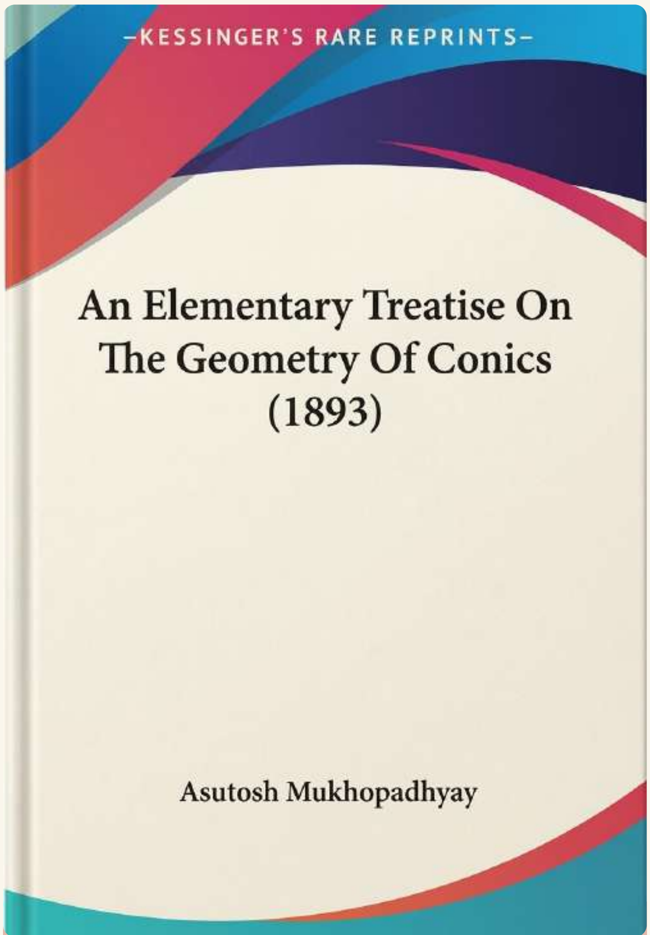
In Sylvain Lévi's words, "Had this Bengal Tiger been born in France, he would have exceeded even Georges Clemenceau". Sylvain Lévi was a renowned French Orientalist and a leading scholar of Indian literature, history, and Buddhism. He played a significant role in promoting cultural exchange between France and Asia and worked closely with Rabindranath Tagore, contributing to the establishment of Visva-Bharati University at Shantiniketan.

Under Mookerjee's leadership, Calcutta University ceased to be a mere examining body and became a centre of teaching and research. He fought British colonial bureaucracy to broaden higher education, secured unprecedented funding from Indian philanthropists, and attracted brilliant minds to India's universities and research institutes.

Early Life and Mathematical Genius

Asutosh Mookerjee was born in Calcutta in 1864 to a physician father and a courageous mother. He excelled in mathematics from an early age. He was the first student of Calcutta University to earn dual master's degrees (Mathematics and Natural Science) by 1886, and his original research on geometry earned international acclaim.

A brilliant geometer, he began publishing research as a youth, proving new results on conics and elliptic functions. Recognized as a prodigy, he published his first research paper at age 17 and completed eleven major mathematical papers by his early 30s. In 1888 he joined the India's first research institutes, IACS as a Lecturer in Mathematics and Mathematical Physics, giving numerous advanced lectures to students. His lecture courses were extensive, he gave 12 lectures in 1887 and 20 in 1888 and covered topics like Differential equations and Optics. Over the next few years, he published 17 research papers (15 in pure math). Scholars later noted that these "monumental" contributions created a mathematical culture for future Indian mathematicians. Mookerjee's lectures at IACS were of "exceptionally high standard" and drew postgraduate students into scientific inquiry. His work helped forge the intellectual culture of IACS at its very beginning. Dr. R.P. Paranjpye, a Mathematician, even remarked that if Mookerjee had devoted himself solely to mathematics, he would have ranked among the world's top mathematicians. However, discouraged by the lack of research support, Mookerjee also studied law and soon became a barrister. From 1904 onward he served as a Judge of the Calcutta High Court, all the while staying active in education.



An Elementary Treatise On The Geometry Of Conics" is a book written by Asutosh Mukhopadhyay in 1893. It is a comprehensive guide that covers the fundamental principles of conic sections

Champion of IACS and Scientific Education

Mookerjee's ties to the IACS remained strong throughout his life. After his initial lectureship, he joined the governing body of IACS, serving as a Fellow and Vice-President for many years. In 1922 he was elected President of IACS (a position he held until his death). He presided over the Association's council meetings and guided its affairs. Even when IACS faced financial crises, colonial authorities provided virtually no grants, Mookerjee used his wide network to rally support. He approached wealthy patrons and alumni, secured small government grants, and organized fundraising events, ensuring that IACS laboratories and equipment were maintained and upgraded. For example, Mookerjee helped oversee the renovation of the Vizianagram and other laboratories at IACS, and ensured needed chemicals and instruments were procured. His efforts kept IACS alive at a time when many feared it would wither.

While leading IACS, Asutosh Mookerjee continued teaching high-level courses there. His lecture series on mathematical physics (1887–89) and physical optics trained a generation of students. In these roles as administrator, lecturer and fundraiser, he essentially treated IACS as India's own Royal Society of Chemistry/Physics. Under his stewardship, IACS remained a hub for Indian science. Not surprisingly, future Nobel laureates like C.V. Raman later credited Mookerjee with providing facilities for research at IACS. Concisely, Mookerjee's IACS section reflects that he not only lent his prestige to the institute, but actively kept its doors open through financial and administrative support.

Sir Asutosh Mookerjee insisted that IACS integrate with the university system, he brokered connections with Calcutta University's laboratories and faculty so that IACS would not remain isolated. Through his influence the first research students at Calcutta University (notably C.V. Raman) carried out experiments in IACS's laboratories under eminent teachers. Thus Mookerjee's role at IACS was as a system-builder, embedding it in the wider academic world, rather than merely as a donor.

Transforming Calcutta University: Endowments and Departments

Sir Ashutosh's tenure as Vice-Chancellor of the University of Calcutta (1906–1914 and 1921–1923) was the era of his greatest institutional achievements. He reimagined the university as a modern research university and higher learning, aligning it with contemporary developments in Europe and America where teaching and research were treated as a unified mission.

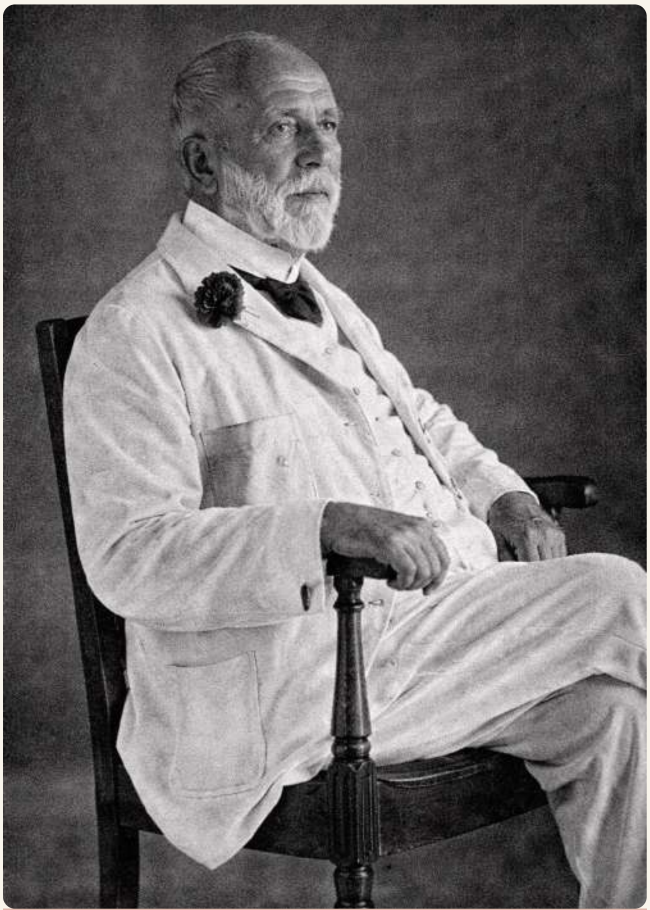
Within a short span, he established numerous postgraduate departments and introduced new fields of study such as anthropology, applied psychology, comparative literature, industrial chemistry, and the history and culture of ancient India and Islam. He also formalized advanced teaching and research in Indian languages, ensuring that Bengali, Hindi, Pali, and Sanskrit each received full postgraduate programs, with the university awarding M.A. degrees in these disciplines for the first time.

Scientific education received a major boost as well. In 1914, he founded the University College of Science (now Rajabazar Science College) to promote advanced study and research in physics, chemistry, and technology. Alongside this, he pioneered postgraduate education in arts subjects that had previously been neglected in India, including some of the earliest Master's programs in comparative literature, applied psychology, and ancient Indian and Islamic history.

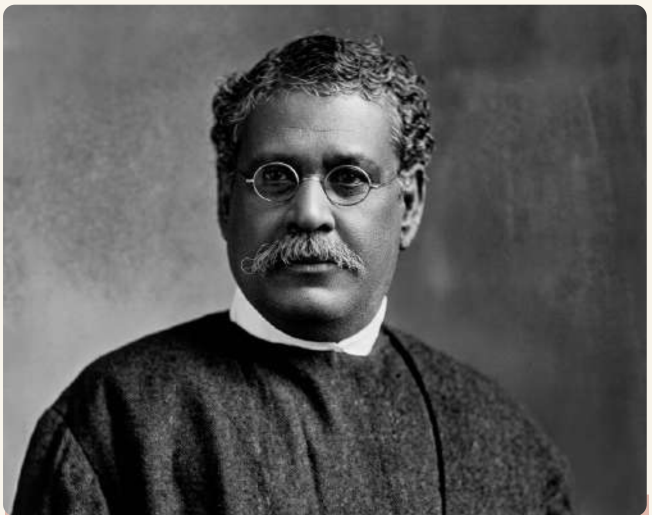
Throughout his tenure, Mookerjee emphasized inclusivity and academic excellence. Students from all castes, creeds, and genders were welcomed, reflecting his commitment to equality in education. At the same time, he invited distinguished European scholars to lecture in Calcutta, nurturing an intellectual environment that blended Western scholarship with Indian cultural traditions.

All of these new initiatives required funding, as the British government consistently refused to provide substantial support for Indian higher education. Mookerjee became exceptionally skilled at fundraising and mobilizing private endowments. He rallied India's wealthy benefactors to establish endowed professorships and construct buildings at Calcutta University. The most notable donor was Sir Taraknath Palit, a Kolkata-based lawyer and nationalist. In 1912, Palit donated around Rs 15 lakh to the university. At Mookerjee's urging, he specified that the funds be devoted to science education. His contribution created two new chair professorships in chemistry and physics and included land and an estate for the university. The chemistry chair was awarded to Prafulla Chandra Ray (appointed Palit Professor of Chemistry in 1916), and the physics chair to C. V. Raman (appointed Palit Professor of Physics in 1917). Palit's generosity gave Indian science a strong foundation, with its first professors already being world-class scientists.

Alongside Palit, Sir Rashbehari Ghosh was another major donor brought in by Mookerjee. A distinguished jurist, Ghosh donated Rs 10 lakh in 1913 specifically for science at Calcutta University and later contributed an additional Rs 13 lakh to establish a technical college that eventually became Jadavpur University.



Tarknath Palit (1831–1914) was a lawyer and a philanthropist. He was associated with the Swadeshi Movement during the Partition of Bengal and was one of the key figures behind the establishment of Science College of the Calcutta University



Rashbehari Ghosh (1845 –1921) was a Barrister, social worker and philanthropist. In 1913, he established an endowment for scientific studies at Calcutta University and establidhed a National Council of Education (NCE) at Jadavpur. Later he donated a princely sum to Acharya Praffulla Chandra Ray for establishing Bengal Chemical and Pharmaceutical Works

Together, the contributions of Palit and Ghosh amounting to roughly Rs 25 lakh that enabled the creation of the University College of Science and Technology on Mookerjee's campus. This institution introduced advanced laboratories for physics and chemistry. Importantly, both donors stipulated that these positions be held by qualified Indians, reflecting a clear nationalist vision. Mookerjee also secured support from the Maharaja of Darbhanga, who funded the Darbhanga Building (about Rs 2.5 lakh) in 1912 on College Street to house the University Law College and central library. Through these efforts, Mookerjee transformed philanthropy into institutional strength, and by 1914, Calcutta University had the infrastructure and faculty needed for advanced research without relying on British support.

With these resources, Mookerjee was able to attract outstanding young talent to India. He had a remarkable ability to recognize potential. During his tenure, he invited C. V. Raman, then working as an accounts officer, to join as the first Palit Professor of Physics. With Mookerjee's support, Raman began his research at IACS and the university, leading to the discovery of the Raman Effect and the Nobel Prize in 1930. Mookerjee also appointed Meghnad Saha and Satyendra Nath Bose as physics lecturers despite their lack of Ph.D. degrees, recognizing their exceptional talent. He brought in Prafulla Chandra Ray to lead chemistry and recruited the young philosopher Sarvepalli Radhakrishnan as George V Professor of Philosophy in the early 1920s. The early holders of the Palit and Ghosh professorships, including D. M. Bose, S. P. Agharkar, and Ganesh Prasad were all future luminaries. Under Mookerjee's leadership, Kolkata earned the title "Athens of the East," becoming a dynamic center where Indian and European scholars collaborated on scientific research.

By establishing these positions and placing Indian scholars in them, Mookerjee effectively built a nationalist scientific infrastructure. He insisted that endowed chairs be held by Indians, ensuring that students learned from Indian pioneers rather than relying solely on colonial faculty. This approach helped prepare Indian scholars to compete internationally, embodying Mahatma Gandhi's vision of combining the best of Western education with Indian heritage to strengthen the nation.

Meanwhile, Sir Asutosh Mookerjee's reforming zeal extended beyond science to every part of the university. In 1909 he founded the Calcutta University Law College, the first separate law college in India, Until then, law instruction had been fragmented across colleges. As Vice-Chancellor, he argued that legal education should teach fundamental principles of law, not mere clerical tricks.

Beyond campus walls, Asutosh Mookerjee was a builder of institutions. In 1908 he founded the Calcutta Mathematical Society, the first such society in Asia, and led it until his death. In 1914 he presided over the first Indian Science Congress, convened in Calcutta under the auspices of the Asiatic Society. He also served multiple terms as President of the Asiatic Society (a record for an Indian at that time) and was a member of the national Sadler Commission (1917–19) on education reform. In each role, he championed Indian self-reliance in education, he helped start explicitly aimed to give "a stronger impulse and a more systematic direction to scientific enquiry" free from colonial neglect.

Despite his dedication to academia, Mookerjee never neglected his duties in law and public life. He continued to serve as a judge of the Calcutta High Court from 1904 until 1923, even acting as Chief Justice for a brief period. Known as a "judge's judge," he wrote over 2,000 judgments praised for their erudition (Sir Hidayatullah later named him one of India's six greatest judges). Unusually for a man of such stature, he treated students and petitioners with humility, he rose at 4 AM, worked, and was known for his simple habits, a strict vegetarian (legend has it he favoured rasgullas for breakfast). He even declined a personal appointment by Lord Curzon to attend King Edward VII's coronation abroad, because it conflicted with his mother's wishes, he famously told the Viceroy, "I will not obey anyone but my mother" in this matter. These anecdotes and his iron self-respect contributed to his "Tiger" legend.

Mookerjee's courage was most publicly displayed in 1923, near the end of his life. The Governor of Bengal (and University Chancellor), Lord Lytton, tried to impose political conditions on Mookerjee's reappointment as Vice-Chancellor. Mookerjee refused outright. He sent a terse reply (hand-delivered by his son Syama Prasad Mukherjee) to Lytton "the University will not be a department of the Government," and resigned his judgeship shortly thereafter rather than compromise his principles. This stand won him the admiration of nationalists everywhere. Similarly, in 1916 when student Subhas Chandra Bose was rusticated from Presidency College for political defiance, Mookerjee arranged for the talented youth to continue his studies at another college despite pressure, effectively protecting the future Netaji's education.

Mookerjee's personal library, one of the largest private collections of his time, itself became a national treasure. In 1910 (the same year he became head of the Imperial Library, now the National Library of India) he donated his own collection of roughly 80,000 books. This Ashutosh Collection, carefully catalogued in its own annex of the National Library, includes rare items like a 1668 edition of Aesop's Fables, Shakespeare's First Folio, and Sarat Chandra Chattopadhyay's handwritten manuscript of Pather Dabi. Modern efforts are underway to digitize its treasures (mica paintings, manuscripts, and rarities) so that the nation can access them more widely.

Sir Ashutosh Mookerjee did not live to see all his dreams fulfilled. He died suddenly in May 1924 in Patna while presiding over a case. But his legacy endures in the institutions and people he nurtured. The University of Calcutta still bears the imprint of his vision in its breadth of disciplines and research culture. Jadavpur University traces its origin to the Bengal Technical Institute he helped found in 1906. Mookerjee College (founded 1916 as South Suburban College and renamed after him) continues educating thousands in South Kolkata. The "Tiger of Bengal" is also honored on a 1964 Indian postage stamp celebrating his contributions to education.

Sir Ashutosh Mookerjee was more than a great man of letters or law, he was an institution builder who understood that knowledge and national progress go hand in hand. He once declared, "From now on the University is not just an institution issuing certificates… it will be a centre of learning and the expansion of the frontiers of knowledge". Indeed, by insisting on autonomy for universities, by raising funds for science, and by cultivating homegrown talent, Mookerjee laid the foundation for modern Indian science and higher education. His "tiger-like" spirit ensured that India would train its own scholars, rather than forever rely on Western frameworks. As a generation of students and researchers passed through the halls he built from C.V. Raman to S.N. Bose to Meghnad Saha, they carried forward Mookerjee's dream of an enlightened, self-reliant India.

Carrying forward the intellectual legacy of his father, Asutosh Mookerjee, Dr. Syama Prasad Mookerjee (1901–1953) who was a distinguished scholar, educationist, and political leader had a strong association with the IACS. His life uniquely combined academic excellence, institutional leadership, and nationalist vision, bridging the realms of education and politics in modern India.

Educated at the University of Calcutta, he excelled academically and later qualified as a barrister in England. In 1934, at just 33, he became the youngest Vice-Chancellor of the University of Calcutta, where he strengthened postgraduate education, promoted research, defended academic autonomy, and encouraged a balance between modern science and Indian cultural traditions. He nurtured collaboration between the University of Calcutta and IACS, helping sustain Calcutta's scientific ecosystem and emphasizing that universities and research institutions must work together.

As a member of IACS's Governing Trustee Board, he shaped policies ensuring the institution's stability and growth, while raising funds and mobilizing public support during the challenging 1930s. A strong advocate of the practical application of science, he emphasized its role in industry, agriculture, sanitation, and public welfare, and in 1935 highlighted IACS as central to the city's scientific reputation.

The University of Calcutta in the late nineteenth century

Authored by Dr Kinkini Dasgupta Misra

Quotes and Tributes
Asutosh Mookerjee

Rabindranath Tagore

"Ashutosh had the courage to dream because he had the power to fight and the confidence to win - his will itself was that path to the goal".

Dr. S. Radhakrishnan

Radhakrishnan, another of Mukherjee's high-profile recruits, viewed him as a transformative mentor who "facilitated the rise to great heights" for himself and others like Raman and Ramanujan.

Sir Asutosh Mookerjee declared in his address to Calcutta University Senate in December 1922

"I call upon you, as members of the Senate, to stand up for the rights of your University. Forget the Government of India. Do your duty as Senators of the University, as true sons of your Alma Mater. Freedom first, freedom second and freedom always – nothing else will satisfy me."

Lord Lytton (Then Governer of Bengal and Chancellor of Calcutta University)

"What the University is today is the result of Sir Asutosh's work. For many years, Sir Asutosh was in fact the University and the University Sir Asutosh."

Syama Prasad Mookerjee on His Father

“He dominated the minds of his countrymen and shaped their affairs in far too many departments- all with the same sheer plenitude of masterful control- for us now to predict that here only is his title to abiding renown. In daring, in determination, in massiveness of intellect, in strength of character, Asutosh belongs to that brotherhood of adventurers who in ages past had founded states and kingdoms. He belonged to the race of heroes of action, the true karmaveers of ancient Indian conception...In boldness of conception, in fertility of resources, in resoluteness of purpose which grows stronger after each defeat, in courage of heart and deftness of hand, which seeks to dare all and do all, Asutosh was almost without a peer. To him man was the creator and not the creature of circumstances; and he always impressed others as a supreme architect, a builder-up of the destinies of our society and nation.”

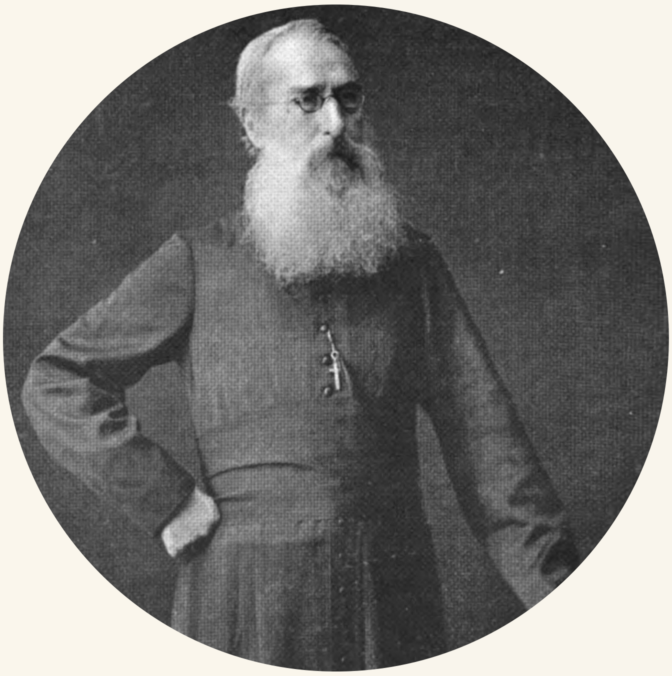
Sir C.V. Raman

"To praise him or pay tribute to him is to paint the lily, gild refined gold and throw a perfume on the jasmine... Ashutosh Mookerjee was like a mountain peak dazzling in the last rays of the setting sun".

Biographies
Architects of Scientific Enquiry

Father Eugène Lafont

1837-1908



Bringing Laboratory Science to Colonial India

In the formative decades of modern science in India, a Belgian Jesuit priest quietly transformed the way science was taught and experienced. Father Eugène Lafont was not merely a teacher of physics; he was among the earliest architects of experimental scientific culture in nineteenth-century India. His association with the Indian Association for the Cultivation of Science during its formative years left an enduring imprint on the intellectual landscape of the country.

Born in 1837 in Belgium, Father Lafont entered the Society of Jesus at a young age. His Jesuit formation included rigorous training in philosophy and the sciences, reflecting the order's long-standing engagement with scientific scholarship. In the mid-nineteenth century- a period when European scientific institutions were rapidly advancing experimental methods, Lafont developed a deep commitment to laboratory-based instruction. He arrived in Calcutta (now Kolkata) in the 1860s, at a time when science education in India remained largely theoretical, examination-driven, and dependent on textbooks imported from Britain.

His appointment at St. Xavier's College, Calcutta (Now Kolkata), proved decisive. There, Lafont established one of the earliest modern physics laboratories in India. He procured instruments, designed demonstrations, and insisted that students learn by observing, experimenting, and questioning. In an era when laboratory culture was still nascent in the subcontinent, this approach was nothing short of revolutionary.

Father Lafont

Lafont's classroom extended beyond enrolled students. He organised public lectures and experimental demonstrations that attracted diverse audiences–-students, scholars, administrators, and curious citizens. Electricity crackled visibly in his apparatus; optical experiments revealed the behaviour of light; mechanical devices illustrated the principles of motion and force. These events helped cultivate scientific curiosity among the educated public of Calcutta and contributed to the early development of a scientific community in the region.

It was during this intellectually dynamic period that Lafont formed a close association with Mahendra Lal Sircar, the visionary physician who founded the Indian Association for the Cultivation of Science in 1876. Sircar envisaged an Indian-led institution devoted to original scientific research, independent of colonial administrative structures. Lafont strongly supported this initiative. Though not the founder, he was an influential early collaborator and advocate, lending his expertise, credibility, and enthusiasm to the fledgling institution.

In the early years of IACS, Lafont contributed to shaping its experimental orientation. He delivered lectures, encouraged laboratory development, and helped sustain a culture of scientific inquiry grounded in observation and demonstration. His belief that science should be cultivated within India not merely transmitted from abroad, aligned closely with Sircar's vision. Together, they nurtured a generation of students who would later participate in the growth of scientific research in the country.

Beyond physics instruction, Lafont made significant contributions to meteorology. He established systematic meteorological observations in Calcutta (Now Kolkata) and took keen interest in atmospheric electricity and weather phenomena. At a time when meteorology was emerging as an organised scientific discipline, such observational work held both academic and practical importance. His efforts contributed to the development of scientific instrumentation and data collection practices in eastern India.

St. Xavier's School and College in 1900, where Father Lafont served as a faculty member and promoted scientific learning

Lafont also played a role in strengthening scientific societies and networks in colonial Bengal. He was associated with scholarly organisations in Calcutta (Now Kolkata) and actively engaged with the broader intellectual currents of his time. His work exemplified a distinctive blend of European scientific training and Indian institutional engagement. Importantly, he did not confine science to elite academic circles. By making experiments visible and accessible, he fostered what would later be called a "scientific temper."

The cultural context of his work deserves attention. Nineteenth-century India was undergoing profound social and intellectual transformation. Debates about education, modernity, and knowledge systems were shaping public life. In this milieu, Lafont's insistence on experimentation helped shift science from abstract theory to lived experience. Students exposed to his laboratory methods encountered science as a dynamic and empirical enterprise rather than a static body of facts.

His influence extended indirectly into the twentieth century. The experimental foundations laid at institutions like St. Xavier's College and IACS would later support landmark scientific achievements. When IACS gained international recognition in the early decades of the twentieth century, culminating in discoveries such as the Raman Effect, it did so within a culture that valued laboratory investigation, a culture to which Lafont had contributed significantly.

Father Eugène Lafont passed away in 1908. By then, he had spent over four decades in India, shaping scientific education and public engagement. His legacy does not rest on a single discovery bearing his name, but on something arguably more foundational–- the establishment of experimental science as a central pedagogical and institutional practice in India.

During the formative decades of the Indian Association for the Cultivation of Science, Father Eugène Lafont emerged as one of its quiet but influential contributors. Through his commitment to experimental teaching, laboratory development, and public scientific demonstrations, he helped shape an early culture of empirical inquiry in Calcutta.

The Indo-European Correspondence,

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CONTENTS.

St. Xavier's College.

LECTURE BY

Father Lafont,

Assisted by Professor J. C. BOSE,

On Telegraphy without Wires.

Thursday, 16th instant, at 9-30 p. m.

Tickets may be had at St. Xavier's College, at Rs. 2 per seat.

Advertisement in newspaper for Lafont and Bose's lectures in September 1897

Authored by Anupama Kaushal

Jagadish Chandra Bose

1858-1937

The Experimental Foundations of Modern Indian Science

Jagadish Chandra Bose stands among the most distinctive figures in the history of Indian science. Trained as a physicist and later recognised for his work in plant physiology, Bose's career crossed disciplinary boundaries at a time when scientific specialisation was becoming increasingly rigid. His investigations ranged from radio waves to the electrical responses of plants, and his institutional efforts culminated in the establishment of one of India's earliest research institutes. Through laboratory experimentation and public engagement, he contributed significantly to the development of modern experimental science in India.

Born on 30 November 1858 in Mymensingh (now in Bangladesh), Bose grew up in a family that valued education and cultural rootedness. His father, Bhagawan Chandra Bose, a deputy magistrate, believed that early education should take place in the vernacular rather than in English-medium institutions. Accordingly, Bose began his schooling in a Bengali-medium school before moving to Calcutta (now Kolkata) for higher studies. This early experience shaped his enduring belief that modern scientific knowledge could coexist with cultural confidence.

Bose studied at St. Xavier's College, Calcutta (now Kolkata), where he came under the influence of Father Eugène Lafont, who encouraged his interest in physics. He later travelled to England and enrolled at Christ's College, Cambridge, to study natural sciences. There he encountered contemporary developments in physics and experimental methodology that would influence his later work. He also completed a B.Sc. degree from the University of London before returning to India.

In 1885, Bose joined Presidency College, Calcutta, (now Kolkata), as Professor of Physics. His early years there were marked by institutional discrimination: he was offered a lower salary than his European counterparts. Refusing to accept this disparity, Bose worked without drawing his salary until the decision was reversed. The episode became emblematic of his insistence on professional equality within colonial academic structures.

The crescograph magnified plant responses many million times, allowing quantitative analysis of stimuli such as heat, light, mechanical shock, and chemical agents. Through systematic experimentation, Bose showed that plants exhibited measurable electrical signals in response to external stimuli, challenging rigid distinctions between plant and animal physiology and contributing to the emerging field of plant electrophysiology.

Bose's Microwave Apparatus at the Bose Institute in Kolkata

In the 1890s, Bose conducted pioneering experiments on millimetre waves, generating and detecting short-wavelength electromagnetic radiation. He demonstrated key wave properties including reflection, refraction, and polarisation–thereby experimentally validating aspects of Maxwell's electromagnetic theory. To carry out this work, he developed specialised apparatus, including a coherer-type detector, to study radio-wave behaviour. His wireless demonstrations in Calcutta in 1895 showed signal transmission without physical contact, preceding several later publicised experiments in Europe. Bose chose not to patent his devices, maintaining that scientific knowledge should remain in the public domain.

By the turn of the twentieth century, Bose's research interests shifted toward plant physiology. Using instruments of exceptional sensitivity, most notably the crescograph, he measured minute growth movements and electrical responses in plant tissues.

Crescograph, Bose Institute, Kolkata

Bose presented his findings before scientific audiences in Europe, where they attracted attention and critical discussion. While some of his broader interpretive conclusions were debated, his experimental techniques and instrumentation were widely acknowledged for their precision. His work helped place plant physiology on a more quantitative and experimentally rigorous footing.

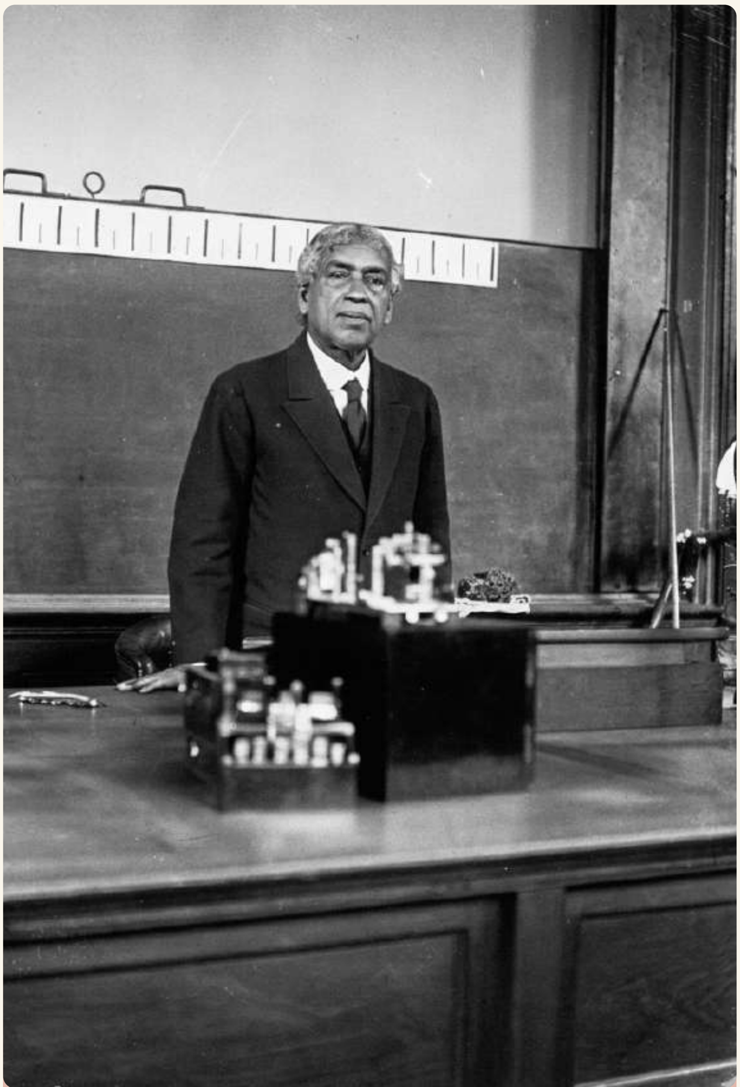
In 1917, Bose founded the Bose Institute in Calcutta (now Kolkata), one of the earliest Indian institutions dedicated to scientific research under Indian leadership. In his inaugural address, “The Voice of Life,” he articulated a vision of science that emphasised the unity of natural phenomena and the value of interdisciplinary inquiry. The institute was conceived as a space where physics, biology, and chemistry could be pursued in an integrated manner rather than as isolated disciplines.

Bose’s scientific career unfolded alongside the broader intellectual ferment of the Bengal Renaissance. He maintained close intellectual associations with figures such as Rabindranath Tagore and Sister Nivedita, who supported his work and helped disseminate his ideas. At a time when colonial narratives often questioned the capacity of Indians to conduct original scientific research, Bose’s laboratory achievements provided a visible counterpoint.

In 1920, Bose was elected Fellow of the Royal Society, becoming one of the earliest Indian scientists to receive this distinction. Over the course of his career, he published extensively and delivered lectures in India and abroad. His ability to combine experimental rigor with philosophical reflection gave his scientific work a distinctive intellectual character.

Jagadish Chandra Bose passed away on 23 November 1937. By then, his contributions had left a lasting imprint on both physics and plant science. His legacy lies not only in specific experimental findings but also in his demonstration that sustained, original scientific research could be conducted in India despite structural constraints.

Bose’s career reflects a broader transformation in Indian intellectual life, when science was being shaped simultaneously as a universal discipline and as a national enterprise. Through research, teaching, and institution-building, he helped secure experimental inquiry as a central pillar of modern Indian science.



J C Bose delivering a lecture on the “nervous system” of plants at the Sorbonne, Paris, in 1926

Authored by Anupama Kaushal

Satyendra Nath Bose

1894-1974

Building Theoretical Physics in India

Satyendra Nath Bose's name is inseparably linked with the emergence of quantum statistics in modern physics. Though widely associated with the term "boson," now fundamental to particle physics, Bose's career extended far beyond a single discovery. He was a scholar, teacher, institution-builder, and a key figure in the development of modern physics in India.

Born on 1 January 1894 in Calcutta (Now Kolkata), Bose grew up in a middle-class Bengali household. His father, Surendranath Bose, worked in the Engineering Department of the East Indian Railway and encouraged his son's early interest in mathematics. Bose showed exceptional aptitude in his school years and went on to study at Presidency College, Calcutta, then one of the foremost centres of higher learning in India.

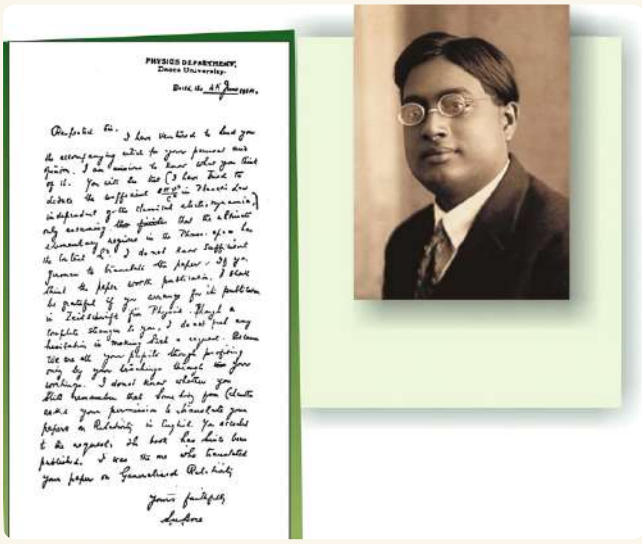
Bose at Dhaka University in the 1930s

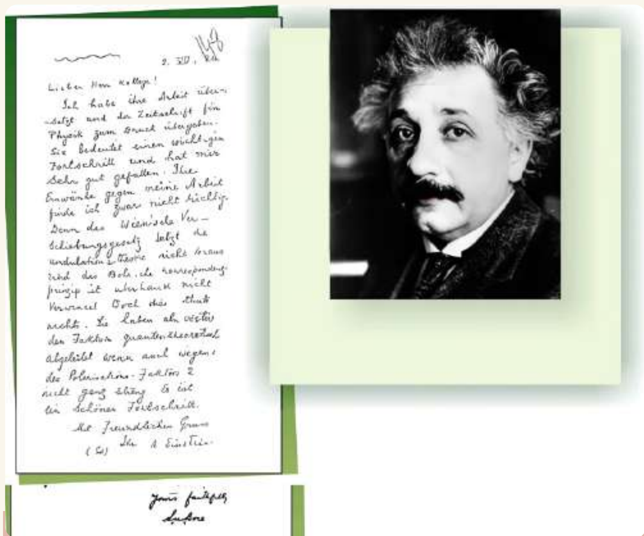
At Presidency College, he belonged to a remarkable generation of students that included Meghnad Saha, with whom he formed a lasting intellectual partnership. The academic atmosphere was shaped by teachers such as Jagadish Chandra Bose and Prafulla Chandra Ray, whose emphasis on scientific inquiry and disciplined reasoning left a lasting impression. Bose graduated with distinction in mathematics and later shifted his focus increasingly toward physics.

After a brief period at the University of Calcutta, Bose joined the newly established University of Dhaka in 1921 as a Reader in Physics.

It was in Dhaka that he made his most celebrated contribution. While preparing a lecture on Planck's law of blackbody radiation in 1924, Bose rederived the radiation formula by treating photons as indistinguishable particles and applying a new counting method to quantum states. The paper, titled "Planck's Law and the Hypothesis of Light Quanta," departed from classical statistical reasoning and introduced what would later be known as Bose statistics.

When his manuscript was rejected by a British journal, Bose sent it directly to Albert Einstein. Einstein immediately recognised its importance, translated it into German, and arranged for its publication in Zeitschrift für Physik. He then extended Bose's method to material particles, giving rise to what became known as Bose-Einstein statistics. Particles obeying this statistical behaviour including photons and certain atomic systems at very low temperatures came to be called "bosons."





S. N. Bose sent his paper on radiation statistics to Albert Einstein from the University of Dacca in 1924; Einstein responded with a postcard accepting the work and recognising its importance

The long-term implications of Bose's work were profound. Bose-Einstein statistics became one of the pillars of quantum mechanics and later of quantum field theory. Decades after Bose's original insight, the experimental realisation of the Bose-Einstein condensate confirmed the continuing relevance of his ideas in modern condensed matter physics.

Though Bose did not pursue quantum statistics extensively after his initial breakthrough, the conceptual clarity of his 1924 paper ensured its enduring influence.

Following the publication of his work, Bose spent time in Europe (1924-1926), interacting with physicists in Paris and Berlin and familiarising himself with developments in contemporary theoretical physics. Upon returning to India, he resumed his position at Dhaka and later moved back to Calcutta (Now Kolkata) in 1945, where he became Khaira Professor of Physics at the University of Calcutta.

While Bose is most widely associated with quantum statistics, his scientific interests were broader. During the 1930s and 1940s, he worked in X-ray crystallography and laboratory-based research in physics. He also explored problems in thermoluminescence and statistical mechanics. In later years, he showed interest in unified field theory and other theoretical questions, though these did not result in contributions of the same transformative scale as his earlier work.

Bose was deeply committed to teaching. Students and colleagues recalled his lectures for their conceptual clarity and intellectual openness. He believed that physics education in India should encourage analytical reasoning rather than rote memorisation. He also supported the use of Indian languages in scientific education, arguing that conceptual understanding should not be limited by linguistic barriers.

His institutional engagements extended beyond university departments. Bose was associated with scientific bodies and advisory roles in independent India, contributing to discussions on science education and research development. He served as Vice-Chancellor of Visva-Bharati University for a brief period and was later appointed National Professor of India, a distinction reserved for scholars of exceptional standing. In 1954, he received the Padma Vibhushan in recognition of his contribution to science.

Bose maintained close connections with scientific institutions in Calcutta (Now Kolkata), including the Indian Association for the Cultivation of Science, which had long provided a platform for independent research in India. Institutions such as IACS formed part of the broader intellectual environment in which Bose and his contemporaries worked to establish modern physics in the country.

Unlike some of his peers who engaged actively in politics, Bose largely remained within the academic sphere, focusing on research and teaching. His temperament was reflective rather than polemical. Yet his influence on Indian science was unmistakable: he helped anchor theoretical physics within Indian universities at a time when research infrastructure was still developing.

Satyendra Nath Bose passed away on 4 February 1974 in Calcutta (Now Kolkata). By then, the terminology derived from his work- Bose statistics, bosons, Bose-Einstein condensation had become integral to modern physics. His name entered not only textbooks but also the fundamental language of particle theory.

Bose's lasting contribution lies in his formulation of quantum statistics and in his sustained role in building and nurturing physics education in India. His career reflects the interplay between theoretical insight and institutional commitment that marked the growth of modern science in the country.

S. N. Bose playing Esraj

Satyendra Nath Bose with Paul Dirac. Dirac later coined 'boson' to honour Bose's work that obeys Bose–Einstein Statistics

Authored by Anupama Kaushal

Sir C. V. Raman

1888-1970

Light, Curiosity, and the Making of Modern Indian Physics

In the history of modern science, few lives combine intellectual brilliance, personal originality, and scientific courage as vividly as that of C. V. Raman. Celebrated worldwide for the discovery of the Raman Effect – a phenomenon that transformed spectroscopy and opened new pathways into molecular science – Raman was not merely a Nobel Prize–winning physicist. He was a scientist who helped establish experimental research culture in India, a charismatic teacher and institution builder, and a personality who defied conventional stereotypes about scientists. His life demonstrates how curiosity, precision, and audacity can produce world-changing discoveries even under modest conditions and with limited equipment.

Born on 7 November 1888 in Tiruchirappalli in southern India, Raman grew up in a family of modest means but strong intellectual ambition. His father, a teacher of mathematics and physics, introduced him to scientific thinking early, and the young Raman quickly displayed exceptional academic talent. With characteristic humour he later remarked, "I was born with a copper spoon in my mouth," referring to his father's small salary at the time. His precocity became evident early: he passed matriculation at the age of eleven and completed the F.A. (intermediate) examination at thirteen with a scholarship, topping the regional board examinations. These achievements reflected not only brilliance but also an unusual intensity of focus that would define his scientific career.

At fourteen he entered Presidency College in Madras, where his father had been transferred to teach. There he excelled spectacularly, earning his B.A. degree in 1904 with first rank and gold medals in both physics and English. Even as a student he displayed rare scientific maturity. At eighteen, he published his first research paper in the

Philosophical Magazine in 1906 – an extraordinary accomplishment for an Indian student of that era. His second paper appeared soon after, alongside work by the eminent physicist Lord Rayleigh, who began corresponding with him attach and respectfully addressed him as "Professor." Raman completed his M.A. with highest distinction in 1907.

Health limitations prevented him from travelling to England for higher studies – a common path for ambitious Indian scientists of the time – and this redirection shaped his life profoundly. Unable to join the Indian Civil Service, he entered the Indian Finance Service in 1907, becoming an Assistant Accountant General in Calcutta before the age of nineteen. Yet science never left him. His real education began after office hours, when curiosity drew him toward a place that would become central to his scientific identity – the Indian Association for the Cultivation of Science (IACS).

Founded in 1876, the IACS was India's first institution dedicated to scientific research. When Raman first visited it, the institute had little organized research activity and minimal equipment. But what it offered was freedom. Raman was deeply inspired by the idea that serious science could be pursued in India outside colonial constraints. He befriended key figures such as Amrita Lal Sircar and Ashutosh Mukherjee, whose encouragement allowed him to conduct experiments late at night after completing his government duties. Raman later recalled working at "very unusual hours," often late into the night, driven entirely by enthusiasm rather than professional obligation. The institute provided a laboratory space – modest, improvised, but open and that was enough.

The equipment available to Raman during these early years was strikingly simple and inexpensive compared to European laboratories. Much of his work relied on everyday optical components: prisms, lenses, polarizers, tuning forks, and mechanical instruments that could be purchased cheaply or assembled locally. Light sources included sunlight and mercury arc lamps; spectroscopic observations were performed using handmade or minimally modified spectroscopes. Later accounts estimate that key experiments leading toward the Raman Effect were conducted using apparatus costing only a few hundred rupees – astonishingly modest by global standards. Raman believed deeply that creativity mattered more than expensive instruments. Precision, he argued, came from careful thinking and ingenious experimental design rather than elaborate machinery.

During his years at IACS, Raman's research covered an extraordinary range. He studied acoustics, fascinated by the unique sound properties of Indian musical instruments such as the tabla and mridangam, producing some of the first scientific analyses of Indian percussion. He investigated the physics of string instruments and even water splashes, treating everyday phenomena as worthy scientific questions. These studies sharpened his experimental skill and prepared him conceptually for later work in optics and quantum theory.

By 1915, Raman had already built enough reputation to supervise research scholars at the University of Calcutta. In 1917 he accepted the prestigious Palit Professorship of Physics, becoming a full-time academic while continuing work at IACS. His laboratory at this time remained modest – wooden optical benches, hand-adjusted mirrors, filters, and simple spectrometers – yet the intellectual atmosphere was vibrant. Students worked closely with him, often assembling or adapting equipment themselves. This culture of hands-on experimentation became a defining feature of Raman's scientific approach.

A turning point came during his sea voyage to Europe in 1921, when he became fascinated by the deep blue colour of the ocean. While Lord Rayleigh had explained the blue colour of the sky through scattering, Raman questioned whether the sea's colour could be explained purely by reflection. Armed with a small handheld spectroscope – one of his favourite tools – he made careful observations and concluded that molecular scattering within water itself played an important role. This insight redirected his research toward light scattering, a field that would soon bring him global fame.

Throughout the 1920s, Raman and his collaborators conducted systematic experiments on the scattering of light by liquids. Their setup was elegant in its simplicity: monochromatic light from a mercury arc lamp passed through filters and was directed onto transparent samples. The scattered light was then analysed using a spectrograph – often painstakingly aligned by hand – and recorded on photographic plates. The total cost of much of this apparatus remained relatively low compared to international laboratories, reinforcing Raman's conviction that groundbreaking science could emerge from modest means when guided by sharp observation.

In February 1928, Raman and his collaborator K. S. Krishnan observed a new phenomenon: when light passed through a transparent medium, a small fraction emerged with altered wavelength – evidence that photons were exchanging energy with molecular vibrations. This shift in frequency, later named the Raman Effect, provided direct insight into molecular structure and became the foundation of Raman spectroscopy, a technique now indispensable in chemistry, materials science, medicine, and planetary exploration. So confident was Raman about the importance of his discovery that he reportedly booked tickets to Sweden months before Nobel announcements were made.

Although disappointed in 1928 and 1929, he finally received the Nobel Prize in Physics in 1930, becoming the first Asian scientist to win a Nobel in the physical sciences. His award symbolized not only personal achievement but also the arrival of Indian experimental physics on the global stage.

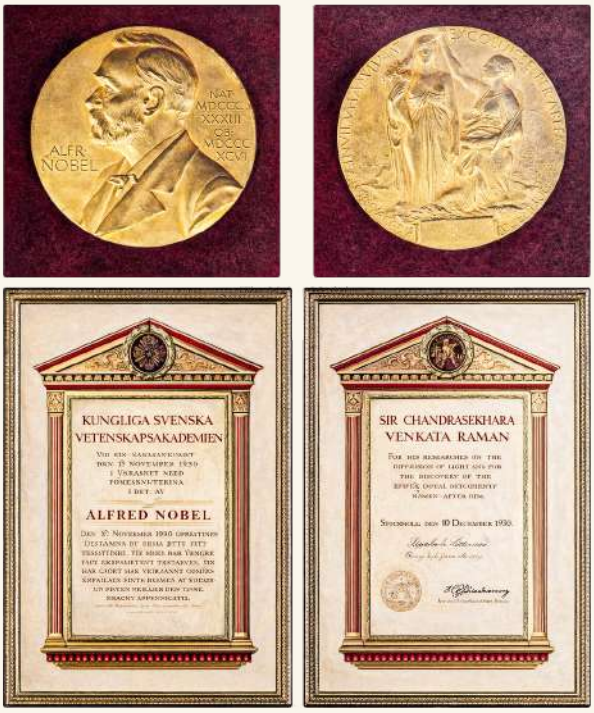
Raman's later career was equally influential. In 1933 he moved to Bangalore to become the first Indian Director of the Indian Institute of Science. He founded the Indian Academy of Sciences in 1934, started scientific journals, and promoted independent research culture. After retiring from IISc in 1948, he established the Raman Research Institute, where he continued experiments on crystal optics, iridescence, and light scattering well into old age. He maintained a personal collection of minerals and optical specimens, often examining them with his handheld spectroscope – a symbol of his lifelong curiosity.

Known for his blunt honesty as much as his humour, Raman frequently challenged scientific and political orthodoxy. He openly criticized policies he felt weakened scientific independence and insisted that Indian science should grow through strong universities and individual creativity rather than central bureaucracy. Yet he remained intensely dedicated to research, working almost until his final days.

On 21 November 1970, Raman passed away at the age of 82. His death prompted tributes across India and the world. Prime Minister Indira Gandhi described him as one of the greatest intellects the nation had produced, whose life's work illuminated the nature of light itself.

Today, Raman's legacy extends far beyond the Nobel Prize. The Raman Effect remains one of the most powerful tools in modern science, used to identify molecules, analyse materials, study artworks, and even explore planetary surfaces. Perhaps more importantly, his career demonstrated that world-class science could be conducted in India with imagination, discipline, and modest equipment. He transformed the IACS from a largely dormant institution into a vibrant research centre, proving that curiosity and persistence matter more than luxury.

Sir C. V. Raman's life reads as a celebration of scientific curiosity – a journey from simple instruments and late-night experiments to one of the most important discoveries in modern physics. It is a story not just of brilliance, but of independence, humour, and an enduring belief that science thrives wherever the human mind asks questions with honesty and wonder.



Raman's Noble Citation and Medal


Ramen's pocket Spectrometer, which can be carried with him at all time

Authored by Dr Kinkini Dasgupta Misra

Kariamanikkam Srinivasa Krishnan

1898-1961

From Raman's Laboratory to National Scientific Leadership

Kariamanikkam Srinivasa Krishnan (K. S. Krishnan) occupies a distinctive place in the history of Indian science, at once as a pioneering experimental physicist and as a statesman of science who helped shape India's post-independence scientific institutions. Co-discoverer of the Raman Effect, a founder of modern crystal magnetism, and later a principal architect of national laboratories, Krishnan's career traces the arc of Indian science from colonial awakening to sovereign self-confidence.

Born on 4 December 1896 in Watrap village in the Tirunelveli district of the Madras Presidency (now Tamil Nadu), Krishnan grew up in modest surroundings. His father was a schoolteacher, and the household valued learning, discipline, and ethical conduct. From an early age, Krishnan showed an unusual curiosity about natural phenomena. He was less interested in memorising textbook results than in understanding how nature behaved an instinct that would later define his approach to experimental physics.

His formal education at the American College, Madurai, and later at Madras Christian College exposed him to inspiring teachers who encouraged hands-on experimentation. Physics, for Krishnan, was not merely a subject but a way of interrogating reality. Even as a student, he built simple experimental devices and cultivated habits of careful observation skills that would soon find fertile ground in one of India's most vibrant scientific environments.

That environment was the Indian Association for the Cultivation of Science (IACS) in Calcutta (Now Kolkata). Founded in the nineteenth century to promote scientific research by Indians, IACS had, by the early 1920s, become synonymous with the dynamic leadership of C. V. Raman. Drawn by Raman's reputation and by the promise of experimental freedom, Krishnan travelled to Calcutta (Now Kolkata) and approached Raman directly. Raman, discerning but demanding, advised him to strengthen his academic credentials. Krishnan duly completed his MSc at the University of Calcutta before formally joining Raman's laboratory.

KS Krishnan, A Sommerfeld, CV Raman at the IACS, Kolkata 1928

The years 1923 to 1928 at IACS proved decisive, both for Krishnan and for Indian physics. Raman had begun systematic studies of light scattering after questioning accepted explanations for the blue colour of the sea during his 1921 voyage to Europe. In the modest laboratories of IACS far removed from the well-equipped centres of Europe, Raman and his students pursued bold experimental questions with ingenuity and rigor.

Krishnan emerged as one of Raman's most trusted collaborators. His meticulous experiments on the scattering of light in liquids, particularly his detailed polarisation studies, were crucial in identifying new frequency components in scattered radiation. Using simple spectroscopes, filters, and improvised optical arrangements, Krishnan demonstrated that these shifted spectral lines were not artefacts but intrinsic to molecular interactions.

These experiments culminated in February 1928 with the discovery of what came to be known as the Raman Effect the inelastic scattering of light revealing discrete molecular energy transitions. The discovery was revolutionary, providing a new spectroscopic window into molecular structure and dynamics. It rapidly transformed physics, chemistry, and later biology, becoming one of the most powerful analytical tools of modern science.

While the Nobel Prize in Physics (1930) was awarded solely to Raman, the historical record clearly shows Krishnan's indispensable role. Raman himself later acknowledged that, had the award been confined strictly to the 1928 discovery, Krishnan would have justly shared the honour.

The Raman Effect thus stands as a landmark of collaborative scientific achievement, rooted in Raman's vision and Krishnan's experimental precision.

K. S. Krishnan with the first flask of liquid Helium at NPL

After this extraordinary phase, Krishnan deliberately chose a new scientific direction. In 1928, he moved to Dacca University, where he worked alongside Satyendra Nath Bose. There, he turned his attention to the magnetic properties of crystals, initiating a body of work that would define his independent scientific identity. His studies on magnetic anisotropy and the relationship between crystal symmetry and magnetic behaviour were pioneering, laying early foundations for solid-state physics and magnetochemistry.

Krishnan's research demonstrated that magnetic properties were deeply linked to crystallographic structure an insight that anticipated later developments in materials science and condensed-matter physics. These works earned him international recognition and established him as one of the leading physicists of his generation, independent of his earlier association with Raman.

He later returned to IACS as the Mahendralal Sircar Professor of Physics, continuing his influential work in crystal magnetism. His international standing was affirmed by invitations to lecture at leading centres, including the Cavendish Laboratory, Cambridge. In 1940, he was elected a Fellow of the Royal Society, one of the highest honours in global science recognition of both his experimental contributions and his intellectual originality.

In 1942, Krishnan took charge as Head of the Department of Physics at Allahabad University, where he built a vibrant research school and mentored a new generation of experimental physicists. Yet his influence increasingly extended beyond the laboratory. With India's independence, the need for robust scientific institutions became urgent, and Krishnan emerged as a natural leader.

In 1948, he was appointed the founding Director of the National Physical Laboratory (NPL), New Delhi. Under his stewardship, NPL became a cornerstone of India's scientific infrastructure, establishing national standards in measurement, materials testing, and physical research. Krishnan combined scientific excellence with administrative integrity, insisting that national laboratories must serve both fundamental science and societal needs.

He also played influential roles in the Council of Scientific and Industrial Research (CSIR), the University Grants Commission (UGC), and advisory bodies linked to the Department of Atomic Energy. His career thus bridged the worlds of discovery and governance, helping translate scientific knowledge into national capability.

Beyond physics, Krishnan was a deeply reflective humanist. Fluent in Tamil and Sanskrit, and well-versed in Indian philosophy and literature, he believed that science should not be culturally alienated. He strongly advocated the communication of scientific ideas in Indian languages and argued that scientific modernity and cultural rootedness were not opposites but complementary pursuits.

Kariamanikkam Srinivasa Krishnan passed away on 14 June 1961, leaving behind a legacy that endures in laboratories, textbooks, and institutions. He represents a rare synthesis: a scientist of exceptional experimental skill, a collaborator of historic importance, and a nation-builder who helped lay the foundations of India's scientific self-reliance. In the annals of Indian science, his life reminds us that discovery and institution-building are not separate callings, but parts of a single, enduring commitment to knowledge and public good.

German delegates with Dr. K.S. Krishnan in Low Temperature Section of NPL in 1956

Authored by Dr Kinkini Dasgupta Misra

Meghnad Saha

1893-1956

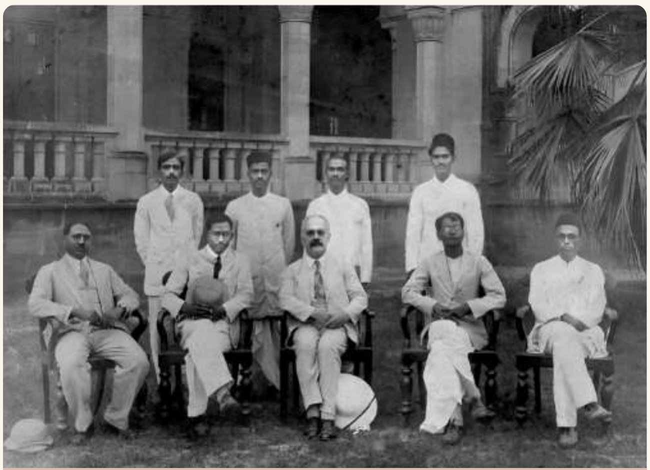
The Physicist Who Transformed Stellar Astrophysics

Few scientists in modern India combined theoretical brilliance, institutional vision, and public engagement as seamlessly as Meghnad Saha. Best known for the Saha Ionisation Equation, which transformed the study of stellar atmospheres, Saha was equally influential as a builder of scientific institutions and as an advocate for the role of science in national development.

Born on 6 October 1893 in Shaoratoli village in the district of Dhaka (then part of the Bengal Presidency, now in Bangladesh), Meghnad Saha grew up in a family of modest means. His father was a small shopkeeper, and financial constraints shaped his early years. Despite these limitations, Saha distinguished himself academically from a young age. He completed his schooling in Dhaka before moving to Calcutta (now Kolkata) for higher studies, supported by scholarships and personal perseverance. His formative years unfolded during a period of intellectual ferment in Bengal, when debates on nationalism, education, and modern science were influencing a generation of young scholars.

At Presidency College, Calcutta (Now Kolkata), Saha entered an intellectually vibrant academic environment. Among his contemporaries was Satyendra Nath Bose, with whom he developed a close and enduring intellectual association. The two studied physics together and later collaborated in translating Albert Einstein's papers on relativity into English, helping to introduce advanced theoretical physics to Indian students and scholars. Presidency College at the time included teachers such as Jagadish Chandra Bose and Prafulla Chandra Ray, whose dedication to scientific inquiry left a lasting impression on Saha. Within this stimulating atmosphere, he built a strong foundation in mathematics and physics, particularly in thermodynamics and statistical mechanics.

His most celebrated scientific contribution emerged in the early 1920s. In a series of papers published between 1920 and 1921, Saha formulated what came to be known as the Saha Ionisation Equation. By applying principles of thermodynamics and statistical mechanics to stellar atmospheres, he demonstrated how the ionisation states of elements vary with temperature and pressure. This theoretical framework provided a physical explanation for stellar spectra and enabled astronomers to determine the chemical composition and temperatures of stars with far greater accuracy. The work received international recognition and established Saha as a leading theoretical physicist.



A picture from Arnold Sommerfeld's visit to Allahabad in 1929. Sommerfeld is seated at the centre, with Meghnad Saha on his right, followed by Jnan Ghosh.

Saha's academic career included appointments at the University of Calcutta and the University of Allahabad. His years at Allahabad were particularly productive, and he helped develop one of the most

Physics Faculty, University of Allahabad (1932). Standing, centre: B. N. Singh; Sitting: Meghnad Saha, A. C. Banerjee, D. S. Kothari

active centres of physics research in India during the interwar period. He also spent time in Europe, engaging with contemporary physicists and keeping abreast of developments in atomic and astrophysical research.

His intellectual engagement extended beyond astrophysics. Saha believed that science should play a central role in national reconstruction. He advocated scientific planning in areas such as river valley development and power generation, arguing that modern industry and infrastructure required systematic scientific input. He was associated with discussions on the Damodar Valley project and frequently wrote and spoke on the need for coordinated technological development.

Saha also chaired the Calendar Reform Committee (1952–1955), constituted by the Government of India to standardise the country's diverse calendrical systems. The committee's recommendations led to the adoption of the Indian National Calendar in 1957, reflecting his interest in applying scientific principles to matters of civil and cultural importance.

Saha Institute of Nuclear Physics, kolkata

Institution-building remained one of his defining commitments. He played a major role in strengthening the National Academy of Sciences, India, and was instrumental in establishing the Institute of Nuclear Physics in Calcutta in 1948, later renamed the Saha Institute of Nuclear Physics in his honour. Through these efforts, he sought to create sustained infrastructure for advanced research in physics.

His association with scientific institutions in Calcutta (now Kolkata), including the Indian Association for the Cultivation of Science, formed part of a broader network of organisations that shaped Indian science in the twentieth century. IACS had already demonstrated the value of independent research in India, and Saha shared that commitment to original scientific inquiry rooted in institutional strength.

In independent India, Saha entered public life and was elected to Parliament in 1952. There, he spoke on issues relating to scientific development, industrial planning, and education. His parliamentary interventions reflected his conviction that science and public policy were closely interconnected.

Meghnad Saha passed away on 16 February 1956 in New Delhi. By the time of his death, he had left an imprint not only on astrophysics but also on the organisational framework of Indian science.

Saha's legacy rests on two enduring pillars: a theoretical contribution that reshaped stellar astrophysics and a sustained effort to build institutions capable of advancing scientific research in India. His career illustrates how intellectual achievement and institutional vision can reinforce one another. In the broader narrative of Indian science, he stands as a figure who helped connect laboratory research, national planning, and scientific education during a transformative period in the country's history.

Meghnad Saha sitting centre in a group photograph taken at the Harvard College Observatory 1936

Authored by Anupama Kaushal

Kedareswar Banerjee

1900-1975

Pioneer of Indian X-ray Crystallography and a Quiet Architect of Indian Experimental Science

The emergence of modern experimental science in India during the twentieth century owes much to a generation of scientists who combined originality, perseverance, and institution building. Among them, Kedareswar Banerjee occupies a distinguished place as one of the founders of X-ray crystallography in India and as a scientist whose influence extended well beyond his own research. A student of Sir C. V. Raman, Banerjee developed into a physicist of international standing whose work connected Indian laboratories with the global frontiers of crystallographic science. He is widely regarded as the initiator of X-ray crystallographic research in India, and his contributions spanned crystal structure analysis, diffraction studies, crystal physics, and methodological innovations that anticipated later developments in modern crystallography. Equally important was his role as a teacher and institution builder who created active schools of research wherever he worked. His career spanning the Indian Association for the Cultivation of Science (IACS), the University of Dhaka, Allahabad University, and eventually the directorship of IACS – reflects both scientific achievement and deep commitment to nurturing future generations of researchers.

Kedareswar Banerjee was born on 15 September 1900 in Sthal, Pabna district, in the Bikrampur region of Dacca (now in Bangladesh). He received his early education at Jubilee School, Dacca, and later studied at the Rajabazar Science College of the University of Calcutta, where he completed postgraduate and doctoral training. His youth coincided with the rise of nationalist political consciousness, and he briefly participated in political activity during the Non-Cooperation Movement. However, he soon returned to academic life, a turning point that redirected his intellectual energies toward science. Influenced by the scientific environment shaped by C. V. Raman, his early research explored the structure of solids and liquids interests that naturally led him toward crystallography. In 1930, he received the D.Sc. degree from the University of Calcutta, marking the beginning of a distinguished scientific career.

Beginning of a Scientific Career under C. V. Raman

Banerjee began his research career at the Indian Association for the Cultivation of Science (IACS) as a member of Raman's pioneering research group. At the time, physics was undergoing major transformation through studies of the interaction of light and X-rays with matter. Raman's laboratory provided an energetic experimental environment that shaped Banerjee's early scientific development. His initial work focused on the colour and structure of crystalline quartz, but he soon moved toward X-ray crystallography, a field then emerging as one of the most exciting areas of modern physics.

Working under challenging conditions in India, often with weak X-ray sources and improvised equipment, Banerjee gained a reputation for exceptional experimental discipline. Long exposure times, careful maintenance of vacuum systems, and painstaking measurements characterised his early work. These limitations did not hinder him, rather, they sharpened his analytical rigor and technical creativity, traits that became hallmarks of his research.

Banerjee's pioneering studies in the 1920s began when only a limited number of crystal structures had been solved worldwide. His investigations into naphthalene and anthracene attracted international attention. Through careful analysis of diffraction intensities, he identified shortcomings in earlier structural models proposed by European researchers and suggested revised molecular orientations. Combining trial-and-error structural analysis with physical reasoning based on magnetic susceptibility data, he demonstrated that the aromatic rings in these compounds were planar and coplanar. His structural interpretation, achieved despite comparatively modest experimental resources, was later accepted as more accurate and highlighted his remarkable insight into crystallographic reasoning.

A major milestone came in 1933, when Banerjee proposed a new approach to the crystallographic phase problem. Moving beyond conventional trial-and-error methods, he established relationships between structure factors that enabled crystal structures to be determined directly from observed diffraction intensities. This pioneering work anticipated what later became known as direct methods in crystallography. The importance of his contribution gained wider recognition when his paper, published in the Proceedings of the Royal Society, was later acknowledged in the Nobel Lecture of Jerome Karle in 1985, underscoring the lasting influence of his ideas on modern crystallographic theory.

Banerjee's scientific career developed within a strongly international context. He maintained professional connections with leading crystallographers of his time, including Sir William Henry Bragg, W. Lawrence Bragg, P. P. Ewald, J. D. Bernal, and Kathleen Lonsdale. In 1931, he worked with W. H. Bragg in England, deepening his expertise in structure determination techniques and reinforcing scientific links between India and Europe. His international standing was further reflected in his invitation as a Guest of Honour to the inaugural conference and General Assembly of the International Union of Crystallography in 1948.

Research at Dhaka University

Between 1934 and 1943, Banerjee served as Reader in Physics at the University of Dhaka, where he established one of the earliest X-ray crystallography laboratories in the region. This period marked a significant expansion of his research programme. He conducted structural studies on numerous organic crystals and published important work, including the determination of atomic positions in para-nitrobenzene using Fourier analysis. His investigations extended to anthraquinone, anthrone, diphenyl, and related compounds, often correcting previously accepted structural interpretations.

Dhaka also marked the beginning of Banerjee's enduring role as a builder of scientific schools. He trained students in rigorous experimental methods and created a research culture grounded in precision and independent thinking. Many of his students later established crystallographic research groups at other institutions, spreading his influence widely across Indian science.

Allahabad University and Expansion of Research

In 1952, Banerjee joined Allahabad University as Professor and Head of the Department of Physics, serving until 1959. There he rapidly expanded X-ray research facilities and initiated systematic studies on diffuse scattering and the elastic constants of crystals. His group explored diffraction phenomena in metals, alloys, glasses, and polymers, as well as thermal diffuse scattering and low-angle scattering methods. These investigations contributed significantly to understanding lattice dynamics and crystal behaviour and helped shape the development of solid-state physics in India.

The long-term impact of his leadership at Allahabad was later recognised through the establishment of the K. Banerjee Centre of Atmospheric and Ocean Studies, reflecting the respect he commanded as a scientist and academic leader.

Return to IACS and Directorship

Banerjee returned to IACS first as Professor of Physics and later served as Director from 1959 until his retirement in 1965. In this capacity, he combined administrative leadership with active scientific engagement. He strengthened laboratory infrastructure, promoted interdisciplinary research involving X-rays, magnetism, and spectroscopy, and encouraged collaborative research programmes. Working with colleagues such as R. K. Sen and A. K. Dutta, he continued experimental investigations while guiding institutional development.

His leadership style was marked by fairness, humility, and deep concern for students and colleagues. Even as Director, he remained closely involved in research, exemplifying the model of a scholar-administrator who saw institutional growth and scientific inquiry as inseparable.

Scientific Breadth and Innovation

Although best known for crystal structure determination, Banerjee's scientific interests were broad and interdisciplinary. He made important contributions to thermal diffuse scattering, low-angle X-ray scattering, diffraction from liquids, and studies of glasses and coal. He devised innovative experimental techniques for recording low-angle scattering with shorter exposure times and explored dynamic clusters in liquids and disorder in solids. His theoretical and experimental work anticipated later advances in phonon studies and disordered systems, reflecting a scientific imagination that extended well beyond conventional crystallography.

Teacher, Mentor, and Builder of Scientific Schools

Perhaps Banerjee's most enduring legacy lies in his role as a teacher and mentor. Wherever he worked, he built active research groups and nurtured young scientists who carried forward his methods and values. Crystallographic centres influenced directly or indirectly by his training emerged across universities including Dhaka, Allahabad, Lucknow, Burdwan, and several IITs. Known for generosity and modesty, he often refrained from adding his name to student publications unless he had contributed substantially an unusual practice that reflected his integrity as a mentor.

Students regarded him as a "guru," admired for both scientific guidance and personal warmth. His leadership extended beyond individual institutions: he served as sectional President of the Physical Science Group at the Indian Science Congress in 1947, later became Vice-President and General President of the National Academy of Sciences, India, and contributed to national advisory bodies including UNESCO-related commissions and Planning Commission committees.

Kedareswar Banerjee passed away suddenly on 30 April 1975 at his home in Barasat near Kolkata, marking the loss of a scientist who had played a formative role in the development of Indian crystallography. Yet his legacy endures through the research schools he established, the laboratories he strengthened, and the generations of scientists he inspired. A student of C. V. Raman, a Fellow of INSA, and later Professor and Director of IACS, Banerjee helped place Indian crystallographic research within the global scientific community. Through quiet dedication and scientific vision, Kedareswar Banerjee laid lasting foundations for modern crystallographic research in India a legacy that continues to resonate across generations of scientists.

Authored by Dr Kinkini Dasgupta Misra

Pramatha Nath Bose

1855-1934

Geological Foundations of Modern India

Pramatha Nath Bose was one of the earliest professionally trained Indian geologists and a key figure in linking scientific geology with industrial development in India. At a time when geological research in the subcontinent was largely directed by colonial priorities, Bose demonstrated how systematic mineral exploration could serve long-term national interests.

Pramatha Nath Bose (The Modern Review, February 1941)

Born on 12 May 1855 in Calcutta (now Kolkata), Bose belonged to a generation shaped by the intellectual currents of the nineteenth century, when Western scientific education began to intersect with Indian aspirations for institutional and economic advancement. He pursued higher education in England and enrolled at the Royal School of Mines in London, receiving formal training in geology, mineralogy, and mining science. This made him one of the early Indians to acquire professional geological education abroad.

Upon returning to India, Bose joined the Geological Survey of India (GSI), the premier geological institution of the colonial administration. His work involved detailed field surveys, stratigraphic studies, and mineral resource assessments across several regions. Geological fieldwork during this period demanded rigorous physical exploration – mapping terrain, studying rock formations, and documenting mineral occurrences with precision. Bose quickly established a reputation for careful documentation and technical competence.

During his tenure at the Geological Survey, Bose rose to positions of responsibility and, at one point, officiated in a senior supervisory capacity, an uncommon achievement for an Indian scientist in that era. However, structural constraints within colonial scientific services limited the advancement of Indian officers. Bose eventually resigned from the Survey, a decision that reflected the broader challenges faced by Indian professionals seeking parity within imperial institutions.

One of Bose's most consequential contributions emerged from his geological work in the Mayurbhanj region (present-day Odisha). Through systematic survey and analysis, he identified extensive high-grade iron ore deposits in the area. Because of his important role in identifying iron ore resources that supported the development of India's iron and steel industry, Pramatha Nath Bose is sometimes referred to as the "Iron Man of India." Recognising the industrial significance of these resources, Bose communicated his findings to Jamsetji Tata in 1904. In his correspondence, he drew attention to the quality and scale of the iron ore reserves, noting their suitability for modern steel production.

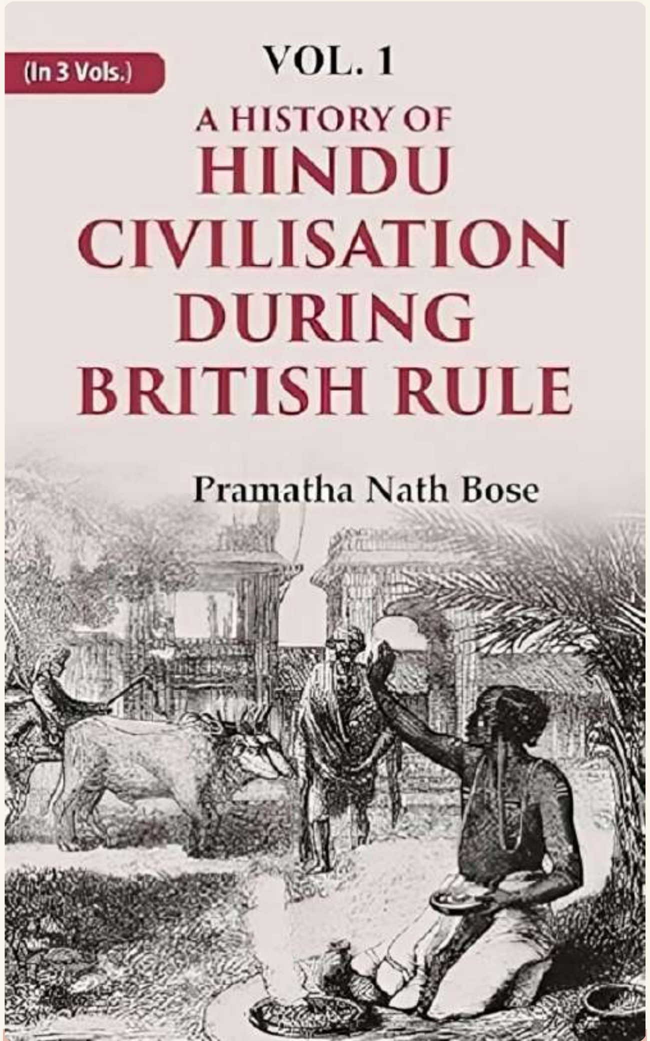
This exchange formed part of the broader sequence of events that led to the establishment of the **Tata Iron and Steel Company (TISCO)** in 1907 at Jamshedpur. While Bose did not directly establish the steel enterprise, his geological assessment provided critical scientific evidence supporting the feasibility of large-scale iron and steel production in India. His role illustrates how geological knowledge can shape industrial infrastructure.

After leaving the Geological Survey of India, Bose continued to work in applied geology and served as State Geologist to the princely state of Mayurbhanj. In this capacity, he carried out further mineral surveys and contributed to resource management strategies. His reports combined stratigraphic description with practical considerations regarding mining and extraction, reflecting an applied orientation to geological science.

Beyond iron ore, Bose conducted studies on coal, mica, and other economically significant minerals. His investigations underscored the importance of systematic geological mapping as a foundation for industrial planning. At a time when industrial development in India remained limited, Bose's work anticipated the later emphasis on mineral-based industrialisation that would become central to twentieth-century economic policy.

Bose was also intellectually engaged with scientific and educational developments in India. He participated in learned societies and contributed to discussions on mineral resources and geological methodology. His professional life unfolded during the same historical period that witnessed the strengthening of Indian-led scientific institutions such as the Indian Association for the Cultivation of Science. Although his primary institutional affiliation was with the Geological Survey, his work formed part of the broader intellectual movement that viewed science as integral to national regeneration.

In addition to his geological surveys, Bose wrote on scientific and educational themes, advocating for the development of technical expertise within India. He believed that scientific training and resource knowledge were essential for economic self-reliance. His career thus bridged descriptive geology and industrial vision.

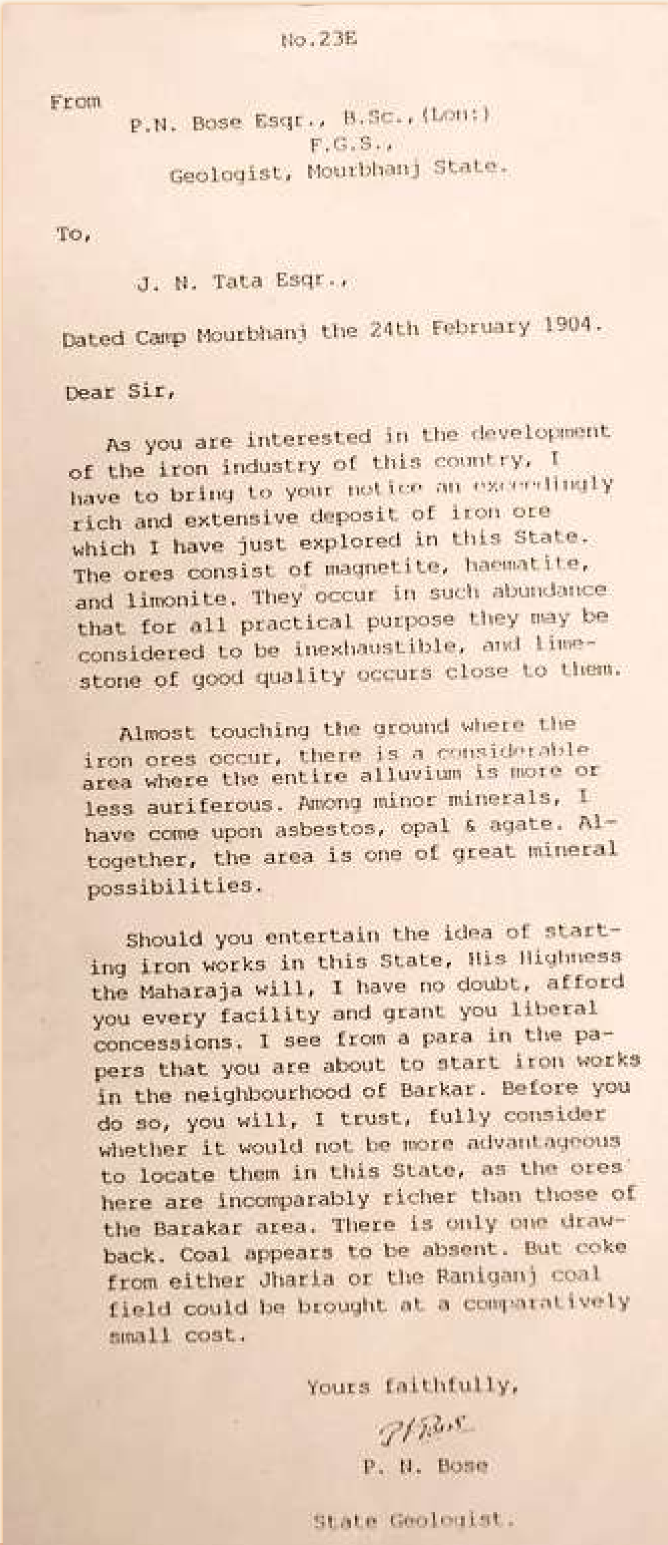


Cover page of the book 'A History of Hindu Civilisation During British Rule', authored by Pramatha Nath Bose

Pramatha Nath Bose passed away in 1934. By the time of his death, India's industrial landscape had begun to change, with the steel industry taking root and mineral exploration expanding. His early identification of iron ore reserves and his insistence on the scientific evaluation of natural resources contributed to this transformation.

Bose's legacy rests on three interrelated achievements. First, he helped establish geology as a professional scientific discipline for Indians through rigorous training and fieldwork. Second, he demonstrated the economic implications of geological research by identifying and documenting mineral resources of industrial value. Third, he exemplified the emergence of the Indian scientific professional navigating and gradually reshaping colonial institutions.

Pramatha Nath Bose demonstrated how geological research could shape industrial development. His careful surveys of mineral resources helped lay important foundations for modern industry in India.



No.23E

From
P.N. Bose Esqr., B.Sc., (Lon:)
F.G.S.,
Geologist, Mourbhanj State.

To,

J. N. Tata Esqr.,

Dated Camp Mourbhanj the 24th February 1904.

Dear Sir,

As you are interested in the development of the iron industry of this country, I have to bring to your notice an exceedingly rich and extensive deposit of iron ore which I have just explored in this State. The ores consist of magnetite, haematite, and limonite. They occur in such abundance that for all practical purpose they may be considered to be inexhaustible, and lime-stone of good quality occurs close to them.

Almost touching the ground where the iron ores occur, there is a considerable area where the entire alluvium is more or less auriferous. Among minor minerals, I have come upon asbestos, opal & agate. Al-together, the area is one of great mineral possibilities.

Should you entertain the idea of start-ing iron works in this State, His Highness the Maharaja will, I have no doubt, afford you every facility and grant you liberal concessions. I see from a para in the pa-pers that you are about to start iron works in the neighbourhood of Barkar. Before you do so, you will, I trust, fully consider whether it would not be more advantageous to locate them in this State, as the ores here are incomparably richer than those of the Barakar area. There is only one draw-back. Coal appears to be absent. But coke from either Jharia or the Raniganj coal field could be brought at a comparatively small cost.

Yours faithfully,

P. N. Bose

State Geologist.

Letter written by Pramatha Nath Bose to Jamsetji N. Tata on 24 February 1904, informing him about the rich iron ore deposits in Mayurbhanj that later supported the development of India's steel industry.

Authored by Anupama Kaushal

Amal Kumar Raychaudhuri

1923-2005

A Pioneer of General Relativity and Architect of the Raychaudhuri Equation

In the history of twentieth-century physics, some breakthroughs emerge from celebrated laboratories and famous collaborations, while others arise quietly through the perseverance of a single mind working against the tide. Amal Kumar Raychaudhuri, affectionately known as AKR, belongs firmly to the latter category. A pioneering Indian physicist whose work transformed our understanding of gravity, spacetime, and cosmology, he is best remembered for formulating the Raychaudhuri Equation, a profound result that later became essential in proving the Penrose–Hawking singularity theorems and helped shape modern ideas about black holes and the origin of the universe. Yet Raychaudhuri's story is not only about a great equation; it is equally a story of intellectual independence, scientific courage, and the quiet power of sustained inquiry pursued far from the world's most famous research centers.

Early Life and Academic Formation

Born on 14 September 1923 in Barisal (now in Bangladesh), Raychaudhuri grew up in a family that valued education and disciplined thinking. His father, Sureshchandra Raychaudhuri, was a school mathematics teacher, and from an early age Amal showed a deep fascination for mathematical reasoning. He later recalled the joy he felt in solving problems and discovering elegant solutions, one of which, during his school years, impressed his teachers enough to be published in the school magazine. This early ability reflected a trait that would remain constant throughout his life, a preference for clarity, simplicity, and conceptual elegance.

After his family moved to Kolkata, he studied at Tirthapati Institution and Hindu School. Although mathematics was his first love, practical considerations guided him toward physics. He graduated with a B.Sc. in Physics from Presidency College in 1942 and completed an M.Sc. in Physics at the University of Calcutta in 1944. These years provided him with strong mathematical training, but opportunities for advanced theoretical research in India, especially in general relativity, were still limited.

In 1945, Raychaudhuri joined the Indian Association for the Cultivation of Science (IACS) as a research scholar. The institute emphasized experimental science, and he was assigned work in X-ray crystallography and later the physical properties of metals. Though conscientious in his duties, his intellectual curiosity increasingly gravitated toward Einstein's general theory of relativity, then a relatively unfashionable subject in India.

This mismatch created tension. Institutional expectations encouraged experimentally driven research, while Raychaudhuri was drawn to abstract questions about space, time, and gravity. At times he faced pressure to abandon his theoretical interests. Yet he persisted, studying relativity independently and often working alone after completing official responsibilities. This period of relative isolation proved crucial: free from prevailing trends, he began asking deep questions about the geometry of spacetime and the nature of singularities.

The Raychaudhuri Equation

In 1955, Raychaudhuri published the paper that would secure his place in the history of physics. The Raychaudhuri Equation describes how bundles of trajectories called geodesics, evolve in curved spacetime. By analyzing expansion, shear, rotation, and gravitational effects separately, the equation revealed how gravity causes matter and light paths to converge.

Its significance lay in its generality. Rather than relying on specific symmetries or idealized cosmological models, the equation showed that gravitational focusing is a generic feature of Einstein's theory. Under realistic conditions, this focusing drives spacetime toward singularities. In essence, Raychaudhuri demonstrated that singularities were not merely mathematical artifacts but natural outcomes of gravity itself.

$$\dot{\theta} = -\frac{\theta^2}{D-1} - 2\sigma^2 + 2\omega^2 - E[\vec{X}]^a{}_a + \dot{X}^a{}_{;a}$$

The Raychaudhuri Equation

Though initially overlooked, the equation soon became central to the revival of general relativity in the 1960s. It offered physicists a powerful geometric tool for understanding the deep structure of spacetime.

Global Impact: Penrose, Hawking, and Modern Cosmology

During the 1960s, Roger Penrose and Stephen Hawking used the Raychaudhuri Equation as a key ingredient in proving their famous singularity theorems. These results showed that black holes and the Big Bang arise inevitably under broad physical conditions, fundamentally reshaping cosmology and gravitational physics. The equation thus became foundational to modern understanding of black holes, gravitational collapse, and the early universe.

The term "Raychaudhuri Equation" soon entered standard scientific language, appearing in textbooks and research papers across the world. Even decades later, it remains central to studies ranging from black-hole horizons to quantum gravity, highlighting how a concept developed in relative isolation in Kolkata reshaped global physics.

Encouraged by growing international appreciation, Raychaudhuri submitted his research as a doctoral dissertation and received a Doctor of Science degree from the University of Calcutta in 1959, with distinguished examiner John Archibald Wheeler recording special appreciation for the originality of his work.

In 1961 he joined the faculty of Presidency College, Kolkata, where he would spend the rest of his academic career. Although international recognition grew steadily, he remained modest and avoided self-promotion. He travelled relatively little despite invitations from abroad, preferring the intellectual environment of Kolkata.

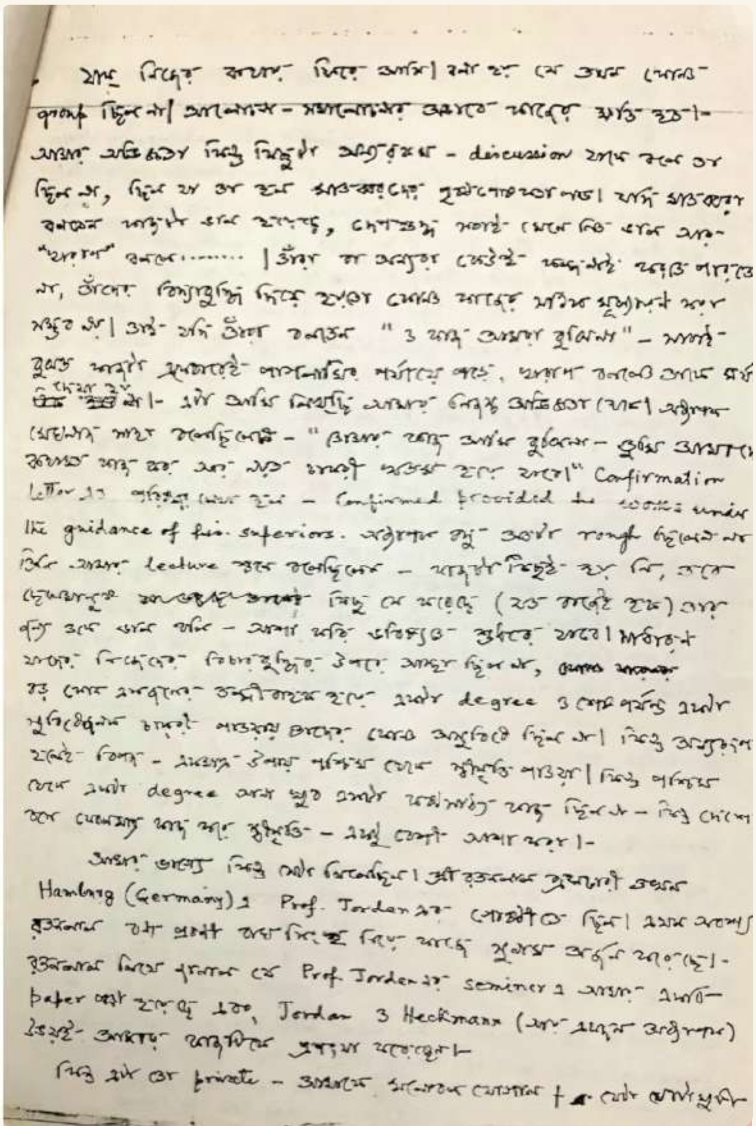
The Teacher Who Inspired Generations

If his equation established his scientific legacy, his teaching shaped his human one. At Presidency College, Raychaudhuri became legendary for his clarity, wit, and originality in the classroom. He explained difficult concepts using simple everyday analogies and emphasized understanding over memorization. Students recalled his habit of deriving results from first principles, revealing the inner logic behind physical laws.

Many future scientists credited him with shaping their scientific thinking. His influence extended through his textbooks and monographs on cosmology, classical mechanics, and electromagnetism, which reflected his pedagogical skill and deep conceptual insight.

Raychaudhuri's intellectual curiosity never faded. Even after retirement, he remained active as an Honorary Professor at the Centre for General Relativity and Cosmology at Jadavpur University and contributed to research activities at IUCAA. He continued exploring singularity-free cosmological models and alternative theories of gravity, driven by a lifelong desire to understand whether the universe must inevitably contain singularities.

He received recognition from major scientific bodies, including election as Fellow of leading Indian academies and service on the International Committee on General Relativity and Gravitation. Yet colleagues remembered him above all for his humility, independence, and devotion to fundamental questions.



A representative page from the manuscript of the scientific autobiography in Raychaudhuri's handwriting

Legacy in Space-Time

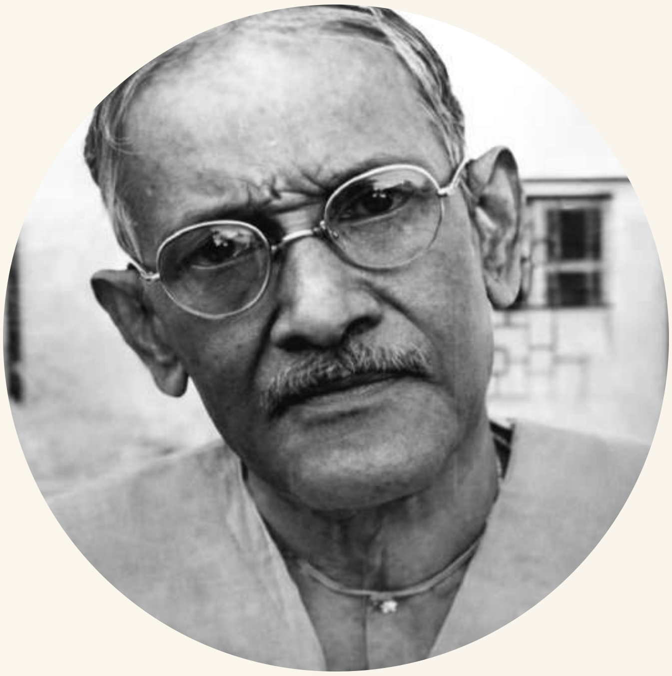
Amal Kumar Raychaudhuri passed away on 18 June 2005, but his influence remains deeply woven into modern theoretical physics. His equation continues to guide research on the evolution of spacetime, the formation of black holes, and the origins of the universe. More broadly, his life stands as a reminder that transformative science does not always emerge from powerful institutions or large collaborations. Sometimes it develops quietly, through patience, independent thinking, and unwavering intellectual curiosity.

Wherever physicists study gravity and spacetime today, the Raychaudhuri Equation remains an essential tool. Through that enduring contribution, the quiet physicist from Kolkata continues to shape humanity's understanding of the cosmos.

Authored by Dr Kinkini Dasgupta Misra

Priyadaranjan Ray

1888-1982



A Life in Structure, Service, and Scientific Memory

In the formative decades of modern Indian science, a small group of chemists worked not only to produce research of international standing but also to build the intellectual and institutional foundations of a national scientific culture. Among them, Priyadaranjan Ray occupies a distinctive place. He was at once a coordination chemist of originality, a designer of analytical reagents, a careful historian of Indian chemistry, and a steadfast steward of scientific institutions especially the Indian Association for the Cultivation of Science (IACS).

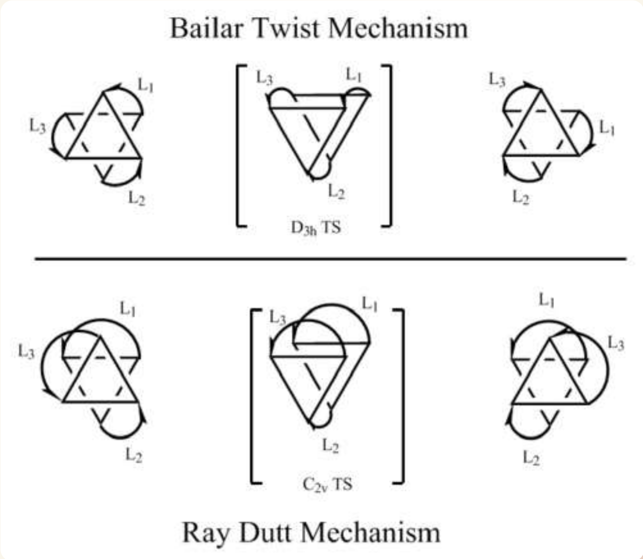
Born on 16 January 1888 in Noapara, in the Chittagong district of the Bengal Presidency (now Bangladesh), Ray came of age at a moment when Indian science was negotiating its place between colonial inheritance and intellectual self-assertion. Educated at Presidency College, Calcutta, he completed his B.A. in 1908 and his M.A. in Chemistry in 1911, securing first-class first position. Under the guidance of Acharya Prafulla Chandra Ray, he entered research in inorganic chemistry, a field that would define his career.

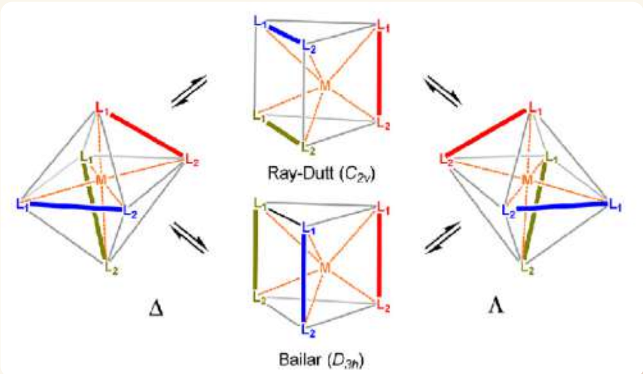
Structure Disciplined by Measurement

Ray's scientific temperament was marked by restraint and precision. At a time when coordination chemistry was still consolidating its theoretical foundations, he turned to magnetic susceptibility measurements as a tool for probing valency and stereochemistry. His experiments sought to correlate magnetic data with structural arrangement , a methodological commitment that reflected his conviction that theory must be anchored in measurable reality.

In his influential 1941 monograph ***The Theory of Valency and the Structure of Chemical Compounds,*** Ray emphasized that chemical structure should emerge from experimental evidence rather than speculative abstraction. **He wrote that "no theory of valency can claim permanence unless sustained by quantitative verification," a statement that captures both his skepticism of premature generalization and his faith in disciplined inquiry.**

His most celebrated theoretical contribution the Ray–Dutt twist mechanism (1943), developed with N. K. Dutt, provided a structural explanation for the racemization of octahedral chelate complexes. Rather than invoking bond cleavage, the mechanism proposed a trigonal twist pathway for stereochemical inversion. The idea offered clarity to a puzzling problem in coordination chemistry and remains referenced in discussions of stereochemical rearrangements.





Ray also stabilized unusual oxidation states, including Ni(IV) in alkali nickel periodates and higher oxidation states of silver, demonstrating how ligand design could modulate electronic stability. In analytical chemistry, he introduced organic reagents such as rubeanic acid derivatives and biguanide complexes for sensitive metal ion detection, advancing trace analysis at a time when Indian laboratories faced material constraints.

IACS - Institution as Laboratory of Continuity

Ray's connection with the Indian Association for the Cultivation of Science was central to his scientific life. Founded in 1876 with the aim of fostering original research in India, IACS had already nurtured pioneering work, including that of C. V. Raman. By the mid-twentieth century, however, the institution required steady leadership to navigate generational transition.

Ray served IACS in multiple capacities and became officiating Director in 1956, following the death of Meghnad Saha, who had earlier shaped its direction. Ray's stewardship during this period ensured institutional continuity. Characteristically, he accepted only a symbolic honorarium, underscoring that his commitment was to scientific stability rather than administrative prestige.

At IACS, Ray emphasized laboratory rigor and methodological self-reliance. He believed that Indian science must develop experimental excellence without dependency on imported materials or theoretical fashions. His guidance reinforced IACS as a centre for serious inorganic and analytical research, while also sustaining its broader mission of scientific dissemination.

In tributes, colleagues often remarked on Ray's quiet authority. Acharya Prafulla Chandra Ray once described him as "an acknowledged authority on complexes and valency, a silent and unobtrusive worker," acknowledging both his intellectual depth and his reluctance to court attention. That description would follow him throughout his career.

Popular Science and Public Engagement

Ray was not confined to technical research. He wrote extensively for broader audiences in Bengali and English, contributing essays that introduced chemical ideas to non-specialist readers. He believed that scientific reasoning, careful observation, willingness to revise conclusions, and freedom from dogma, was essential not only in laboratories but in civic life.

His popular science writing conveyed complex ideas without dilution. Rather than romanticizing science, he presented it as a disciplined way of thinking. This commitment reflected his broader belief that a scientifically literate public was indispensable to a modern nation.

Bridging Chemistry and History

Parallel to his laboratory achievements, Ray devoted considerable effort to the historiography of Indian chemistry. He undertook the revision and expansion of History of Hindu Chemistry, originally authored by his mentor. The 1956 edition, retitled History of Chemistry in Ancient and Medieval India, subjected Sanskrit alchemical and metallurgical texts to rigorous philological and experimental scrutiny.

Ray resisted both exaggerated glorification and dismissive skepticism. He argued that India's metallurgical and chemical traditions, including zinc distillation and pharmaceutical preparation deserved recognition grounded in textual and material evidence. "Historical claims," he observed in his editorial reflections, "must stand the test of documentation." This balanced approach strengthened the credibility of Indian contributions in global histories of science.

Institutional Leadership and National Science

Ray was also deeply engaged in scientific organizations. He served as President of the Indian Chemical Society (1947–48) and was elected a Foundation Fellow of the National Institute of Sciences (now Indian National Science Academy). In these roles, he advocated self-reliant scientific development and responsible application of emerging technologies.

He expressed measured support for India's early atomic energy initiatives, emphasizing peaceful applications and ethical responsibility. For Ray, scientific progress and moral restraint were inseparable.

Resilience and Personal Ethos

A laboratory accident early in his career left Ray visually impaired. In later years, he lost both sight and hearing. Yet these physical limitations did not diminish his intellectual engagement. He continued mentoring students and participating in scholarly discourse.

Despite honorary doctorates and numerous memorial lectures, he remained indifferent to titles. He never pursued a formal doctoral degree, believing that scientific work, rather than designation, defined a scholar.

He passed away on 11 December 1982 at the age of ninety-four. By then, he had witnessed the transformation of Indian chemistry from colonial dependence to confident national enterprise.

A Legacy Beyond Mechanisms

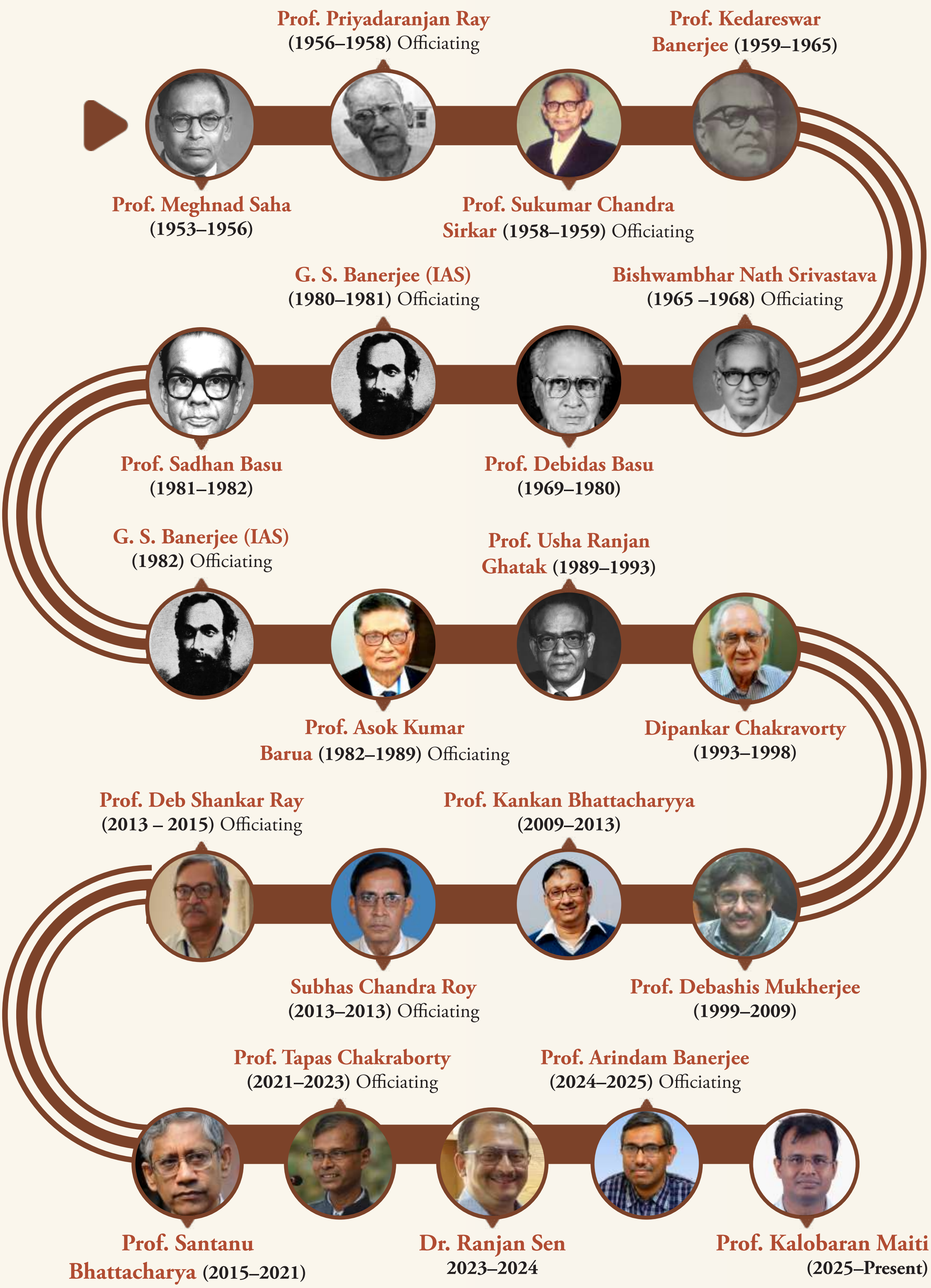
Priyadaranjan Ray's legacy extends beyond the Ray–Dutt twist mechanism or the reagents that bear his imprint. He exemplified a model of scientific citizenship rooted in rigor, humility, and institutional responsibility. He demonstrated that enduring influence arises not only from discovery but from stewardship – from nurturing laboratories, mentoring scholars, preserving intellectual memory, and defending methodological integrity.

In the history of Indian science, Ray stands as a figure who unified structure and service. His life reminds us that chemistry is not merely the study of molecules, but the disciplined pursuit of truth, carried forward through institutions, guided by evidence, and sustained by character.

If Indian chemistry today speaks with confidence in both laboratory and historical scholarship, it does so in part because Priyadaranjan Ray quietly built the foundations upon which that confidence rests.

Authored by Dr Kinkini Dasgupta Misra

DIRECTORS OF IACS



PRESIDENTS OF IACS

Sir Richard Temple
1876 – 1877

Sir Ashley Eden
1877 – 1882

Sir Augustus Rivers Thompson
1882 – 1887

Sir Steuart Bayley
1887 – 1890

Sir Charles Alfred Elliott
1890 – 1895

Sir Alexander Mackenzie
1895 – 1898

Sir John Woodburn
1898 – 1903

Sir Andrew Henderson Leith Fraser
1903 – 1909

Sir Edward Norman Baker
1909 – 1911

Raja Pyare Mohan Mukherjee
1911 – 1922

Hon. Justice Sir Ashutosh Mukherjee
1922 – 1924

Sir Rajendra Nath Mookerjee
1924 – 1934

Sir Nilratan Sircar
1934 – 1942

Prof. Rai Bahadur Sir Upendranath Brahmachari
1942 – 1946

Prof. Meghnad Saha
1946 – 1951

Prof. Sir Jnan Chandra Ghosh
1951 – 1954

Hon. Justice Charu Chandra Biswas
1954 – 1957

Hon. Chief Justice Phani Bhusan Chakravartti
1957 – 1958

Prof. Satyendra Nath Bose
1958 – 1962

Hon. Justice Rama Prasad Mookerjee
1962 – 1965

Prof. Jnanendra Nath Mukherjee
1965 – 1968

Prof. Basanti Dulal Nagchaudhuri
1968 – 1970

Prof. Sushil Kumar Mukherjee
1970 – 1973

Prof. Sukumar Chandra Sirkar
1973 – 1974

Prof. Basanti Dulal Nagchaudhuri
1974 – 1977

Prof. Bimal Kumar Bachhawat
1977 – 1983

Prof. Sushil Kumar Mukherjee
1983 – 1997

Prof. Arun Kumar Sharma
1997 – 2000

Prof. M. M. Chakraborty
2000 – 2003

Prof. Ashesh Prosad Mitra
2003 – 2007

Prof. Shri Krishna Joshi
2007 – 2014

Prof. Man Mohan Sharma
2014 – 2021

Prof. Srivari Chandrasekhar
2021 – 2022

Prof. Vinod K. Singh
2022 – 2024

Dr Renu Swarup
2025 – Present

Snapshots of Scientific Instruments and Laboratories at IACS

^{57}Fe Mössbauer spectrometer

Flow reactor in the laboratory of Prof. Joyram Guin

High-Performance Computer Cluster at IACS, Kolkata

Prof. Parthasarathi Dastidar demonstrating SC-XRD

Glove box for anaerobic reactions

Research Facilities in the laboratory of IACS

HPLC setup

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