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This image, released on Feb. 12, 2025, is the deepest X-ray image ever made of the spectacular star forming region called 30 Doradus. By combining X-ray data from NASA's Chandra X-ray Observatory (blue and green) with optical data from NASA's Hubble Space Telescope (yellow) and radio data from the Atacama Large Millimeter/submillimeter Array (orange), this stellar arrangement comes alive.

Otherwise known as the Tarantula Nebula, 30 Dor is located about 160,000 light-years away in a small neighboring galaxy to the Milky Way known as the Large Magellanic Cloud. Because it one of the brightest and populated star-forming regions to Earth, 30 Dor is a frequent target for scientists trying to learn more about how stars are born.

Link: https://www.nasa.gov/image-article/nasa-telescopes-deliver-stellar-bouquet-in-time-for-valentines-day/

Bulletin of The Indian Association of Physics Teachers

http://www.indapt.org.in

The Bulletin is the official organ of the IAPT. It is a monthly journal devoted to upgrading physics education at all levels through dissemination of didactical information of physics and related areas. Further, the Bulletin also highlights information about the activities of IAPT.

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From the President's Desk

Indian Association of Physics Teachers (IAPT)
(Regd. Under Section XXI Societies Act 1860-Regd. No. K-1448)
An Appeal to CONTRIBUTE/ DONATE
to
IAPT @ 40 Corpus Fund

Crowd fund to enhance and strengthen the reach of activities of IAPT to Serve the community of Physics Teacher, Students and STEM Educators and STEM Students through collection of funds from our benefactors, Corporates and Philanthropic Foundations and anybody who loves Physics.

A. Objectives of the Corpus Fund:

This fund is a milestone for strengthening the working of IAPT at grassroot levels and seek improvement in the quality of Physics Education at all levels. This fund has been instituted as **IAPT@40 Corpus Fund** to celebrate the dedicated journey of IAPT for the last 40 plus years to serve a wider community of teachers and students across the country through a strong network of 30 Regional and Sub Regional Councils by a resolution of the IAPT Executive Council in its meeting held on 15th October 2024 and approved in General Body meeting held on 16th October 2024 during Dharamshala Convention.

This corpus fund is part of Ruby Jubilee Year of the establishment of IAPT. It is to improve the availability of financial resources for the purpose of reaching the unreached by initiating targeted programs/projects through individuals, Regional/ Sub-Regional Councils and National IAPT networks in the form of innovative programs. The submitted projects shall be supported through a peer review process. Please visit our website www.indapt.org.in for more information.

The following is a representative list of such activities, which can be modulated by IAPT from time to time as per the needs/feedback from the community:

1. Support teachers and students in rural areas to become part of IAPT's activities by encouraging them to attend its programs like attending the regional and central conventions through TA support as per IAPT rules, support registration waivers and providing them an opportunity to present papers.
2. Programs to conduct PER projects at school, college, and University levels with active participation of volunteers of IAPT.
3. Supporting the creation and distribution of low-cost physics experiment kits for schools, to encourage and bring back focus on laboratories in schools, colleges, and Universities.
4. Faculty development programmes in the light of changes occurring at national and state levels regarding National Curriculum framework for Schools and Higher education qualification framework for colleges and Universities.
5. Create online resources of the IAPT through targeted theme-based projects/ conferences/ workshops etc.
6. Partial support for any online programme /Quiz /

Lecture series

7. For the publication of any volume of special articles / manuscripts generated through theme based IAPT programs or invited projects.

The Contributions/donations from any individual / organisation / institution are welcome. Life Members of IAPT are hereby appealed to contribute towards this fund liberally. We are also beholden to corporates to contribute to this fund under Corporate Social Responsibility (CSR)

A. How is this fund managed?

1. A corpus Fund account Namely **IAPT@40 Corpus Fund** has been opened by IAPT in Indian Bank, Kanpur managed by the Treasurer IAPT, General Secretary IAPT and Secretary IAPT Registered Office at Kanpur.
2. Only the interest part of the amount collected and kept as fixed deposit also will be utilized for the proposed activities.

A. Contributions/donations to this fund are invited through crowd funding with a link available on the official website of the IAPT, www.indapt.org.in

B. Target Amount to be Gathered:

Two Crore Rupees (Rs. 2,00,00,000/-)

C. Mode of Contribution:

- Online mode through the link provided on the website.
- Through cheques in the name of IAPT@40 corpus fund account, as detailed below:

Account Name:

IAPT@40 CORPUS FUND

Bank : INDIAN BANK

Branch : KAKADEO, Kanpur

Account No. : 7841397792

IFSC Code : IDIB000K521

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P. K. Ahluwalia
President IAPT

Physics News

First dark matter search using WINERED spectrograph sets new lifetime constraints

Dark matter is an elusive type of matter that does not emit, absorb or reflect light and is thus impossible to detect using conventional techniques employed in particle physics. The recent paper by Yin and his colleagues was the result of several years of research that involved both particle physics theorists and experts in advanced instruments. Its primary objective was to search for dark matter using the WINERED high-dispersion spectrograph mounted on one of the Magellan telescopes in Chile. . As they observed some excesses in the data collected by WINERED, they are now planning to carry out additional analyses to determine whether they could be linked to a possible dark matter signal. The researchers plan to continue exploring possible technological advancements that could contribute to the detection of signals linked to dark matter. Specifically, they believe that the development of new spectrographs especially tailored for dark matter searches could play a key role in the future observation of these signals.

Read more at: https://phys.org/news/2025-02-dark-winered-spectrograph-lifetime-constraints.html

Original Paper: Physical Review Letters (2025). DOI: 10.1103/PhysRevLett.134.051004

Scientists reveal key to affordable, room-temperature quantum light

Quantum light sources are fickle. They can flicker like stars in the night sky and can fade out like a dying flashlight. However, newly published research from the University of Oklahoma proves that adding a covering to one of these light sources, called a colloidal quantum dot, can cause them to shine without faltering, opening the door to new, affordable quantum possibilities. A research study led by OU Assistant Professor Yitong Dong demonstrates that adding a crystalized molecular layer to QDs made of perovskite neutralizes surface defects and stabilizes the surface lattices. Doing so prevents them from darkening or blinking. But since perovskite QDs can be used at normal temperatures and synthesized for very little cost, they could become the photonic chip light source for future quantum computing and quantum communication devices. These findings pave the way for future quantum emitter designs that extend beyond this specific material or molecular structure.

Read more at: https://phys.org/news/2025-02-scientists-reveal-key-room-temperature.html

Provided By: Nature Communications (2025). DOI: 10.1038/s41467-027-55619-7

New calculation links disparate pion reactions in nuclear physics

An early-career physicist mathematically connects timelike and spacelike form factors, opening the door to further insights into the inner workings of the strong force. A new lattice QCD calculation connects two seemingly disparate reactions involving the pion, the lightest particle governed by the strong interaction. This numerical calculation is simultaneously able to describe the spacelike and timelike processes, demonstrating the interconnectedness of different reactions described by QCD. While this connection had been observed experimentally, now physicists have the math to corroborate it. Previous work by Ortega-Gama motivated this inaugural calculation. After particles collide in an experiment, the collision products fly outwards until captured in a detector, travelling a distance vastly farther than the reach of the strong interaction, a 'theoretical infinity.' But during numerical calculations, which are limited by available computational power, these particles are placed in a finite box just a few times larger than the range of the strong interaction. To solve this problem, Briceño, Dudek and other members of the community have developed a formalism—a set of mathematical relations that, once you have the numerical results in hand, will yield the infinite-volume prediction.

Read more at: https://phys.org/news/2025-02-links-disparate-pion-reactions-nuclear.html

Original paper: Physical Review D (2024). DOI: 10.1103/PhysRevD.110.094505

Soumya Sarkar
IISER PUNE

Nanoscience and Technology: An Introduction

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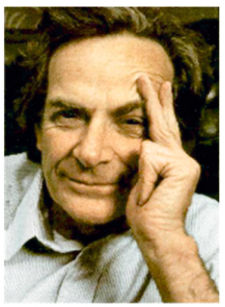
Advancements in technology — be it machines during the 18th century industrial revolution, or the digital computers of the 20th century, or the life-saving vaccines during the recent COVID pandemic — have all played an important role in the existence and evolution of man. In the past few decades, *nanoscale science and technology*, which concerns the study and application of extremely small nanoscale objects, has emerged as a disruptive and an enabling technology. Capable of being used across science fields, such as chemistry, biology, physics, materials science and engineering, nanoscale science and technology holds enormous potential for a radical development of science and technology and in contributing to alleviating the challenges facing humankind. [1-4].



Richard P. Feynman
Nobel Laureate

It may be of interest to know that the underlying concept and idea of nanoscience and nano-technology was first introduced by Nobel Laureate Richard P.Feynman in his now famous lecture "*There's Plenty of Room at the Bottom*" presented at the American Physical Society meeting at Caltech on December 29, 1959.

1. What is nanoscale?

We are all familiar with the meter scale which we use for measuring objects surrounding us in everyday life, such as the height of a building, a table, or a man. Nanoscale is the dimensional range of approximately 1 – 100 nanometres, one nanometre (nm) being a billion times smaller than one meter (m): 1 nm = 10^{-9} m. The word 'nano' comes from the Greek word '*nanos*' which means 'dwarf' or 'very small'. So, nanometre-sized things are very small. For example, a human hair is about 100,000 nm (that is, 100 microns) in width, and the diameter of a human red blood cell measures about 7,000 nm; note that, one micro-meter (or micron) is one-thousand times larger than one nanometre (1 mm = 10^3 nm) in size. Further, a strand of DNA, which is only about 2 nm in diameter, is one of the building blocks of human life. Thus, at the nanoscale one can 'see' the atoms (of typical size 0.1 – 0.5 nm) and molecules (typically 10 – 50 nm) that make up matter and life.

2. Nanoscience and nanotechnology

Nanoscience (NS) is the study of physical systems of nanoscale dimensions, and of understanding the phenomena and the fundamental processes and interactions occurring in them. NS reveals how these systems or materials possess their characteristic novel properties — physical, chemical, and biological — that have been successfully used in innovative ways in a wide range of applications. Nanotechnology (NT), based on the ability to observe, manipulate, assemble, control and manufacture matter at the nanoscale to form useful materials, structures, devices, and systems, is the application of NS especially for industrial and commercial objectives, such as, in devices like lasers, LEDs or cell phones [2].

Interest in NS and NT has arisen because they have revealed interesting and novel aspects both of matter and life. Materials of nano- dimensions, commonly referred to as *nanomaterials* (NMs), can have amazingproperties quite different from our normal experience. For instance, the colour of unaggregated gold nanoparticles (NPs) of size less than 50 nm is red, and not golden. The soft and delicate silk is strong because, at the nanoscale, it is seen to be made up of molecules aligned in cross-links. Graphene, a nanomaterial comprising a honeycomb latticed single layer of carbon atoms 0.345 nm thick has, because of its unique properties — one of the strongest materials, a good conductor of heat and electricity, optically transparent — emerged as a promising two-dimensional (2D) nanomaterial for NT applications [3,4].

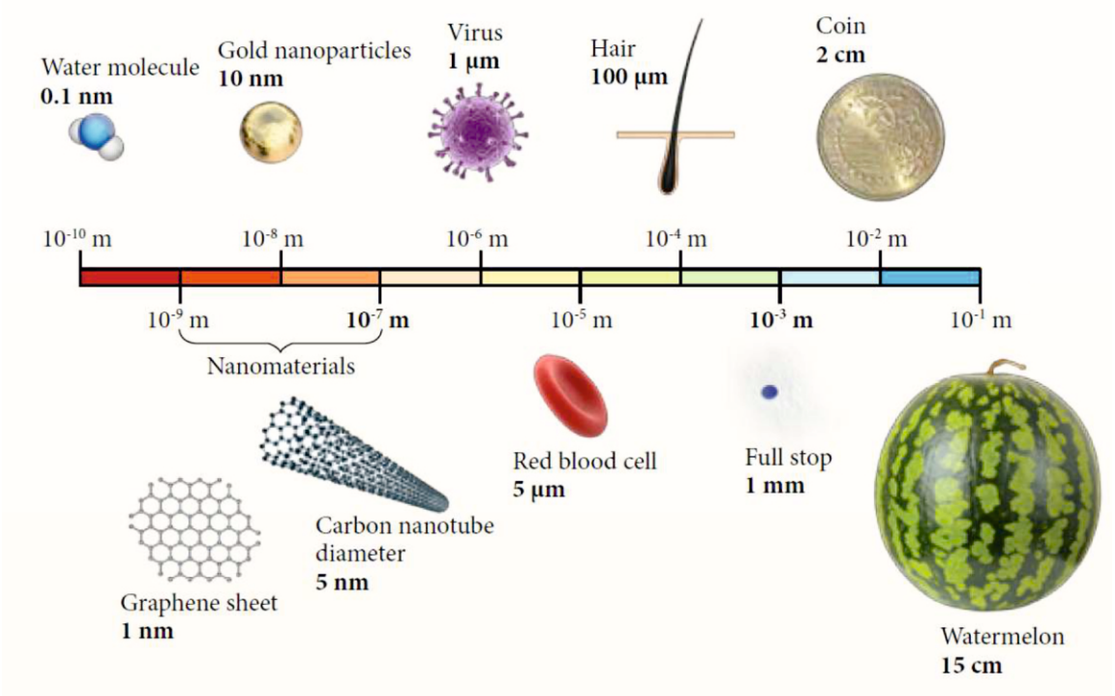


Figure 1: Various sizes (approximate) of matter [5]

Nanoscale systems, which are ideally suited to study quantum mechanical effects exhibited especially at the length scale of atoms and molecules [1,2], harness the principles of quantum mechanics in determining the nature of structures and materials. NS and NT have thus opened up vast vistas for gaining knowledge of and contributed in unveiling the secrets of the unexplored characteristics of structures/materials at the nanoscale. They have also contributed to the creation of exciting new materials and in the development of new devices having wide-ranging influence on almost all areas of our lives. To name a few: health and medicine, agriculture and food, textiles, electronics, tele-communication, sensors, nanomaterials' manufacturing, transport, energy, and environment. The most important one in the recent past was in enabling the quick development of the COVID vaccines, and in recent times, the area of Quantum Science and Technology, which encompasses the field of NS and NT, has enabled the development of quantum computers.

3. Observing nanoscale objects

The properties of nanoscale objects critically depending on their dimensions, their characterization is of equal importance. Thus, to be able to 'see' and 'feel' objects, image them and manipulate matter at the nanoscale, as in NT, one uses special and sophisticated instruments such as the Scanning Electron Microscope (SEM), the Transmission Electron Microscope (TEM), the Scanning Tunnelling Microscope (STM) and the Atomic Force Microscope (AFM) [1-4]. These instruments, which have enabled NT, behave essentially like microscopes but with resolutions much greater than that of the common 'optical' microscopes. They work on the principles of quantum mechanics. While the SEM and the TEM offer high lateral resolution (1 – 10 nm) and detailed internal structure imaging (0.1 – 0.2 nm), respectively, the AFM and the STM provide high vertical (< 0.1 nm) and lateral (~1 nm) resolutions. The most appropriate technique of measuring nanoscale dimensions that needs to be employed, therefore, depends on the type of the sample and the desired information to be obtained.

4. Nanoscale landscape

Nanostructures and nanomaterials are commonly classified based on the number of dimensions of the structure/material, which are *outside* the nanoscale (<100 nm) range [1-4]. For example, in zero-

dimensional (0D) nanostructures and materials (also called quantum dots) *none* of their dimensions is larger than 100 nm (that is, all the dimensions are within the nanoscale). The most common example of 0D nanomaterials include carbon buckyballs (also known as fullerenes) [6], and nanoparticles (NPs) of gold, silver, etc. The class of one-dimensional (1D) nanostructures, called quantum wires, in which one dimension is outside the nanoscale, includes carbon nanotubes (CNTs), silk nanofibers and nanowires of copper, GaAs, etc. Accordingly, in two-dimensional (2D) nanostructures, two dimensions are outside the nanoscale and one dimension is only a single or few atomic layers thick. Monolayer materials such as graphene, and phosphorene (black phosphorous), and diatomic MoS_2, hexagonal BN, as well as semiconducting heterostructures such as GaAs/AlGaAs come under this class. Similarly, the three-dimensional (3D) structures are bulk materials that are not confined to the nanoscale in *any* dimension (see Figures 2 and 3).

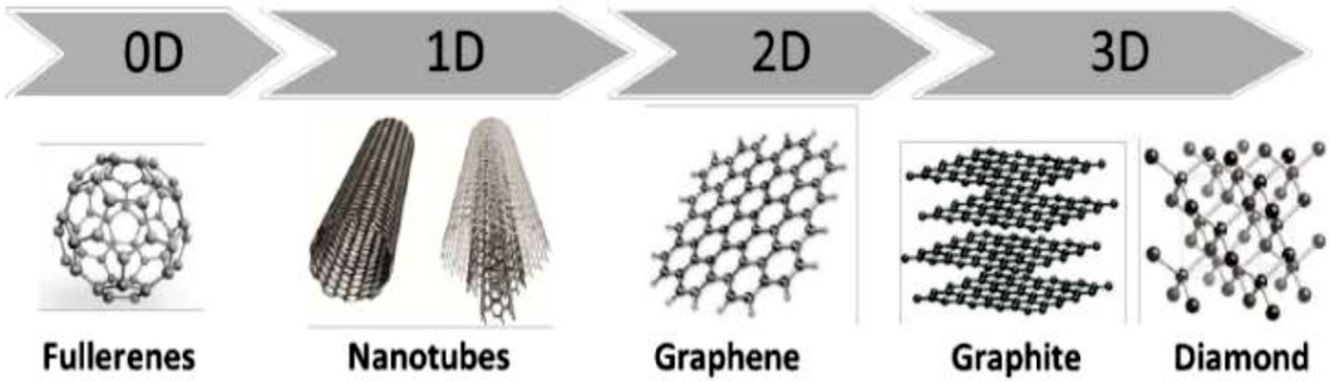


Figure 2: Carbon nanomaterials [3,6]

5. Realizing the nanoscale objects

Structures and materials of the nanoscale dimensions can be realized/synthesized in two ways: the top-down and bottom-up approaches. In the *top-down* approach, the size of a bulk object/structure is reduced toward the nanoscale; while in the *bottom-up* approach the 'large' nano-structure/device is formed or built starting from the smaller atoms or molecular components, which assemble themselves to form the nanostructure. In these two approaches, different physical (such as, milling, sputtering) and chemical (such as, pyrolysis, sol-gel) methods and processes are employed [1-4].

On the other hand, semiconductor nano- structures, such as the 2D quantum well hetero- structures, the 1D quantum wires and the 0D quantum dots, which are required in realizing/

forming the basic components like diodes, MOSFETs and transistors in electronic devices, need to have atomically flat and even abrupt hetero interfaces. Fabrication of these structures requires specialized tools such as the molecular beam epitaxy (MBE) and the metal organic chemical vapour deposition (MOCVD) systems.

6. The unique properties at nanoscale

Matter at the nanoscale, as stated earlier, exhibits properties quite different from those of the bulk form [1-4]. These dramatic changes in the properties stem from the effects of quantum physics prevalent more at the nanoscale mainly due to the surface area and quantum size effects.

Surface effects: As most chemical reactions occur at the surfaces of substances the surfaces of materials have a role to play in deciding their properties and reactivity. As can be easily verified, the surface area per unit volume of nanostructured materials is larger compared to that of bulk materials of same volume, and a greater amount of the material can come in contact with surrounding materials, thus improving

chemical reactivity. This enhanced reactivity, for instance, in automotive catalytic converters, fuel cells and batteries using engineered NMs, can be put to use in producing cleaner and safer methods of producing and storing energy. The larger areas of nano-structured membranes is also useful for water treatment and drug delivery.

Quantum size effects: The physics of the electronic properties of nano-systems, wherein quantum effects become important/dominant, is different from that of bulk systems. They are size-dependent and tuneable. The lower-dimensional semiconductor structures are, in fact, considered as examples of do-it-yourself-quantum-mechanics. When the system size is made nanoscale sequentially in one, two and three dimensions, the movement of the electrons in the system becomes more and more restricted, and the electron energy states become increasingly quantized (see Figure 3).

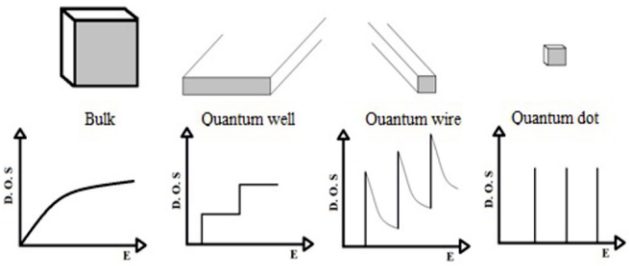


Figure 3: Quantum size effects on energy DOS in nanostructures

Further, as the size of the nanosystem of a given dimension (2D, 1D or 0D) is further reduced, the spacing between the quantized energy levels increases thus causing a decrease in the energy density of states (DOS). This makes the properties, such as, optical reflectivity, melting point, fluorescence, electrical conductivity and magnetic permeability of the nanosystems, to change as a function of the size of the system [1,2,4].

At the nanoscale, gold NPs are not yellow in

colour because the energy levels for the NPs are spaced more widely than in bulk systems and hence the interaction of light with electrons in NPs is different from that with electrons in larger-scale particles/systems. The free electrons, for instance, in gold NPs of size ~30 nm, and in In-based QDs of size 6 nm (Figure 4), are facilitated to absorb green light causing red light to be reflected, which thus appear red or purple. In the case of layered semiconductor nanostructures, bandgap and wavefunction engineering, through modulation of their physical parameters (size, shape, composition, and layer sequence and thickness), allow designing optoelectronic devices [7].

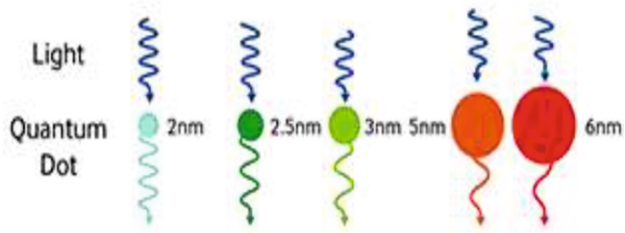


Figure 4: Colour of light emitted depends on size of QD [7]

Further, when the electrons confined in two-dimensional material systems like graphene or the semiconducting heterostructure systems, like GaAs/AlGaAs, are subjected to a large applied magnetic field at low temperatures, a striking quantization of resistance, characterized by plateaus in their Hall resistance, is observed. This effect is known as *quantum Hall effect*, discovered by Klaus von Klitzing in 1980. An important implication of this effect is its use in defining fundamental constants, including an electrical resistance standard now called the von Klitzing constant, $R_K = h/e^2 = 25812.\ 80745...$ Ω [8]. Another important quantum effect of the nanoscale, known as "tunnelling", is the phenomenon that enables the functioning of an STM and a flash memory device for computing [1,2].

7. How can Nanotechnology change the way we live?

Nanoscience and technology being multi- disciplinary, their applications which can impact our lives are many and diverse (Figure 5). NT has, in fact, influenced and helped

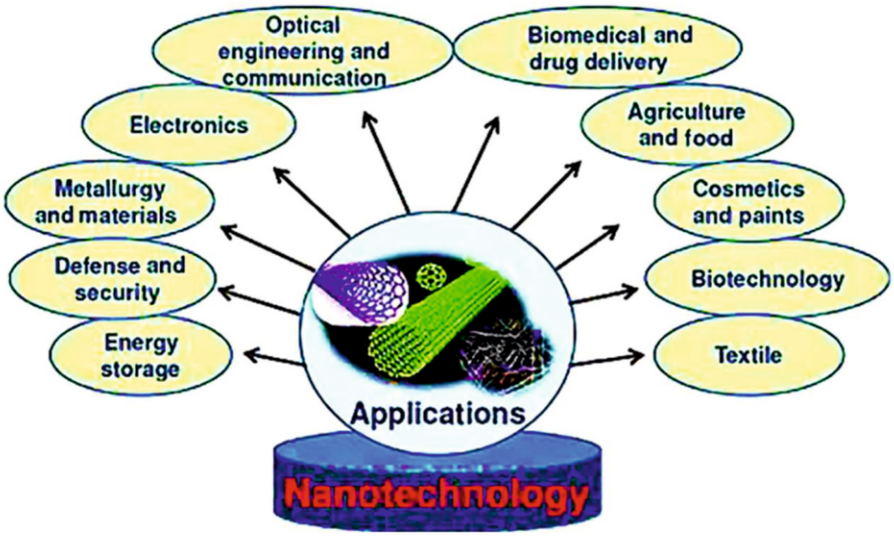


Figure 5: Applications of NT in daily life [10]

improve many technology sectors including semiconductor electronics, computation, and telecommunication technologies, and energy.

In addition, Nature which is the best nanotechnologist is often seen as a source of inspiration, innovation, and a guide in the progress and development of NS and NT. In fact, many NS-based systems in the living world have inspired NT applications [1-4]. To name a few, synthetic load-bearing CNT-based adhesives are inspired by foot-hairs of geckos (lizards) which can walk upside down on a ceiling, the iridescent coloration strategies have been inspired by photonic-crystal-like structures in butterfly wings, and the self-cleaning wall surfaces and dirt-resistant fabrics are inspired by super-hydrophobicity exhibited by lotus plant leaves. Some of the rapidly growing applications of NT are described below [1-4,9,10].

Commercial products: A few of the daily-use products that rely on nanoscale materials and processes include eyeglasses, windows, and display screens made water-repellent, anti-reflective, self-cleaning, scratch-resistant or anti-microbial using clear, specially treated nanoscale films on them. Lightweight and strong, and stiff and durable sports equipment like baseball bats, tennis rackets, bicycles, and automobile parts, as well as paints are manufactured using nanoscale additives like carbon fibre in polymer composite materials.

Textiles: Smart fabrics with nanoscale material sensors are capable of monitoring a person's health and also harvesting energy through the wearer's movement. Nanoscale additives in fabrics can make them hydrophobic, spill- and dirt-resistant, anti-microbial and anti-bacterial.

Medicine: With the advent of NT, medicine is becoming more personalised, cheaper, safer and easier to deliver. NT-enabled vaccines, imaging and diagnostic tools are playing an effective role in disease prevention, diagnosis and treatment. NT also has potential to produce target-specific drug-delivery systems for a range of diseases including cancer, heart disease and diabetes. Silver NP-embedded bandages can kill bacteria and prevent infection. The size and the physical properties of nanoscale gold particles can enable their selective accumulation in tumours, for both precise imaging and targeted laser destruction of the tumour avoiding harming healthy cells [11].

Nanobots — robotic devices of sizes close to the nanoscale — have potential for use in biomedical instrumentation for drug delivery, clearing blockages

in blood vessels, localized release of medicine to kill cancer tumours. Recently, scientists at the Centre for Nano Science and Engineering (CeNSE), IISc, Bengaluru, have reported developing nano-sized robots that can help kill bacteria in hitherto inaccessible microscopic regions deep inside the teeth. Made of silicon dioxide coated with iron, they can be manipulated using a low-intensity magnetic field. [12].

Energy: NT is being used to improve efficiency and cost-effectiveness of windmills and solar cells; to improve the efficiency of fuel production using better catalysis; to create new kinds of batteries and better lighting systems.

Nano-engineered materials are being used in fuel additives, fuel cells, in high-power rechargeable batteries in electric vehicles (EVs), and in improved catalytic converters which produce cleaner exhaust.

Electronics: The impact of NT on the field of electronics is far reaching. Material growth techniques like MBE provided an impetus to fabrication of made-to-order devices comprising multi-layered ultra-thin semiconductor nanostructures. CNT-based transistors which emit less heat and consume less electricity and also further reduce the sizes of microprocessors in computers, make them attractive as device components. Memristor memory chips made of magnetic material nanowires can achieve higher memory densities than flash memory devices. Nanostructured polymer film-based LEDs are used for new screen-based appliances to produce a better picture quality. Further, NT-enabled sensors, with increased detection sensitivity, microsystems integration capability and portability, are providing new solutions for health safety and environmental assessments.

Optical communication: In the recent past, micro- and nano-lasers, whose performance is tuneable by bandgap engineering, materials synthesis, cavity structure design, and also the operational environment, are finding great potential in optical communications and solid-state lighting. [13].

Recently, inspired by nature, scientists have designed a tuneable, reversible and highly-sensitive-to-strain nano-laser device having a flat elastomer sheet covered with metal nanoparticles that can reflect a laser beam into different colours using the same mechanism as chameleons. As the sheet is stretched (compressed), the spacing between the particles increases (decreases), thereby altering the wavelength (the perceived colour) of the reflected laser beam. This device could find use in as ultra-sensitive sensors to indicate mechanical strain [14].

Food and Agriculture: NT, by helping in the improvement of the design of today's agrochemicals, promises high yields and reducing any harmful impact on the environment and human health, and thus contribute to global food security. For instance, silver NPs are used in food packaging and household appliances. Nano sensors in the packaging can also detect contaminants in food.

Environment: Research is on in developing nanostructured filters to remove virus cells and impurities from water, which will help create clean, affordable drinking water. Nanobots can be employed for detection of toxic components in environment.

Nanobiotechnology concerns manipulating bio-logical systems at the nanoscale, and has the potential to improve agricultural productivity, human health, environmental sustainability.

During the past few decades, first-principles computations are becoming an indispensable part of materials design, with applications ranging from energy harvesting, conversion, and storage, to quantum information and drug design. With development of data sets for nanometric materials, the outlook for NMs research utilizing big data is encouraging. For instance, the various types of nanoscale *sensor* devices are aiding in the processing of the information being produced by and collected from sources, such as aircrafts, nuclear power plants, vehicular traffic, or climate variations, making it possible to handle and process big data efficiently. NT, together with machine learning and artificial intelligence (AI), is thus enabling big data contribute in the improvement of our lives.

8. Nanotechnology in India

India has been one of the first few countries to take initiatives to promote the potential of NS and NT. In 2001, the Govt. of India (GoI) started the Nano-Science and Technology Initiative. The "Nano Mission" programme, established in 2007 by Prof. C.N.R. Rao FRS, Bangaluru, Karnataka, has since been promoting nano-related research and technology in the country. Prof. C.N.R. Rao is striving to build a strong base for NS & NT in the country. He was instrumental in establishing the Institute of Nano Science & Technology in Mohali, Punjab, a national institution devoted to NS and NT.

Bharat Ratna Prof. C.N.R. Rao *FRS*

The Karnataka Science and Technology Academy (KSTA) promotes NS & NT in higher education institutions. Over the past decade, India's Flagship Nanotech Event "Bengaluru India Nano" has been an excellent platform bridging NT Research, Industry, Government and Academia successfully. The 13th edition held in August 2024, had the focal theme '*Nanotechnology for sustainability: Climate, Energy and Healthcare"* and featured a broad range of topics from cutting edge research to practical industry applications in NT. Further, the Ministry of Electronics and Information Technology (MeitY) has taken several major initiatives for promoting nanoelectronics research and innovation in the country [15]. The state-of-the-art nano-fabrication facilities at the major nanoelectronics centres of international standards, established at premier institutes in the country, have become very popular both in India and abroad. Recently, the focus of Nanotechnology Initiatives Division has been towards development of an eco-system for semiconductor manufacturing in India through cutting edge research in nanoelectronics, developing products/devices for meeting the societal requirements in the country and creating world class fabrication facilities at Nano level.

9. Education and training in NS and NT

Science and Technology feed on each other. NS and NT, the science and engineering of very small materials, being inter-disciplinary in nature, call for transforming basic research in the physics, chemistry, and biology of NS over to NTs for applications in a wide range of industrial sectors. However, a challenge encountered by NT industry in India is the education and training of scientists and engineers skilled in NS and NT.

Courses on NS & NT are now being offered in many universities and technical institutions. A student needs to have a broad interdisciplinary background to understand the properties and functions of the novel nanomaterials and devices. Conforming to the requirements of the new National Education Policy (NEP-2020), this can be achieved through properly curated academic programs and courses in NS & NT, multi-disciplinary in content, wherein the student learns to apply the basic concepts of the related disciplines. With necessary infrastructural facilities and exposure to relevant technical training, say, at the UG/PG levels, one can make students emerge competitive and aim for exciting career opportunities in a wide range of scientific areas, from nanomedicine and biotechnology to functional materials and the energy and environment sectors. Further, implementing a multipronged approach can leverage and ensure that the potentials of NS & NT open up new vistas in the field of R&D in various multiple disciplines. An integration of AI with NT can aid material design, fabrication process optimization, and thus in the development of new and better products [16].

10. Concerns regarding Nanotechnology

NS and NT hold potential to address the current health and environment problems especially in India such as air, water & soil pollution, disease diagnosis, better therapy, and better living. However, like any new technology, NT carries with it potential not only for good but also harm. Concerned about the planet and the future of children, Nobel Laureate Richard E.

Smalley, who discovered the buckyball, had a motto:

"*Be a scientist, save the world*" [2].

The most salient challenges about NT concern the likely possibility that some of these novel NMs could turn out to be hazardous to the environment or even to our health and safety. Such nanosized particles, owing to their size and potential, could get into our body say through the skin and the respiratory and digestive systems thereby causing damage to them. The recent Corona pandemic was a cause for alarm and concern.

With nanotechnology-enabled products already making their way into the life of man, and the emergence of AI, the implications of patronising nanomaterial-based products need to be properly understood, and well thought out strategies, including regulatory requirements, concerning and involving various stakeholders, and contributing to betterment of life and sustainability, need to be effectuated.

Conclusions

Nanoscience, the study of physical systems of nanoscale dimensions reveals how these systems possess characteristic novel properties. NT, which concerns manipulating matter at the atomic and molecular scales to create new materials and devices, has enabled opportunities for new products' development and manufacture, and spawned applications in varied fields, such as, agriculture, drug design, semiconductor electronics and tissue engineering. Nanoscale systems have also become resources for technologies, such as the emerging quantum technology including quantum communication and computation.

With the impact and understanding that NT is growing globally and spreading across many fields, there is a need for encouraging academia-industry cooperation and facilitating application-oriented research and development in keeping with the UN SDGs in areas relevant to the various local needs and resources. The transformative potential of the field of nanoscale science and technology, along with necessary integration of AI, thus needs to be poised to address the current needs and future challenges facing mankind, with applications directed towards sustainable growth not damaging to the environment and human health.

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A Life Dedicated to Science: Professor Babulal Saraf's inspiring Journey

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Abstract: Professor Babulal Saraf's remarkable journey embodies dedication, passion, and pioneering contributions to physics. Born with an innate curiosity, he pursued excellence in academia, becoming a distinguished physicist. His groundbreaking research in theoretical physics illuminated novel perspectives. With unwavering commitment, he mentored generations of scientists, fostering intellectual growth. Professor Saraf's leadership transformed institutions, promoting scientific advancement. His collaborations bridged international boundaries, enriching global scientific discourse. Through tireless advocacy, he championed science education and outreach. Professor Saraf's legacy extends beyond accolades, inspiring a community of scholars. This biography honors his selfless devotion to science, education, and humanity. By sharing his story, we celebrate the power of human curiosity and the transformative impact of a life dedicated to scientific pursuit.

1. Introduction

Professor Babulal Saraf was a scientist, physicist and master experimentalist. He was renowned for his groundbreaking research and unwavering commitment towards teaching the nation's youth and has been an immense source of inspiration to countless students and scholars alike. He has made many tremendous contributions to the field of Physics, which have made an immense impact on society. "In the realm of Indian physics, few names shine brighter than Professor Babulal Saraf, a trailblazing scientist whose tireless pursuit of knowledge illuminated the world. A distinguished physicist, educator, and leader, Professor Saraf's remarkable journey spans over five decades, leaving an indelible mark on the scientific community. This biography delves into Professor Saraf's inspiring life, exploring his early days, academic triumphs, and lasting impact on the world of physics. As Professor Saraf once remarked, 'Science is not just a profession, but a way of life."

2. Early Life and Contribution to Physics Education

He was born on 2nd December 1923 in Badnawar, Madhya Pradesh, in a modest family, but his journey was paved with intellectual curiosity and unwavering determination. He completed his education at prestigious institutions, which gave rise to his deep passion for physics. He did a B.Sc. from Jaipur and an M.Sc. in Physics from Agra University in 1949. He married Vimla Saraf and moved to Delhi University. In 1952, he went to the Bartol Research Foundation, USA. He also spent some time at the Noble Institute of Physics in Stockholm. On his return to India in 1955, he joined the Atomic Energy Establishment in Bombay, later known as Bhabha Atomic Research Center (BARC). He was awarded a PhD in 1958 from Agra University for his work on electron capture decay. His early research focused on various theoretical aspects of physics. One of his contributions has been in condensed matter physics. He has also done pioneering research in quantum phase transitions and low-dimensional systems. His research has led to the development of electronics, energy, and medicine. In 1965, he returned to his University roots in Jaipur, where he was a Professor and Head of the Department of Physics. He established a 'Centre for Development of Physics Education'(CDPE) with help from the University Grants Commission. He developed kits and equipment in almost all fields of Physics and conducted several workshops and summer programs to train college/University teachers in these experiments. Professor Abdus Salam, then Director of ICTP, invited him to help universities in some African countries upgrade their laboratories and train their science teachers. During this time, he spent time in Nigeria, Tanzania, and Kenya. After retiring from Jaipur, Prof Saraf conducted a Physics Education Project in Ratlam under the UGC and Madhya Pradesh government. Under this project, he designed 7-8 equipment that could be used to perform a large

variety of Physics Experiments, especially nuclear physics experiments. He also supplied a set of these experiments to the postgraduate colleges of Indore and Ujjain University and helped them set up laboratories. After the Ratlam Project, he was offered to continue his activities at IPS Academy, Indore, with their financial support. During his time there, he developed a few new experiments and associated equipment, including the Foucault Pendulum, Timers with unique features, sample and a hold voltmeter. He also succeeded in convincing the Department of Atomic Energy (DAE) to allow the preparation of laboratory-grade radioactive sources in the laboratory at IPS Academy. It was an excellent achievement since DAE only permitted this type of activity in its own territory. He also wrote two books with his co-workers.

Prof. Saraf's legacy is not just his academic contributions, but also his exceptional role as an educator. He dedicated his career to nurturing young minds and inspiring them to pursue scientific research. His commitment to his students' success is evident in the countless aspiring physicists he has mentored, many of whom have made significant contributions to their field. Prof. Saraf's influence extends beyond his students, as he played a crucial role in promoting scientific literacy and public engagement with science. He made complex scientific concepts accessible to a wider audience through various science articles. His dedication to science has been recognized with numerous awards, including being named a Fellow of the Indian Academy of Sciences, the National Academy of Sciences, India, and the Royal Society of Chemistry.

He has left a legacy that only a few can achieve in a lifetime. His intellectual prowess and dedication towards science and society were truly remarkable. He shall always be remembered as a dedicated mentor, visionary scientist and unwavering science advocate.

The Professor Babulal Saraf Memorial Award is a prestigious award given to those who have made exceptional contributions to the field of Physics education. It is given by the Indian Association of Physics Teachers (IAPT) and is generally given to Physics teachers who have shown outstanding dedication, commitment, innovation and effectiveness in their teaching methods, making a significant impact on a student's learning and development.

3. Conclusion

Professor Babulal Saraf's remarkable journey serves as a testament to the power of human curiosity, dedication, and passion. Through his groundbreaking research, mentorship, and leadership, he has left an indelible mark on the world of physics. His legacy extends far beyond the scientific community, inspiring generations to pursue excellence and push the boundaries of human knowledge. Professor Saraf's story is a shining example of how individual contributions can collectively shape the future. His selfless devotion to science, education, and humanity has created a lasting impact, ensuring that his legacy will continue to inspire and motivate future scientists, educators, and leaders.

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Report (RC-08B)

A Hands on workshop on Error Analysis in Physics - Using Excel

Venue: KET's V G Vaze College of Arts, Science and Commerce (Autonomous), Mulund, Mumbai

Organized by: SRC-08B and V. G. Vaze College of Arts, Science and Commerce, Mumbai

Participants: 26 students and 4 teachers.

Date: 12th and 13th February 2025.

Schedule: 8.00 am to 10.00 am

Resource person: Dr. K G Bhole

Coordinator: Dr Suresh Kad

The theme of the workshop was "**Error Analysis-Using Excel**". The purpose was to make students aware of error calculations in physics practical. It was hands-on training for undergraduate students. The workshop started with the introduction of speaker/trainer Dr K G Bhole. The resource person first talked about IAPT and its functioning. Then he introduced the concept of errors in experiments. In his presentation, he covered the information about precision, accuracy, types of errors, significant figures, rounding of numbers, uncertainty, standard deviation, and propagation of errors.

The students were then taken to the computer lab where the data was given to them, and they calculated final result including relative error, graph and graphical analysis using excel functions.

The students were very attentive and asked many questions about errors and significant figures. The joy of calculating final answer with error was seen on their faces at the end. The experiments for which data calculations were done were i) Estimation of error ii) Koenig's method, iii) thermal conductivity by Lee's method iv) Katers pendulum v) Estimation of errors in Quincke's method. The certificates of participation were given to each participant. The workshop ended with a vote of thanks.

K G Bhole
President

Report (RC-15)

On the Workshop

Conducted at Bally Bangasishu Balika Vidyalaya, Bally, Howrah

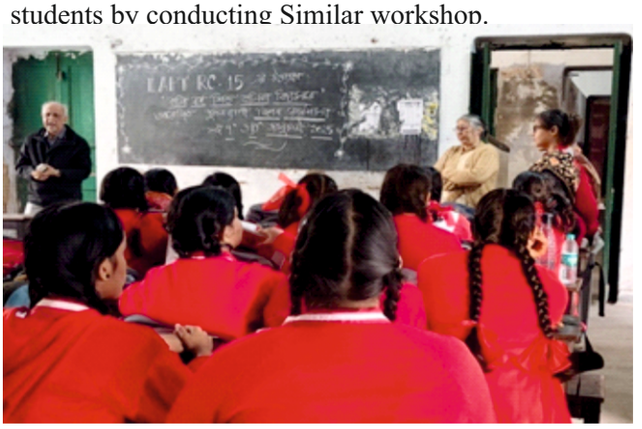
A one-and-a-half-day workshop was conducted in the school premises on 9th and 10th January, 2025. This well-known school of Bally is going to celebrate its centenary in the next year. Nearly forty students of Class X participated in the activities of the workshop. On 9th January, Dr. Bhupati Chakrabarti delivered a talk on some interesting mathematical concepts with some physical examples. He drew the attention of the participating students how mathematics helps in understanding the real-life physical situations.

On 10th January, the same batch of students performed some experiments involving simple measurements. For this a classroom was converted into a lab where all the 40 participants could work comfortably. With basic measuring devices like a common ruler with inch and cm calibration, they could establish the relationship

between inch and centimeter. In another experiment

they could see that the ratio of the circumference and the diameter of a circle comes out to be same irrespective of the size of the circle. This helped them to estimate the value of pi (π) while using circular discs of different sizes. Students could appreciate the importance of measurements.

Smt. Sukla Chakraborty of IAPT conducted the session with the active help from the two physics teachers of the school, Smt. Suvra Joarder and Smt. Arunima Mukherjee. Also, Smt. Jayanti Chakraborty, an educator guided the students to perform the tasks given to them. The support from the school authorities were commendable. IAPT members felt that it is possible to motivate at least a section of the students by conducting Similar workshop.



Sukla Chakraborty

Report (RC-13)

National Symposium on Frontiers of Physics Teaching

The Department of Physics, Dwaraka Doss Goverdhan Doss Vaishnav College organized the National Symposium on Frontiers in Physics Teaching on 4-5, February 2025, during the Diamond Jubilee year of the institution. This was conducted by the department in association with IAPT RC13. This symposium brought together eminent scientists and professors working in various areas of physics to exchange their expertise. The symposium was devoted to acquainting teachers with new pedagogical perspectives, teacher development, trans-disciplinary approach and science outreach.

During the two days of the symposium, four talks were delivered in plenary sessions, three hands-on workshops were conducted, empowering teachers for experiential classrooms. The resource persons were eminent professors from IMSc., IIT Madras, Delhi University, University of Madras and Alagappa University.

Dr J Jeyakanthan, Head of Bioinformatics, Alagappa University, Karaikudi talked about the importance of

multidisciplinary research techniques in which tools from different science disciplines are used to find an explanation for the question being studied. Multidisciplinary research is needed to solve many, if not all, of the major research challenges of the next decade. This cooperative and coordinated research requires the unified effort of experts from different disciplines. They all pool their knowledge to solve a problem(s) at hand. The participants were able to understand the need for dedication and multidisciplinary approach in the research field.

Dr.Vandna Luthra, Professor of Physics, Gargi College, Delhi and an active member of IAPT RC 01 delivered a plenary talk on the effective classroom strategies for transforming Physics education@VIKSIT BHARAT. Her speech was really informative which highlighted research based pedagogical tools for teaching Physics effectively. Her information on the EXPEYES device was interesting and useful. The session was so useful in all ways to improve the way of teaching and to drive a passion for teaching.

Dr Rita John, Professor and Head, Department of Theoretical Physics, University of Madras spoke on the topic Physics Teaching and Learning-Inducing Passion & Knowledge. The teacher participants learnt many methods on how Physics can be taught to young aspirants, through her interactive session. The participants were able to understand the need for passion in teaching Physics through this session.

Mr Rangarathnam Gopu, Varahamihira Science Forum, spoke on Spherical earth and it's mathematical consequences. He threw light upon the concept of the Earth's shape and its various mathematical implications, namely, the Sine value and how it is used in the mathematical convention, interpretation of gravitational forces, time zone and global navigation. The session was truly informative which gives a wide range of inputs to the teacher participants on ancient Indian astronomy.

Dr. Varuni, Outreach associate, The Institute of Mathematical Sciences, Taramani, Chennai introduced valuable learning resources from the Homi Bhabha Centre for Science Education (HBCSE), Tata Institute of Fundamental Research (TIFR). This hands-on session aimed to familiarize participants with various educational materials and methodologies to enhance the teaching and learning experience in science. She emphasized the significance of interactive and inquiry-based learning approaches in developing a deeper understanding of scientific concepts. Participants engaged in problem-solving exercises and interactive discussions.

On 4th February, a hands-on workshop, headed by Dr. T S Natarajan, Professor (retd.) IITM/Tirupathi, President IAPT RC 13 was conducted in the symposium, during the afternoon session. Prof.TSN demonstrated concept based experiments on the application of Bernoulli's theorem, the working principle of the Tesla coil, superconductors, magnetism and many more. The session continued with lots of hands-on activities, involving teacher participants. They learnt how to take the concepts such as angular momentum, centre of mass, total internal reflection, difference between distance and displacement, Eddy current, to their classrooms with simple experimental aids.

The concluding session of the symposium was a workshop on “Learner's Engagement in Teaching a Course” on the 5th of February, 2025. The session was conducted by Dr. Edama Prasad, Head, Teaching Learning Centre, IIT Madras. This session was aimed to explore effective strategies for fostering learner engagement in academic courses, particularly in the higher education sector. Dr Prasad gave his inputs on how to deliver an engaging and creative learning session for the teacher participants. He discussed the proper ideology a teacher should know and understand to make sure their students have an engaging learning environment.

The talks and workshops helped the teacher participants learn effective classroom strategies for transforming Physics education. The hands-on workshops provided resources to teacher participants

and equipped them with contemporary techniques. The Principal and the Secretary appreciated the department for this initiative towards Viksit Bharat. More than 80 teachers from various colleges and higher secondary schools were benefitted through the interactions.

V Renganayaki
Co-Convener
NSFPT

Report (RC-15)

Activity on

The International Day of Women and Girls in Science

Responding to an invitation from the Headmistress, Lake Town Govt. Sponsored Girls' High School, Kolkata, RC-15 took part in the one-day program organized by the school on Tuesday, the 11th February, 2025. Coincidentally, 11th February happens to be the Foundation Day of the school..

The school observed "The International Day of Women and Girls in Science". Prof. Manimala Das delivered a talk on "Breaking Barriers: Empowering Women and Girls in Science". Through her talk, she introduced to the audience the phenomenal contribution made by the women scientists facingr several adversities.

Prof. Bhupati Chakrabarti gave an introduction of IAPT and its activities. This was followed by a Quiz Contest conducted by Prof. Chinmoy Kumar Ghosh. The students of Class lX, X and Xl participated in the competition, and Class XI turned out to be the winner. It was basically a Science Quiz, which comprised of general oral rounds, two visual and a quick fire round. Most of the questions had direct connection with the women scientists. It aroused considerable enthusiasm among the students.

Apart from the IAPT members named above, Prof. Surajit Chakrabarti, Smt. Sukla Chakrabarti and Dr. Shinjinee Das Gupta were also present.

Sukla Chakraborty

Report (RC-15)

Two-Day Workshop on Textbook Experiments in Physical Science

A two-day workshop on Textbook Experiments in Physical Sciences was conducted on 4th and 5th February 2025 at Hadipur Adarsha High School (H.S.), Dist. 24 Parganas (South) bringing together 17 teachers from 10 different schools and 30 enthusiastic student-participants from the host school. These were all first-generation learners (29 Female, 1 male). The workshop aimed to deepen the understanding of key scientific concepts and improve the experimental skills of both students and teachers. Moreover, it was also targeted towards discussions of how easily those experiments can be performed in classes and even outside using highly inexpensive devices.

Force and Motion Experiments: Students explored the concept of Moment of Couple using Scale balance where they were able to measure different masses using one standard weight bar. They performed the experiment to determine the volume and density of irregularly shaped objects. They also performed some experiments on Newton's Laws of Motion using everyday objects and some experiments on the concept of friction using wooden blocks and spring balances.

Electricity and Circuits: Simple circuits were built using basic items like batteries, copper wires, and LEDs to demonstrate the flow of electricity. Electricity was produced using potato-cell and lemon-cell inserting copper and magnesium strips as electrodes. Internal resistances of these cells was also determined.

Energy Transformation: The participants engaged in experiments that illustrated the conversion of energy, such as from potential to kinetic, using marbles and inclined planes.

Fluid dynamics: Paths of a horizontal water jet coming out of a water-filled bottle were observed and various graphs were plotted based on it. It was also observed that the horizontal range of the water jet varies with the height of the plane surface on which the bottle was placed. Density of a liquid was determined using a known liquid in a U-shaped tube.

The action of a water manometer was demonstrated.

The participants found the workshop to be enriching. The teachers appreciated learning new methods of grasping the scientific concepts in a way that would be more engaging for their students. The opportunity to collaborate with peers from other schools further enhanced the learning experience, creating an environment of shared knowledge and support. Through their feedback they have even requested to organize this type of workshop in future.

The resource persons were mainly from IAPT. Dr. Subhash Chandra Samanta, Dr. Surajit Chakrabarti, Dr. Chinmoy Kumar Ghosh, Smt. Sukla Chakraborty, Dr. Birendra Nath Das, Dr. Lipika Santra, Dr. Swati Das, Mr. Kalyan Mukhopadhyay, Mr. Soumya Jana, Mr. Subhajit Chakraborty, Mr. Sandip Sarkar (convener) and Dr. Shinjinee Das Gupta.

he workshop was supported by two Non-Governmental Organizations viz. Manabik Samsthan and Muhurta Foundation.

Students and teachers are being guided by Dr. S.C. Samanta, how to verify Ohm's law using potatoes, as electric cells.

IAPT-Midnapore College (Autonomous) Centre for Scientific Culture provided the required apparatus and guided us to prepare the handbook, containing the procedural details of every experiment, which was distributed among the participants in this workshop.

The workshop successfully met its objectives of enhancing the practical skills of students and teachers of Physical Sciences. By practicing experiments and learning how to demonstrate them using The workshop successfully met its objectives of enhancing the practical skills of students and teachers of Physical Sciences. By practicing experiments and learning how to demonstrate them using common materials, the participants gained valuable skills that would improve the teaching and learning experience in their classrooms.

Measurement of density of Kerosene using U-tube. Dr. Lipika Santra and Dr. Swati Das are explaining to the students

Sandip Sarkar
Assistant Teacher

Report (RC-06)

Annual General Meeting

The Annual General meeting of IAPT RC-6 was held on 1st February 2025 at 1:00 pm in the Vinayak Hall, IIS (deemed to be University), Jaipur.

Prof. K.S.Sharma, President, IAPT RC-6 welcomed all the members of the council and also briefed about the different activities to be undertaken by the council in the times to come.

Prof. Natthi Lal Sharma, Former Professor, Eastern Michigan University, USA was the Chief Guest of the event. He gave an enriching lecture on “Quantum Superposition, Entanglement, Bell's inequalities and Applications”. All UG and PG students of the Department of Physics, IISU also attended the lecture. The lecture was very interesting and informative.

A number of scientific models from the Innovation hub, IISU were also displayed for all the attendees. Prof. Y.K.Vijay, Director, CIST, IISU explained the principle and working of these models in a very easy and interesting way.

A number of Senior members from the fraternity of Physics attended and enjoyed the session. All members were invited to give their suggestions to spread beauty of Physics amongst the young generation, especially the school students. The members assembled near the stage for a group photograph. The meeting ended with a formal vote of thanks.

Ritu Jain
Secretary

Report (RC-13)

International Conference on

Advanced Materials and Energy Applications Functional

The International Conference on Advanced Functional Materials and Energy Applications (ICAFMEA-2025) was successfully conducted by the Department of Physics, Lekshmipuram College of Arts and Science, Neyyoor, on 4th February 2025 in collaboration with the Kudankulum Nuclear Power Project (KKNPP) & IAPT (RC–13). The event brought together researchers to discuss advancements in functional materials and their applications in energy. The inaugural session started with a positive, energetic prayer song by students, followed by a welcome address, extending a warm greeting to all the dignitaries, resource persons, and participants by the head of the department, Dr. S. Goma. The presidential address was given by Dr. M. Sankari, the principal, who emphasised the significance of advanced materials in energy applications and the role of research in shaping future technologies. The keynote address was given by Dr. V. Bena Jothi, Head of the Department of Physics, Women's Christian College, Nagercoil, highlighting the recent developments and future scope of research in functional materials and energy applications. Dr. P. Saravanan, IQAC Coordinator, offered a felicitation address, appreciating the efforts of the organisers and encouraging young researchers to pursue innovative research. The technical sessions featured distinguished resource persons who shared their expertise. Dr. S. Jerome Das, retired professor, Department of Physics, Loyola College, Chennai, discussed advanced nanomaterials for energy storage and conversion. Dr. S. Sadhadivam, Research Professor, Department of Chemical Engineering, Yeungnam University, South Korea, provided insights into polymer-based functional materials for sustainable energy solutions. Scientist B. Vijayakumar, Kudankulam Nuclear Power Project, elaborated on nuclear energy applications and advancements in power generation. The conference

proceedings book with ISBN was released by the college principal. The event was accomplished with 160 participants, including students, research scholars, and staff from various colleges. In the conference, 74 research papers were published by young researchers and academicians. The best oral and poster presentation awards were distributed. The partial financial support was rendered by KKNP and IAPT.

The conference concluded with a vote of thanks delivered by Lt. Dr. T. Suthan, the organising secretary, acknowledging the contributions of all dignitaries, participants, and organising members. The program ended with the national anthem, marking the successful completion of the conference.

T. Suthan
Organising Secretary

Report (SRC-08E)

Foundation Course on Astronomy and Sky Watching

The Foundation Course on Astronomy and Sky Watching was organized by Prof. Rajendra Singh Science Exploratory (PRSSE), Nagpur in collaboration with IAPT SRC08E Vidarbha from January 23 to January 28, 2025. The event took place on the zoom platform from 8 p.m. to 9:30 p.m., having six sessions, with 56 participants registered, ranging in age from 11 to 56 years. Notably, 43 students have been awarded the annual membership of the IAPT.

This initiative aimed to deepen participants' understanding of astronomy and enhance their sky observation skills. The course was mentored by esteemed experts from National Astronomy Network of India IAPT, Dr. Hemant Kumar and Dr. Reshma Desai, who guided the sessions throughout the week. Event was convened by Dr. Govinda Lakhotiya, Vice-President, SRC08E (Vidarbha) and coordinated by Ms. Radhika Kayande from PRSSE.

The inaugural and valedictory sessions featured prominent guests, including Prof. PK Ahluwalia, President of IAPT; Dr. Shyamkant Anwane, President of SRC08E IAPT; and Dr. Seema Ubale, Director of PRSSE. Their presence underscored the importance of the event and highlighted the collaboration between various educational institutions focused on astronomy.

On January 23, the course commenced with the topic "Introduction to Astronomy and Space: Our Place in The Universe," presented by Dr. Subhendu Patnaik, a retired Deputy Director (Technical) from the Pathani Samantha Planetarium in Bhuvneshwar. The session was chaired by Dr. Shyamkant Anwane, the President of SRC08E, IAPT.

The following day, January 24, Dr. Chandan Joshi, an Associate Professor at JECRC University Jaipur, delivered a talk on "Windows of the Universe," covering various aspects of optical, radio, x-ray, infrared, and ultraviolet telescopes. This session was chaired by Dr. R.M. Shewale, former President of RC08, IAPT.

On January 25, Dr. Reshma Raut Dessai from the School of Physical and Applied Sciences at Goa University discussed "Understanding Universe: Celestial Sphere, Constellations," focusing on the basics of observing the sky. The session was chaired

by Prof. Mahesh Shetti, the President of RC08, IAPT.

The course continued on January 26 with a presentation by Dr. Tushar Purohit from IUCAA, Pune, on "Understanding Local Sky." This session was chaired by Dr. Halim Ahamad, Secretary of SRC08E.

On January 27, Dr. Hemant Kumar, a former Director at SCERT SOLAN, HP, presented on "Tycho Brahe, Kepler, Kepler's Laws, Galileo." The session was chaired by Prof. Subhash Kondawar from RTM Nagpur University.

Finally, on January 28, Dr. Sandeep Bhattacharya, a former Director of BM Birla Planetarium in Jaipur, delivered a talk on "Observation of Moon - Our Celestial Neighbor." The session was chaired by Dr. Rekha Ghorpade, the General Secretary of IAPT.

Overall, the event was a resounding success, fostering a deep interest in astronomy among participants and providing them with valuable insights from esteemed experts in the field.

G.V. Lakhotiya
Convener

Report (RC-13)

Experiential Insights-Hands-on Training on Physics Concepts

On February 7, 2025, The Department Of Physics Chevalier T.Thomas Elizabeth College For Women in association with Indian Association of Physics Teachers (IAPT – RC 13 Tamilnadu and Puducherry) organized an "Experiential Insights - Hands-on Training on Physics Concepts" for school and college students. Higher Secondary School students from St. Mary's Girls Hr. Sec School, KRM Public School, St. Mary's Boys Hr. Sec School, Sufa Matriculation Hr. Sec School, St.Mary's Hr. Sec School, Redhills and UG students from CTTE College participated. The event was conducted by Prof. T.S. Natarajan Department of Physics, IIT Madras/Tirupathi,

along with Mr. Prem Kumar expertly demonstrated a variety of key physics concepts through engaging, practical experiments. Among the topics covered were Boyle's Law, Bernoulli's Theorem, Corona Discharge, Internal Reflection, and the Doppler Effect. Prof. Natarajan provided a detailed explanation of each phenomenon, allowing students to gain a deeper understanding of the underlying principles. The hands-on nature of the session not only enhanced the

students' theoretical knowledge but also sparked their curiosity, fostering a greater appreciation for physics in everyday life.

S.Geetha
Coordinator

Announcement

Regional Council (Delhi and Haryana) Executive Council of IAPT, RC

Following candidates are declared elected for the Executive Council of IAPT, RC-01 for the term January 01, 2025 to December 31, 2027:

S. No.	Designation	Elected Candidate	Life Member ship No.	Address	E-Mail and	Mobile Number
1	**President**	**Prof. H. K. Sahajwani**	L0609	SD PG College, GT Road Panipat Haryana	harishsahajwani@gmail.com	9871679878
2	**Vice-President**	**Mr. Surjan Singh**	L8624	DG-2/155-B, Vikas Puri, Delhi-110018	surjanmathuria@gmail.com	8851430140
3	**Secretary**	**Dr. S. K. Singhal**	L7285	Amity International School, Mayur Vihar, Phase-1, Delhi-110091	Singhal_s_k@yahoo.co.in	9868516554
4	**Treasurer**	**Dr. Manoj Kaushik**	L 2886	SCERT, Gurugram	manoj_kaushik6171@yahoo.com	9868180395
5.	**EC member**	**Dr. Alka Gupta**	L 8713	ASN Sr. Sec . School, Mayur Vihar, New Delhi	alka.gupta@ashschool.org	9013013987
6.	**EC member**	**Prof. Manish Kumar Kashyap**	L 5356	School of Physical Sciences, JNU, New Delhi	mkkashyap@jnu.ac.in	9467210306
7.	**EC member**	**Dr. Prajwalit Shikha**	. L 5079	Physics Dept. Maitry College (DU), New Delhi	prajwalitshikha@yahoo.in	9999914246
8.	**EC member**	**Dr. Gagan Gupta**	L 4769	DESM, NCERT, New Delhi	ggupta1965@gmail.com	9654121185
9.	**EC member**	**Mr. Vikram Verma**	L 8857	S.D. Public School, Jagadhari, Haryana	Vikramverma100@gmail.com	7206613877

M. S. Bhandari (RO)
Email: msinghbhandhari@gmail.com
Mobile No. : 9811354042 and 8851198827

EC Members of Sub RC-08B- Mumbai for the term 2025-2027

S. No	Designation	Name	Life Membership Number	• Address • E – Mail • Mobile Number
1	President	Krishna Bhole	L2503	202, Ramkrishna Apt, Mithagar Rd, Mulund East, Mumbai 400081 kgbhole@gmail.com 9820551156
2	Vice-President	Vivek Bhide	L-5895	Department of Physics, Gogate Joglekar College, Ratnagiri 415612 vivekbhidestar@gmail.com 9421139296
3	Secretary	Sushmita Meta	L-5840	504, Akash I, Yashvant Nagar, Vakola,. Santacruz, Mumbai 400055 homesushmita@gmail.com 9867498395
4	Treasurer	Shyamala Bodhane	L-3528	501, Pravin smruti chs, Paranjape Scheme "A" rd no. 1, Subhash Rd, Vileparle East, Mumbai 400057. spbodhane@gmail.com 9869336624, 022 35614406
	MEMBERS			
1	Member	Prof. Kiran Kolwankar	L-8556	Prof. Kiran Kolwankar, Ramniranjan Jhunjhunwala College, Ghatkopar (W), Mumbai 400 086 Kiran.kolwankar@rjcollege.edu.in 9920381051
2	Member	Dr. Padmanabh Sarpotdar	L-7106	5 262 B4, Parshuram Nagari, Near Modkagar, Guhagar, Tal. Guhagar, ?Dist. Ratnagiri 415703 padphy@gmail.com 7507861988
3	Member	Dr. Leena Joshi	L-5176	Flat 4, 2A, Amarjyoti chs, Thane(w) 400602 Leena.joshi@xaviers.edu 8268828282
4	Member	Dr. Hemangi Raut	L-9542	C-2602, Northern Heights, Shantinagar, Nr Celebration Hotel, Dahisar (East), Mumbai 400068. hemangiraut@vivacollege.org
5	Member	A M Sheker	L-3191	A &-2-4 Millenium Towers, Sector-9, Sanpada, Navi Mumbai 400705 shekeram@gmail.com 8169435187,9869612993
6	Ex-officio member	Dr Atul Modi	L-3132	B-2089, Maruti Paradise, Sector -15, CDB Belapur, Navi Mumbai 400614 atulmody@gmail.com 7774030403

K G Bhole

List of New Member from 01.01.2024 to 31.12.2024
Member from 14342 - L9263 to 14953 - L9702

OMNO	Membership No.	Name	City	Pincode
		DELHI		
14937	L9688	Brajesh Chaudhary	New Delhi	110001
14904	L9665	Monu Mishra	New Delhi	110003
14915	L9671	Dr. P. V. Raghavendra	New Delhi	110016
14508	*2404	Sudhanshu Singh	Delhi	110017
14895	*2512	Diya Gupta	New Delhi	110017
14757	L9558	Shibu Saha	Delhi	110019
14561	L9427	Shaan Ameer	Delhi	110025
14734	S2508	Shourya Yadav	New Delhi	110045
14894	S2412	Akhil Tripathi	New Delhi	110046
14347	L9267	Aanchal Jain	New Delhi	110052
14651	L9478	Parnika Arora	New Delhi	110059
14546	I9418	Abhishek Yadav3	New Delhi	110067
14636	L9468	Abhijit Sarkar	New Delhi	110067
14642	L9473	Veera Venkata Satyanarayana Venna	New Delhi	110067
14828	*2410	Ram Prasad Prajapati	New Delhi	110067
14665	L9488	Taruna Kapoor	New Delhi	110070
14637	L9469	Vijay Kumar Prajapati	Delhi	110086
14693	*2407	Saksham Pokhriyal	Delhi	110086
14366	S2502	Tanisha Shukla	Delhi	111111
14492	*2404	Ashutosh Singh	Delhi	111111
14500	S2504	Inbisat Ahmad Shah	Delhi	111111
14511	L9391	Ankur Mandal	Delhi	111111
14830	L9610	Nirmala Jothi	Delhi	111111
14604	*2506	Shilpa Gaikwad	Delhi	110001
14370	*2402	Yogini Suradhar	Delhi	110001
		HARYANA		
14470	L9364	Jyoti Chauhan	Faridabad	121004
14439	S2503	Vidit Nirwal	Gurgaon	122001
14535	*2404	Manish Rathore	Gurugaon	122001
14876	L9647	Miss Anita	Gurgaon	122001
14472	L9366	Ravi Ramakrishna Reddy	Gurgaon	122003
14906	S2512	Shibar Rafiq	Gurugram	122003
14935	*2412	Mohammed Azam Khan	Sohna	122103
14762	L9561	Rakesh Kumar	Narnaul	123001
14420	L9318	Dr. Rakesh Kumar	Mahendragarh	123031
14490	L9378	Dr. Priya Rani	Mahendragarh	123031
14432	L9329	Tammana Bansal	Rewari	123401
14791	L9585	Pradeep Singh	Hisar	125001
14889	*2412	Dr. Jai Bhagwan	Hisar	125001
14606	L9455	Sri Satish	Mandi Dabwali	125104
14780	L9577	Dr. Rahul Rathee	Jind	126102
14756	L9557	Mrs Ritu	Charkhi Dadri	127306
14700	L9517	Sandeep Kumar	Karnal	130001
14400	L9305	Nidhi Jast	karnal	132001
14401	L9306	Dr. Ambika Rani	Karnal	132001
14953	L9702	Dr. Heena	Karnal	132001
14661	S2507	Aditya Goyal	Ambala	134009
14908	L9666	Dr. M.S Mehta	Panchkula	134102
14724	L9535	Govind Singh	jagadhri	135003
14798	L9588	Basant Kumar	Yamuna Nagar	135101
		PUNJAB		
14556	L9422	Dr. Sheenam Savchdeva	Mohali	140301
14602	*2506	Vandana Yadav	Mohali	140306
14862	L9636	Rahul Bhatia	Jagraon	142026
14888	L9657	Harmanpreet Singh	Amritsar	143001
14860	L9634	Dr. Roopkiranpreet kaur	Batala	143505
14865	L9639	Prince Syal	Batala	143505
14866	L9640	Dr. Mridula Dogra	Batala	143505
14867	L9641	Gautam Bhardwaj	Batala	143505
14853	L9629	Simmi Garg	Jalandhar	144008
14863	L9637	Kapil jairath	Jalandhar	144009
14861	L9635	Dr. Sandeep Kumar	Jalndhar	144012
14509	L9389	Haramanpreet kaur	Tanda	144204
14864	L9638	Poonam Sharma	Dasuya	144205
14855	*2411	Yogesh Kumar	Hoshiarpur	144209
14684	L9504	Miss Akshidha	Hoshiarpur	144216
14482	L9372	Hitesh Sharma	Kapurthala	144603
14578	S2505	Navneet Kaur	Kapurthala	144624
14593	L9448	Miss Sangeeta	Patiala	147001
14564	*2405	Manish Jha	Gobindgarh	147301
14676	L9496	Neetu Bansal	Sangrur	148024

OMNO	Membership No.	Name	City	Pincode
14356	*2501	Vishruti Garg	Bathinda	151001
		CHANDIGARH		
14936	*2412	Bhupender Sudan	Chandigarh	160047
14743	*2408	Neru Bala	Mohali	160059
		HIMACHAL PRADESH		
14523	L9403	Neha Katoch	Shimla	171004
14364	L9279	Anuj Keshav Kushesh	Solan	173212
14573	L9436	Hansa Devi	Ghumarwin	174021
14377	L9285	Dr. Anshu Sharma	Solan	174103
14801	L9591	Sandeep Kumar	Una	174308
14574	L9437	Suneeta Singh	Joginder Nagar	175015
14731	*2408	Ashwani Kumar	Sundernagar	175019
14909	*2412	Nisha Sharma	Mandi	175019
14834	L9614	Satinder Sharma	Mandi	175075
14575	*2405	Kewal Sharma	kangra	176023
14768	L9567	Vinay Pathania	Kangra	176027
14902	L9663	Dr. Manish Sharma	Bagwan	176047
14787	L9583	Ashutosh Sharma	Palampur	176061
14907	S2512	Ashish Kumar	Palampur	176061
14898	L9661	Vinod Sharma	Palampur	170001
14819	S2510	Aryansh Saxena	Hamirpur	177005
14825	S2510	Navaneeth Shetty B	Hamirpur	177005
14896	*2512	Vaishnavi R	Hamirpur	177005
14900	S2512	Pradeep Kumar	Hamirpur	177005
14905	S2512	Abhishek Bharadwaj	Hamirpur	177005
14911	S2512	Danish Kumar	Hamirpur	177005
14897	L9660	Bimal Kumar	Una	177213
		JAMMU & KASHMIR		
14579	L9439	Parshotam Singh manhas	Jammu	180011
14755	L9556	Dr. Manju	Ganderbal	191131
14497	L9382	Mandeep Singh	Awantipora	192122
14920	L9676	Dr. Amir Ahmad Dar	Pulwama	192304
		UTTAR PRADESH		
14567	L9431	Dr. Shivani Agarwal	Sahibabad	201005
14608	*2405	Manoj Joseph	Ghaziabad	201014
14375	L9283	Dr. Sarvendra Kumar	Ghaziabad	201204
14881	L9651	Ashutosh Mani Tripathi	Ghaziabad	201204
14545	L9417	Pragati Ashdhir	Noida	201303
14882	L9652	Priyank Kr. Singhal	Noida	201307
14784	L9580	Vaibhav Rawoot	Noida	201309
14591	L9446	Sujit Tandel	Gautam Buddha Nagar	201314
14709	*2408	Aftab Ahmed	Aligarh	202002
14790	*2409	Devendra Bhatt	Gautam Buddha Nagar	203207
14374	*2402	Deepak Kumar	Hathras	204212
14435	L9332	Shamoon Ahmad Siddqui	Lucknow	206016
14859	L9633	Jitendra Kumar	Kanpur	208002
14659	L9485	Ashwani Tiwari	Kanpur	208003
14662	*2407	Subham Shukla	Kanpur	208012
14559	L9425	Praveen Kumar	Kanpur	208013
14349	L9268	Niraj Mohan Chwake	Kanpur	208016
14350	L9269	Dr. Anurag Tripathi	Kanpur	208016
14649	L9476	Pragya Pathak	Kanpur	208016
14923	L9679	Tapobrata Sarkar	Kanpur	208016
14924	L9680	Anand Kumar Jha	Kanpur	208016
14925	L9681	Amit Agarwal	Kanpur	208016
14926	L9682	Dipankar Chakrabarti	Kanpur	208016
14928	L9684	Anjan Kumar Gupta	Kanpur	208016
14929	L9685	R. Vijaya	Kanpur	208016
14930	L9686	Kaushik Bhattacharya	Kanpur	208016
14931	L9687	Adhip Agarwala	Kanpur	208016
14361	L9276	Seema Kumari	Kanpur	208017
14927	L9683	Aditya H Kelkar	Kanpur	208017
14363	L9278	Yogesh Kumar Jha	Kanpur	208019
14368	L9281	Anurag Kumar Kori	Kanpur	208019
14362	L9277	Bankey Bihari Agarwal	Kanpur	208022
14481	L9371	Amit Shukla	Kanpur	208027
14562	L9428	Piyush Shukla	Kanpur	208027
14815	*2410	Satyam Joshi	Kanpur Dehat	209310
14759	*2409	Abhishek Dixit	Unnao	209801
14739	L9544	Atul Singh Bhardwaj	Prayagraj	211002
14705	L9520	Anshu Prakash maurya	Varanasi	221003
14735	*2408	Jaya Dwivedi	Varanasi	221005
14799	L9589	Sanjay Singh	Varanasi	221005
14553	*2505	Sarthak Vishwakarma	Barabanki	225305
14817	L9602	Salman Warsi	Lucknow	226016
14849	L9627	Akanksha Khare	Lucknow	226018
14823	L9607	Seema Srivastava	Lucknow	226021
14592	L9447	Salman Ahamad Khan	Lucknow	226026
14820	L9604	Afraj Ahmed Khan	Lucknow	226026

OMNO	Membership No.	Name	City	Pincode
14816	L9601	Tahira Khatoon	Lucknow	226028
14893	S2412	Shashank Mishra	Amethi	227408
14773	L9572	Tathamay Basu	Rai Bareilly	229304
14447	L9343	Hrishabh Bhardwaj	Bareilly	243001
14671	L9492	Apoorva Raj	Bareilly	243122
14409	L9313	Dr. Varsha Yadav	Moradabad	244001
14870	L9644	Dr. Anil Kuamr	Amroha	244241
14615	L9460	Aman Kumar	Meerut	250001
14831	L9611	Navin Kumar	Baghpat	250621
14692	L9512	Bhawna Pandey	U S Nagar	263145
14887	L9656	Apara Tripathi	Gorakhpur	273008
14775	*2409	S. K. Dubey	Maharajganj	273151
14367	*2402	Reetesh Kumar	Deoria	274206
14737	*2408	Aditya Vishwakarma	Deoria	274603
14858	L9632	Ritesh Kumar Singh	Mau	275101
14803	L9593	Bhanu Prakash	Mathura	281004
14351	*2401	Vivek Kumar	Jhansi	284001
14408	L9312	Dr.Sanjeev Kumar Srivastava	Jhansi	284003
		Uttarakhand		
14832	L9612	Dr. Sandeep Kumar	Haridwar	247667
14721	L9532	Ashish Kumar Porwal	Dehradun	248001
14423	L9320	Prof. Alok Srivastava	Dehradun	248013
14477	*2404	Deepak Negi	Uttarkshi	249193
		RAJASTHAN		
14502	*2404	Rohit Mehta	Alwar	301707
14656	L9483	Chitra Banerjee	jaipur	302001
14462	L9357	Rina Sharma	Jaipur	302015
14381	L9286	Richa Sharma	Jaipur	302018
14471	L9365	Sudhanshu Dwivedi	Jaipur	302019
14512	L9392	Tanay Agarwal	Jaipur	302019
14557	L9423	Minali Tayal	Jaipur	302020
14412	L9315	Abhik Mukherjee	Jaipur	302026
14410	L9314	Dr. Anurag	Jaipur	303007
14829	*2410	Ravi Yogi	Kotputli	303105
14568	L9432	Rachana Sharma	Phulera	303338
14807	L9597	Manish Kumar Srivastava	Tonk	304022
14840	L9619	Bhal Singh	Ajmer	305001
14699	L9516	Ramiz Gori	Dungarpur	314001
14857	L9631	Pradeep Narayan Tiwari	Kota	324002
14635	L9467	Dr. Vivek Kumar Jain	Kota	324005
14655	L9482	Dr. Himanshu Dadhich	Sikar	332002
14480	L9370	Gourav Singal	Raisingh Nagar	335051
		GUJARAT		
14611	S2506	Dakshesh Kotia	Porbandar	360477
14891	*2412	Niraj Singh	Jam Nagar	361004
14365	L9280	Priya L mange	Junagadh	362001
14653	L9480	Dr. Rajesh Ganai	Kodinar	362715
14726	L9536	Niketa Joshi	Bhuj	370001
14641	L9472	Nirali Shah	Ahmedabad	380007
14804	L9594	Maitri Shukla	Ahmedabad	380008
14572	S2505	Aayushee Patel	Ahmedabad	380026
14812	S2510	Henil Soni	Ahmedabad	380028
14797	L9587	Ayushi Girish Patel	Ahmedabad	380050
14719	L9530	Vaishali Adhwaryu	Ahmedabad	380052
14720	L9531	Hiral Raval	Ahmedabad	380061
14800	L9590	Dr. Nisha Thankachen	Ahmedabad	382115
14776	S2509	Kavya Wadhwa	Gandhi Nagar	382421
14796	L9586	Rishit Shukle	Ahmedabad	382481
14872	*2411	Jignesh kumar Barot	Sabarkanta	383255
14619	L9463	Rahul Prajapati	Patan	384265
14478	*2404	Eagle Darbar	Nadiad	387002
14425	L9322	Shweta Dabhi	Anand	388320
14786	L9582	Alkesh Patel	Ghunteli	388440
14810	S2510	Nandani Jha	Vadodara	390004
14652	L9479	Alpa Dashora	Vadodara	390008
14617	L9461	Swagata Roy	Vadodara	390019
14618	L9462	Samrat Sarkar	Vadodara	390019
14620	L9464	Sejal Patel	Chhottaudepur	391135
14598	S2505	Ratan Kumar Singh	Vadodara	391410
14667	L9490	Dr. Trilok Kumar Akhani	Vadodara	391410
14668	L9491	Dr. Yogesh Kale	Vadodara	391760
14681	L9501	Dr. Nirav Ranpura	Bharuch	392011
14682	L9502	Dr. Nirav Pandya	Bharuch	392011
14916	L9672	Trupti Patel	Surat	393135
14912	L9668	Padsala Abhay Vinubhai	Surat	394326
14391	L9296	Dr. Niket Shastri	Surat	395001
14654	L9481	Dr. Vipul Kheraj	Surat	395007
14386	L9291	Anurag Maheshbhai Kadve	Surat	395009
14387	L9292	Dr. Pinank Hiteshkumar Jariwala	Surat	395009
		MAHARASHTRA		
14597	L9450	Dr. Vinod Shridhar Gokarna	Mumbai	400067
14736	L9542	Hemangi Raut	Dahisar	400068

OMNO	Membership No.	Name	City	Pincode
14725	S2508	Aditya Singh	Mumbai	400071
14486	S2404	Aanya Punatar	Mumbai	400078
14848	L9626	Pushpendra Kumar Mishra	Mumbai	400101
14744	L9548	Sagar Tamhankar	Mumbai	400104
14558	L9424	Udayan Sathe	Thane	400606
14789	S2509	Arhum Gandhi	Navi Mumbai	400703
14352	L9270	Meeta Saxena	Navi Mumbai	400706
14689	L9509	Sanjay Kumar Jagdish Tiwari	Mira Bhayander	401107
14479	L9369	Nerissa Lopes	Mumbai	401203
14712	L9524	Mudita Sonawane	Panvel	410206
14380	*2501	Janjavi Vindhate	Pune	411003
14382	L9287	Dr. Johny T Abraham	Pune	411007
14613	S2506	Pankaj Gupta	Pune	411008
14372	L9282	Shalini Garg	Hadpsar	411013
14698	L9515	Swati Mule	Pune	411017
14571	L9435	Dipali Hodade	Pune	411028
14702	*2407	Gauri Purnik	Pune	411028
14688	L9508	Balasaheb Salunke	Pune	411033
14600	L9451	Ashish Arora	Pune	411045
14746	L9549	Manjusha Kothawade	Pune	411057
14527	L9407	Rajendra Salunke	Osmanabad	413051
14824	L9608	Dinesh Shinde	Sangala	413306
14765	L9564	Ashok Kamble	Sangola	413307
14914	L9670	Onkar Pore	Solapur	413308
14444	L9340	Dr. Suraj Shankarrao Deshmukh	Osmanabad	413501
14464	L9359	Dr. Shesherao Patil	Dharashiv	413501
14537	L9413	Sidram Dongrge	Latur	413512
14540	*2404	Prajwal Jaje	Latur	413512
14541	*2404	Sairaj Karad	Latur	413512
14713	L9525	Mangesh Awale	Latur	413512
14722	L9533	Dr. Dayanand Raje	Latur	413512
14723	L9534	Abhijit Yadav	Latur	413512
14728	L9538	Shweta Lakhande	Latur	413512
14750	L9552	Rishikesh Vibhute	Latur	413512
14565	S2505	Vivek Bondar	Latur	413513
14449	*2403	Ghanshyam Jadhav	Omerga	413606
14899	*2412	Kailash Warale	Daund	413801
14460	L9355	Asha Nawpute	Ahmed Nagar	414001
14398	L9303	Dr. Raghunath Gopinath Vidhate	Beed	414202
14406	L9310	Dr. Jawaharlal Motilal Bhandari	Beed	414202
14458	L9353	Dr. Ramdas Bhanudas Kavade	Beed	414202
14459	L9354	Dr. Namdeo Nivrutti Waghule	Beed	414203
14392	L9297	Rupesh Yuvaraj Kakate	Beed	414204
14603	L9453	Dr. Priti Jadhav	Ratnagiri	415612
14749	L9551	Guruprasad Kadam	Kolhapur	416012
14886	L9655	Tejaswini Desai	Kolhapur	416012
14587	*2405	Sushant Pangam	Kolhapur	416502
14344	L9265	Dr. Sunetra Laxman Dhere	Sindhudurg	416613
14921	L9677	Sarang. K	Ulhasnagar	421003
14792	S2509	Vedanti Gor	Thane	421301
14813	*2410	Tanwin Ashrafi	Bhiwandi	421308
14763	L9562	Pramod Kamale	Nashik	422003
14694	*2407	Mayur Murkute	Ahemad Nagar	422602
14463	L9358	Anil Ramji Gayake	Jalgaon	424209
14427	L9324	Dr. Anup More	Dhule	424304
14428	L9325	Sudam Chavhan	Dhule	424304
14431	L9328	Rajendra Ahire	Dhule	424304
14456	L9351	Kishore More	Sakri	424304
14494	L9379	Dr. Sachin Nandre	Sakri	424304
14346	*2312	Dr. Umesh Gawai	Erandol	425109
14422	L9319	Archana Deshpande	Aurangabad	431001
14445	L9341	Dr. Smita Pradeep More	Aurangabad	431001
14450	L9345	Arundhati Anantrao Wadewale	Chhatrapati Sambhajinagar	431001
14452	L9347	Kavita Nanabhau Pawar	Chhatrapati Sambhajinagar	431001
14453	L9348	Harish Kulkarni	Chhatrapati Sambhajinagar	431001
14467	L9361	Avinash Kachere	Chhatrapati Sambhajinagar	431001
14513	L9393	Vaibhav Devidas Murumkar	Aurangabad	431001
14525	L9405	Dr. Sangeeta Uttareshwar Shinde	Chhatrapati Sambhajinagar	431001
14534	*2504	Suraj Birare	Aurangabad	431001
14536	S2504	Chandraprakash Jadhav	Aurangabad	431001
14779	L9576	Rahul Pandit	Chhatrapati Sambhajinagar	431001
14785	L9581	Seema Mehetra	Aurangabad	431001
14769	L9568	Sudarshan Gawali	Chhatrapati Sambhajinagar	431004
14396	L9301	Dr. Shailendra Jagannath Shukla	Chhatrapati Sambhajinagar	431005
14443	L9339	Shivprasad Vaijanthrao Shinde	Chhatrapati Sambhajinagar	431005
14451	L9346	Dr. Sandip Kadubal Fasate	Chhatrapati Sambhajinagar	431005
14466	L9360	Mahesh Babrekar	Chhatrapati Sambhajinagar	431005
14515	L9395	Dr. Swati Kale	Chhatrapati Sambhajinagar	431005
14644	*2406	Jalinder Shilwant	Chhatrapati Sambhajinagar	431005
14778	L9575	Vishnu Surashe	Aurangabad	431007

OMNO	Membership No.	Name	City	Pincode
14394	L9299	Dr. Sanjay Bhaskar Gopale	Aurangabad	431009
14514	L9394	Dr. Madhuri Patil	Chhatrapati Sambhajinagar	431009
14395	L9300	Dr. Rani Devidasrao Dudhal	Aurangabad	431010
14468	L9362	Pallavi Nalle	Aurangabad	431011
14516	L9396	Nakul Mhaske	Chhatrapati Sambhajinagar	431011
14442	L9338	Neha Prashant Ahuja	Aurangabad	431107
14498	L9383	Ashok Pandit	Chhatrapati Sambhajinagar	431112
14519	L9399	Gopinath Dapke	Chhatrapati Sambhajinagar	431112
14521	L9401	Sunil Bhonde	Sillod	431112
14783	L9579	Dr. Jaiswal S.B.	Bhokardan	431114
14522	L9402	Saurabh Surse	Chhatrapati Sambhajinagar	431120
14390	L9295	Shivaji Shankarrao Raut	Beed	431122
14397	L9302	Dr. Shivanand Vishwanath Kshirsagar	Beed	431122
14645	S2506	Yogesh Chavan	Georai	431127
14767	L9566	Dr. Shivshankar Mitkari	Majalgaon	431131
14539	L9414	Dr. Dilip R Sapate	Jalna	431203
14446	L9342	Dr. Vijaykiran N Narwade	Parbhani	431401
14526	L9406	Ashish Mohan Waghumbare	Parbhani	431401
14533	L9412	Ravindra Shinde	Parbhani	431402
14528	L9408	Pankaj Chalikwar	Manwath	431505
14529	L9409	Bhaskar Munde	Manwath	431505
14648	L9475	Dr. Vijendra Anant Chaudhari	Latur	431512
14530	L9410	Kashinath Bogle	Nanded	431606
14560	L9426	Kanchan Jivnapurkar	Nagpur	440008
14932	*2412	Vidhya Meshram	Nagpur	440010
14345	L9266	Smita Talani	Nagpur	440014
14503	L9386	C Ruchir Kumar	Nagpur	440015
14827	L9609	Dr. Sarang Daf	Nagpur	440015
14621	*2406	Rupali Thete	Nagpur	440016
14610	L9457	Ritesh Raikundliya	Nagpur	440024
14883	L9653	Dr. Sugandha Khangar	Nagpur	440027
14691	L9511	Dr. Diptee V Jamkar	Nagpur	440030
14348	*2501	Yugansh Kanoje	Phata	440034
14487	L9376	Chanda Jatgade	Nagpur	440034
14934	*2412	Lalit Kaithwas	Nagpur	440034
14658	L9484	Priyanka Bhoyar	Nagpur	441001
14399	L9304	Mangesh Yerpude	Wardha	442001
14624	L9465	Sudhir Tiple	Wardha	442001
14461	L9356	Swapnil Ashok Bhagat	Buldhana	443001
14730	L9539	Pratik Gaiki	Motala	443013
14732	L9540	Parag Bramhankar	Motala	443103
14754	L9555	Dr. Nilesh Ramdas Thakare	Amravati	444604
14440	L9336	Jitendra Kounsalya	Yavatmal	445103
		GOA		
14847	L9625	Shubhangi Agni	Panjim	403001
14485	L9375	Murga Dabhokar	Panaji	403002
14818	L9603	Deepraj Prabhu	Sankhali	403105
14483	L9373	Amey Shirodker	Ponda	403401
14850	L9628	Sudipta Kanungo	Ponda	403401
14879	L9650	Mandar Karandikar	Ponda	403401
14488	L9377	Rohit Naik	Ponda	403406
14376	L9284	Pradeep Morajkar	Mapusa	403507
14484	L9374	Joalita Rebello	Salett	403716
		MADHYA PRADESH		
14413	*2403	Rohit Singh Tomar	Indore	452013
14505	L9387	Neeraj Asthana	Dhar	454001
14550	*2405	Sunil Pandey	Betul	460661
14748	S2508	Ajeet Salunke	Nanded	461809
14809	L9599	Santosh Kumar	Bhopal	462002
14438	L9335	Pramod Kumar Purohit	Bhopal	462024
14680	L9500	Sharad Chandra Tripathi	Sehore	466114
14384	L9289	Dr. Mukesh Chandra	Guna	473226
14360	L9275	Kaushtubh Ranjan	Bhind	477001
		CHHATTISGARH		
14532	L9411	Deepak Kumar Yadav	Bhatapara	493118
14733	L9541	Goverdhan Prasad Sahu	Baloda Bazar	493526
14941	L9690	Anamika Dwivedi	Bilaspur	495001
14774	L9573	Dr. Nidhi Rai	Bilaspur	495006
		TELANGANA		
14806	L9596	Dr. Durgam Chinni krishna	Hyderabad	500002
14695	L9513	Aslam Shareef	Hyderabad	500008
14697	L9514	Shaik Hussain Bee	Hyderabad	500008
14844	*2411	Rohit Hazra	Secunderabad	500010
14616	*2406	Ramkrishna Sarma	Hyderabad	500035
14357	*2401	Prasad T S P Ln	Hyderabad	500036
14491	*2404	B. Somanadha Sharma	Hyderabad	500048
14938	L9689	Shakeer Ahmad	Hyderabad	500049
14913	L9669	Dr. K. Hadasa	Hyderabad	500070
14802	L9592	Dr. Parvathalu Kalakonda	Hyderabad	500079

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14717	L9528	Shireen Tagore	Hyderabad	500080
14714	*2408	Dr. Mujeeb Hasan	Hyderabad	500091
14666	L9489	Prasanna M	Secunderabad	500094
14910	L9667	Subhashini Palaka	Hyderabad	501301
14841	L9620	Vippala Veera Reddy	Hayath Nagar	501501
14664	*2407	Sirisha Bandi	Hyderabad	502305
14371	*2402	Venkatesh D	Medak	502313
14379	*2401	Aneela Regala	Narsapur	502313
14405	*2402	Jyothi B	Narsapur	502313
14643	*2406	Dr, Ashok Kumar Kusuma	Narsapur	502313
14646	*2406	Vamshi Prasad Talloju	Narsapur	502313
14758	L9559	Manohar Reddy Rupireddy	Hanamkonda	506001
14506	L9388	Reddyvari Venugopal	Warangal	506002
14586	S2505	Spoortika Boora	Warangal	506002
14837	L9617	Aruna Penumantra	Hanamkonda	506002
14704	L9519	Srinivas Kuchana	Hyderabad	506015
14851	*2411	Aditya Kumar Munindlapalli	Khammam	507001
		ANDHRA PRADESH		
14821	L9605	Zarena D	Anantapur	515002
14842	L9621	Jamal Basha	Kapada	516001
14434	L9331	Bapanayya Chitikela	Srikalahasti	517644
14625	*2406	Thollarama Sunkanna	Tirupati	517644
14340	L9262	Prem Pankaj	kurnool	518002
14499	L9384	Papori Seal	Kurnool	518007
14678	L9498	Dr. S. Sailaja	Kurnool	518007
14601	L9452	Dr. B Narasimharao	Nandyal	518501
14706	L9521	Senthil K	Vijayawada	520012
14903	L9664	N Abhiram	Vijayawada	521108
14584	L9442	Srinivasa Krishna	Tenali	522201
14711	*2408	Dr. Muneeswaram Muniyandi	Vijayawada	522237
14788	L9584	Prof. Hushnud	Guntur	522302
14407	L9311	Dr. Amit Chakraborty	Guntur	522508
14570	L9434	Dr. C. Salma	Nellore	524001
14884	L9654	Dushyanth Edadasula	Vishakhapatnam	530012
14710	L9523	Jayadev Kanta	Kakinada	533003
14940	S2601	Bala Siva Teja	Rajamahendravaram	533103
14414	L9316	Jeevana Mounika	Chintalapudi	534460
14622	*2406	Suryanarayana karukola	Vizianagaram	535002
14629	*2406	Thamatapu Sravan Kumar	Vizianagaram	535002
14630	*2406	Chinnam Naidu Chodavarapu	Vizianagaram	535002
14633	*2406	Ramakrishna Reddy	Vizianagaram	535148
14632	*2406	Gantla G Sreenivasarao	Vizianagaram	535183
14673	L9494	Kolati Krishnarao	Vizianagaram	535214
14627	*2406	Mahanti Praveen Kumar	Salur	535591
		KARNATAKA		
14614	L9459	Naresh Raghava	Bangalore	560016
14670	S2507	Miss Shilpa	Bangalore	560021
14358	L9273	Karthik Kumar MB	Bangalore	560060
14703	S2507	Rishabh Praveen	Bangalore	560062
14814	*2410	Chirag S	Bangalore	560062
14811	L9600	Dr. T. Ranjeth Kumar Reddy	Bangalore	560064
14890	L9658	Rohit Mishra	Bangalore	560064
14760	*2409	Muniraj G	Bangalore	560068
14707	*2407	Sindhoora Shetty	Bangalore	560073
14373	*2402	kaushalya P R	Bangalore	560074
14378	*2401	Geetha Subbaraya	Bangalore	560098
14543	L9416	Dr. Namrata Yaduvanshi	Bangalore	560108
14752	L9553	Supriya Nayaka M K	Chikkallpura	561208
14415	L9317	PVNM Kaushik	Chikkaballapura	562101
14761	L9560	Ayesha Anjum	Malabagilu	563131
14476	L9368	Sankarshan B M	Mysuru	570008
14674	L9495	Prajwal P	Mandya	571807
14605	L9454	Raghvendra S	Ujire	574240
14599	*2506	Dr. Rajesh K	Mangalore	575028
14822	L9606	Vishwanatha G S	Davanagere	577004
14510	L9390	Vijaya Kumar	Shivamogga	577201
14839	L9618	Basavaraj V Meti	Godag	582111
14385	L9290	Yogananda H.G	Ballari	583102
14833	L9613	Dr. Nagbasavanna Guragol	Kalaburagi	585102
14740	L9545	Anand R	Chikodi	591201
		TAMIL NADU		
14465	S2503	Vanisha Satish	Chennai	600024
14359	L9274	Vasantharajan G	Chennai	600033
14852	*2411	Suchithra Chandrasekara	Chennai	600041
14835	L9615	Murugaraj Rathinasamy	Chennai	600044
14747	L9550	Paulson Priyadoss W	Chennai	600045
14805	L9595	Dr. Rizwana R	Chennai	600048
14729	*2408	Kaleel Mohamed Ibrahim S	Chennai	600059
14429	L9326	C.Preferencial Kala	Chennai	600064
14770	L9569	Pradeep Reddy Vanga	Chennai	600071

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14771	L9570	C Parthasaradhi Reddy	Chennai	600071
14433	L9330	Ramesh V	poonamallee	600072
14939	*2601	Anirudh Mangesh	Chennai	600078
14868	L9642	Joseph Prabagar C	Chennai	600094
14355	L9272	Dr. Gurulakshmi S	Chennai	600100
14657	*2407	Malar Selvi M	Chennai	600117
14552	*2405	Bharathy G	Chennai	600122
14843	L9622	Dr. C Esther Jeyanthi	Chennai	600123
14430	L9327	Bakthavatchallu Gunasekaran	Chennai	600125
14493	*2404	Simi Sarathy	Chennai	600130
14772	L9571	Sridhar S	Thiruvallur	602024
14455	L9350	Karthigeyan A	Perumattunallur	603202
14437	L9334	Tusharbhai Himmatbhai Rana	Chengalpattu	603203
14448	L9344	Kalaivani Thirunavukaras	Chennai	603203
14454	L9349	Hariharan R M	Kancheepuram	603203
14675	*2407	Vasanthi S	Puducherry	605005
14595	L9449	Gokul Raj Srinivasan	Pundicherry	605011
14596	S2505	Varalakshmy Kumar	Villupuram	605111
14518	L9398	Padmavathy Murugan	Chidambaram	608001
14885	*2411	Ms. Nithya	Chidambaram	608001
14411	*2403	PrakashIgnacimuthy	Thanjavur	613006
14718	L9529	Dr. V. Kathiravan	Tiruchirappalli	620005
14457	L9352	Dr. G. Maheswari	Tiruchchirappalli	620007
14517	L9397	Anitha Azhagan Ganapathy	Tiruchchirapallai	620007
14403	L9308	Dr. Kavimani Mahanani	Tiruchirappalli	620018
14424	L9321	Dr. Anitha B	Tiruchirappalli	620024
14389	L9294	Dr. T. Noorunisha	Tiruchirappalli	620102
14402	L9307	Dr. S. Priya	Tiruchirappalli	620102
14393	L9298	R. Meenakshi	Tiruchchirappalli	621216
14520	L9400	Rizwana Begum	Tiruchchirappalli	621216
14751	S2508	Sriram Palanippan	Pudukkottai	622003
14683	L9503	Jesu Raja	Madurai	625007
14640	*2406	Durai Manoharadoss Prabaharan	Madurai	625014
14531	*2404	Vijayanarayan V	Madurai	625017
14507	*2404	Aravindan V	Madurai	625018
14650	L9477	Dr. R. Premkumar	Madurai	625019
14538	*2404	Karuppasamy Balasubramanian	Srivilliputtur	626125
14808	L9588	Aravinthkumar . K	Kovilpatti	628714
14343	L9264	Virgin Jeba. S	Nagercoil	629004
14795	*2409	Biny Wiston	Nagercoil	629601
14631	L9466	Dr. M. Malathi	Sivaganga	630001
14383	L9288	Dr. Tarun Garg	Vellore	632014
14854	*2411	Suwathi Jain. J	Vellore	632014
14473	L9367	Alagiri M	Dharmapuri	635305
14609	*2405	Rajarathinam. L	Salem	636016
14685	L9505	Mohan K S	Erode	638052
14686	L9506	Dr. Jayanalina T	Erode	638052
14781	*2409	Janarthanan Manickavasagam	Erode	638107
14690	L9510	Mobika J	Erode	638451
14687	L9507	Thayanithi V	Erode	638452
14716	L9527	Hariharan M	Karur	639001
14388	L9293	Dr. R. Mekala	Karur	639110
14582	*2405	Raman Thangavel	Karur	639117
14426	L9323	Sudha d	Coimbatore	641022
14436	L9333	Dr. Vasanthapriya R	Coimbatore	641022
14549	L9420	Dr. Uthayarani K	Coimbatore	641022
14880	*2411	Ravishankar Balasubramanian	Coimbatore	641034
14745	*2408	Janani R	Coimbatore	641045
14777	L9574	Venkatesan T	Tiruppur	641606
		KERALA		
14838	*2410	Senin Ahammed V	Kozhikode	673571
14826	*2410	Dr. Praveen H	Palakkad	675623
14353	L9271	Dr. Sunil NK	Edappal	679576
14638	L9470	Ann Rose Abraham	Kochi	682013
14708	L9522	Ramkumar V.R	Ernakulam	682314
14496	L9381	Dr. Minu Mohan	Trivandrum	695583
		WEST BENGAL		
14612	L9458	Dr. Sitikantha Dhorjati Das	Kolkata	700009
14474	*2404	Shilpi Pal	Kolkata	700035
14417	*2403	Payel Mondal	Kolkata	700041
14626	*2406	Apurba Ghosh	Kolkata	700057
14917	L9673	Dolan Champa Saha	Kolkata	700075
14489	*2404	Deesha Sen	Kolkata	700078
14416	*2403	Dr. Sarbani Gonguly	Kolkata	700084
14547	*2405	Subhasree Bhattacharjee	Kolkata	700084
14874	*2411	Rishab Bhattacharya	Kolkata	700084
14542	L9415	Soham Chatterjee	Kolkata	700108
14594	*2405	Sandipan Shah	Kolkata	700108
14623	*2406	Debopriya Dey Hazra	Kolkata	700108
14419	*2403	Rupa Bhattacharya	Kolkata	700109

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14475	*2404	Miss Puja	Kolkata	700109
14551	*2405	Abhik Sinha Mahapatra	Agarpara	700109
14404	L9309	Dr. Sudipta Sasmal	kolkata	700112
14701	L9518	Saurish Chakrabarty	Kolkata	700132
14918	L9674	Promita Howli	Kolkata	700150
14580	L9440	Madhumita Muzumder	Howrah	711102
14418	*2403	Susmita Karan	Howrah	711112
14585	L9443	Nababrata Ghoshal	Howrah	711401
14504	*2404	Md Nurulla Mollick	Hooghly	712706
14588	S2505	Sreyasi Samanta	Bardhaman	713103
14524	L9404	Amarjyoti Gorai	Durgapur	713201
14660	L9486	Kamal Hussain	Durgapur	713211
14577	L9438	Sumita Santra	Kharagpur	721302
14634	*2406	Moumita Arya	Kharagpur	721304
14873	S2511	Arindam Ghosh	Bankura	722207
14495	L9380	Shuvam Dutta	Siliguri	734006
14544	*2404	Mouleena Jana	Siliguri	734010
14354	*2401	Sajal Biswas	Nadia	741101
		ODISHA		
14738	L9543	Dr. Sakti Prasan Mohanty	Bhubaneswar	751003
14583	*2405	Dr. Chandan Kumar Das	Bhubaneswar	751024
14901	L9662	Pankaj Kumar Sahoo	Cuttack	754029
14581	L9441	Nibedita Dash	Balasore	756001
14589	L9444	Rasmita Mohapatra	Balasore	756030
14563	L9429	Dr. Kamala Kanta Jena	Bhadrak	756100
14766	L9565	Krushna Hial	Berhampur	761003
14715	L9526	Malaya Kumar Pradhan	Bargarh	768028
14944	L9693	Arpita mahapatra	Rourkela	769004
14945	L9694	Jayashree Lakra	Rourkela	769004
14950	L9699	Santosh Kumar Sahu	Rourkela	769004
14469	L9363	Ramyaranjan Das	Rourkela	769008
14753	L9554	Somesh Sabat	Rourkela	769008
14764	L9563	Dr. Dillip K Pradhan	Rourkela	769008
14943	L9692	Gopi Nath Daptary	Rourkela	769008
14946	L9695	Soudamini Sahoo	Rourkela	769008
14949	L9698	Ananta Charan Pradhan	Rourkela	769008
14951	L9700	Mithun Biswas	Rourkela	769008
14952	L9701	Shraddha Shrma	Rourkela	769008
14948	L9697	Madhulita Das	Sundargarh	769008
14947	L9696	Jiten Kumar Patnaik	Rourkela	769015
14942	L9691	Chandan Kumar Beura	Sundergarh	770016
		ASSAM		
14845	L9623	Dr. Ranjit Deka	Guwahati	781003
14871	L9645	Sanghamitra Roy	Guwahati	781008
14607	L9456	Nandita Lakhar	Guwahai	781012
14566	L9430	Bandita Deka	Guwahati	781014
14590	L9445	Abhilasha Bora	Guwahati	781021
14501	L9385	Deepak Goswami	Guwahati	781034
14922	L9678	Neha Pathak	Guwahati	781039
14919	L9675	Dr. Debashis Saikia	Barpeta	781301
14569	L9433	Dr. Devabrat Mahanta	Nalbari	781348
14794	*2409	Atanu Nath	Tihu	781371
14554	L9421	Abhijeet Das	Diphu	782462
14555	S2505	Debasish Chabanya	Darrang	784147
14548	L9419	Kalyan Malakar	Dhemaji	787059
14696	*2407	Asoke K Sen	Silchar	788001
14663	L9487	Dr. Gayatri Ghosh	Silchar	788006
14782	L9578	Atri Deshamukhya	Silchar	788011
14441	L9337	Susmita Paul	Karimganj	788710
		MIZORAM		
14741	L9546	Lalruatfela Renthlei	Lunglei	796701
14742	L9547	C Laremchhunga	Lunglei	796701
		TRIPURA		
14892	L9659	Dr. Chandan Debnath	Agartala	799001
14793	*2409	md. Nurul Islam	Agartala	799003
14639	L9471	Dr. Arunabha Saha	Mohanpur	799210
		BIHAR		
14836	L9616	Dr. Ram Shrestha Roy	Patna	800013
14727	L9537	Dr. Ritesh Kumar	Arrah	802302
14672	L9493	Joydip Ghosh	Muzaffarpur	842002
14856	L9630	Reena Kumari	Dharbhanga	846003
14869	L9643	Prakash Ranjan Deen	Purnia	854301
		JHARKHAND		
14679	L9499	Tushar Mahanta	Hazaribagh	825301
14878	L9649	Preeti Minz	Ranchi	834001
14846	L9624	Dr. Bhupendra Singh	Ranchi	834004
14875	L9646	Sunil Singh	Ranchi	834004
14677	L9497	Anupam Kumar	Ranchi	834008
14877	L9648	Santosh Singh	Ranchi	834010

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Concept Inventories - Introduction to some more examples

In this column we continue the discussion on concept inventories by briefly reviewing few more examples. So far we covered CIs mostly in the area of mechanics. Here we discuss one in electricity and magnetism and another two on quantum mechanics.

Conceptual Survey of Electricity and Magnetism (CSEM)

Maloney, D. P., O'Kuma, T. L., Hieggelke, C. J., & Van Heuvelen, A. (2001). **'Surveying students conceptual knowledge of electricity and magnetism**. *American Journal of Physics*, *69* (S1), S12-S23.

This is a 32 item inventory to assess student knowledge of topics in electricity and magnetism. The content areas covered include charge distribution on conductors/ insulators, Coulomb's law, electric field, principle of superposition, electric potential, induced charge, magnetic force, magnetic field by a current and Faraday's law. The authors noted that the number of studies on preconceptions in electricity and magnetism were limited, in contrast to mechanics and uncovered an array of reasoning pitfalls. Poor understanding of charge distribution on conductors and insulators was noted. Students seemed to answer based on memorized statement about distribution of charge with little understanding of the physical mechanism. Another example is students' belief that a magnetic force acts on an electric charge whenever it is in a magnetic field. They often did not realize that the charge must have a velocity, with a component perpendicular to the direction of magnetic field. It was also found that many students failed to extend Newton's third law to electric and magnetic forces. The notion that the 'larger magnitude charge exerts larger force' on a smaller charge was popular.

Quantum Mechanics Conceptual Survey (QMCS)

McKagan, S. B., Perkins, K. K., & Wieman, C. E. (2010). **Design and validation of the quantum mechanics conceptual survey**. *Physical Review Special Topics—Physics Education Research*, *6*(2), 020121.

QMCS is a 12 question instrument designed to evaluate student understanding of conceptual aspects of quantum mechanics such as the relationship of probability density to wave function, wave particle duality, and the relationship of amplitude and wavelength to potential, among others. The paper provides an appendix that lists out the specific learning goals of each of the 12 questions, along with the concepts that is being tested by them. For example, the learning goal corresponding to question 2 is to `interpret the solutions of Schrodinger equation so as to recognize that electron energy levels are spread out in space', while that of question 11 is to determine the probability distribution when a wave function is given. The authors describe the design and development of the survey which was based on student observations, faculty interviews, textbook analysis and review of relevant PER literature. The survey can be used as part of any modern physics course at the early undergraduate level in our context.

For those interested in a tool that is pitched at a higher level (akin to say masters level in our context) may refer to the Quantum mechanics concept assessment (QMCA) test referred below. It has 31 items on concepts such as time dependence of probability density, role of Hamiltonian in energy measurement, time evolution of quantum mechanical measurement, among others.

Sadaghiani, H. R., & Pollock, S. J. (2015). Quantum mechanics concept assessment: Development and validation study. *Physical Review Special Topics-Physics Education Research*, *11*(1), 010110.

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