

Bulletin of



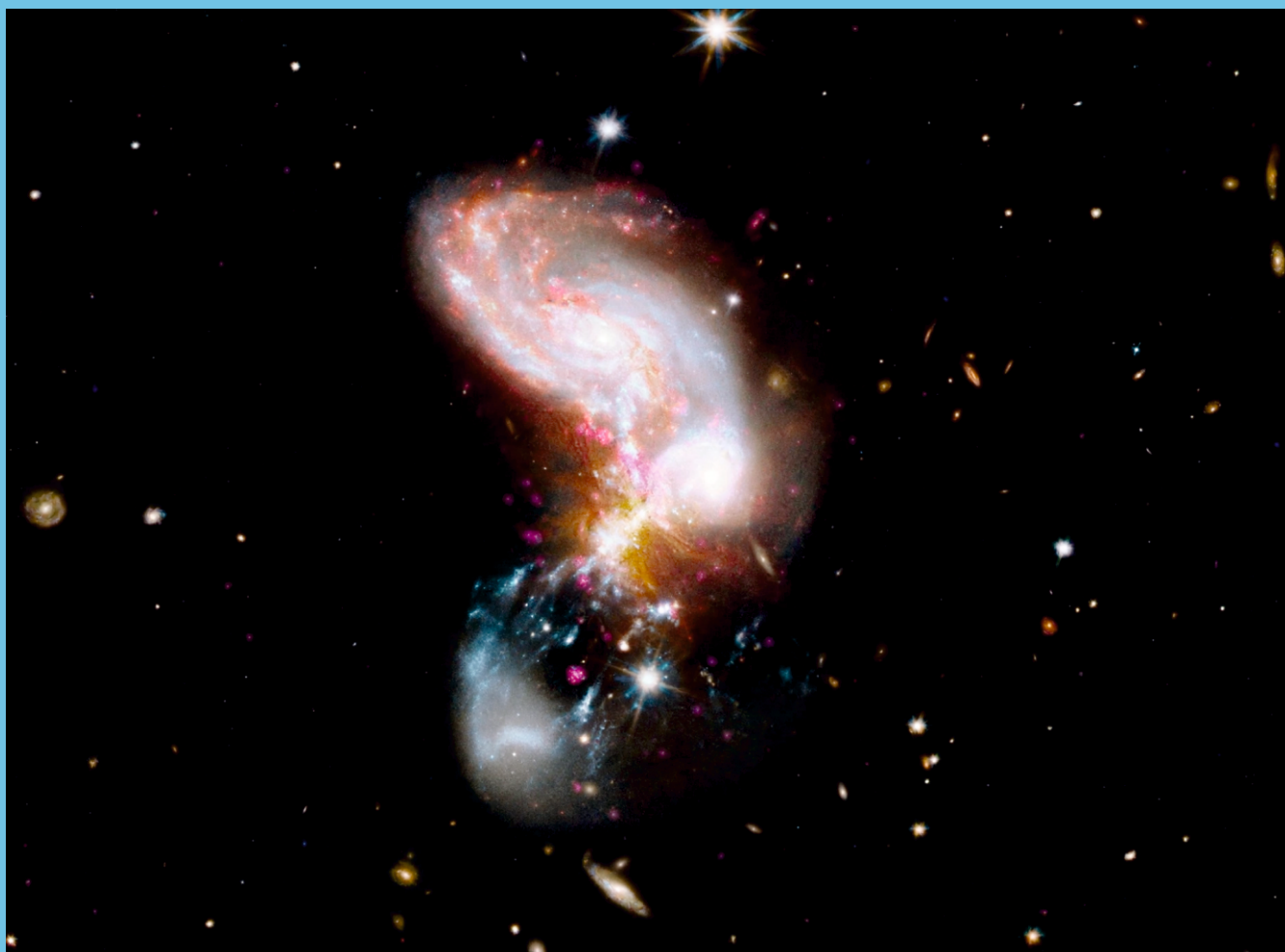
THE INDIAN ASSOCIATION OF PHYSICS TEACHERS

A MONTHLY JOURNAL OF EDUCATION IN PHYSICS & RELATED AREAS

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Two galaxies merge at a furious rate in this Aug. 25, 2026, image of the II Zw 096 system. This and several other images of both visually and scientifically interesting galaxies were released by NASA's Chandra X-ray Observatory and other telescopes.

Chandra X-ray data (magenta) pinpoint powerful black hole activity and hot gas, while optical data (blue and white) from NASA's Hubble Space Telescope and infrared data from NASA's James Webb Space Telescope illuminate vast stellar nurseries hidden behind interstellar dust. Systems like II Zw 096 show us how powerful galaxy collisions shaped the early universe.

Link: <https://www.nasa.gov/image-article/nasas-chandra-spots-galactic-gem/>

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. All communications should be addressed to:

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From A Single Step to Ruby Jubilee Milestone

From Seed to Shoots to Fruits: A Vision Unfolded.

We earnestly appeal to all those who are interested in upgrading science education (including that in the masses) to contribute papers for the Convention and participate in the discussions. IAPT membership, though helpful, is not essential for such participation, the doors are open to all. The only constraints are: (a) let us not get lost in local problems; we have to see things in the national perspective, and (b) let us not end up with criticism alone; we have to come out with concrete work for obtaining better results.

Seed: The First Appeal

FIRST CONVENTION OF INDIAN ASSOCIATION OF PHYSICS TEACHERS

Dates : Oct 19-21, 1984 Place : Kanpur

FIRST CIRCULAR

General. The First Convention of IAPT is being sponsored by Kanpur University and IIT Kanpur and will receive assistance from the UGC and other agencies.

Dates and Place. The dates are Oct 19-21, 1984 and place : Kanpur. Detailed programme will soon follow. It is going to be quite a tight schedule including some workshop type activity so that we can draw up some concrete lines of work. IAPT is designed for productive work and it may be advisable for participants to come prepared for a fourth day of group meetings.

Themes. The Themes for the Convention, as already given in Bulletin IAPT August '84 issue, are as follows :

A— Analysis of the present state of Physics education with positive suggestions for upgrading in syllabi/teaching/evaluation.

B— Reading materials for students and teachers (books/monographs) :
[a] planning and producing, [b] evaluating and vetting of existing ones, [c] propagating (including translation).

C— Demonstration and Lab experiments : [a] evaluating the existing ones, [b] making comprehensive programs, [c] possible film strips/loops

D— Reading material for the general public

[a] producing science readers [b] translating.

E— Science shows, exhibitions, museums Science centres etc. for the general public, including films/video tapes.

F— Radio and TV propagation of science education (a) for students (b) for the general public.

G— Reorientation programs for teachers and coordination with other agencies.

H— Identifying talents among teachers and recognizing merit.

I— Any other area of IAPT interest.

Papers and Abstracts. Papers and Abstracts are invited for the Convention. Any person interested in upgrading of teaching or teachers in Physics and related areas may submit a paper. It may be typed or neatly written on one side of foolscap paper. Length may not exceed 3000 words. An Abstract on a separate sheet, not exceeding 150 words must accompany the paper. Please mark at top right the Theme (A, BI) under which the paper falls.

Last Date : Last date of receipt of Papers is Sept. 30, 1984. Acceptance or otherwise will be communicated latest by October 5, 1984.

Address : Papers and correspondence regarding them may please be sent at the address of—

Dr. K. N. Khanna
93, M. I. G., Indira Nagar,
KANPUR—208026

Bull. IAPT, 1 (7) Sept. 1984

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Roots: The First Circular

IAPT CONVENTION Tentative Programme

I day

0830-1000 Registration (Fee Rs 50/-) †

1000-1130 Inaugural Session

1150-1300 NSC meeting : **The Statutes (I)**

1500- 630 Open Session I : **General**

1650-1800 NSC meeting : **The Statutes (II)**

1800-2000 Open Session II :

Papers (Themes A, B)

2130-2300 Trials of Science Show

II day

0830-1000 Open Session III :

The Statutes

(1000-1300 Nominations for elected posts)

1020-1150 Open Session IV : **Papers**

(Themes C, D, E)

1150-1300 Open Session V : **Papers**

(Themes E, F, G, H)

1500-1630 NSC Workshop. **The Tasks**

(1500-1630 Voting for elected posts)

1650-1900 Open Workshop I : **The Tasks**

(Themes A, B, C)

1930-2230 Science Show

III day

0830-0950 Open Workshop II :

The Tasks (Themes D, E, F)

0950 1130 Open workshop :

The Tasks (Themes H)

1150-1 00 NSC meeting :

Programming the Tasks

1400-1630 Concluding session

Bull. IAPT, 1 (7) Sept. 1984

The First Shoots: The Tentative Programme of the First Convention

The IAPT Convention

A challenge and an opportunity

The IAPT Convention on Oct. 19-21, 1984 (details inside) is going to be a great challenge to all those who desire seriously to initiate a massive nationwide movement and program for the upliftment of science teaching. IAPT is Designed to start this with physics, and in the Convention we come face to face with the task of planning for effective and intensive work to obtain results in a handsome measure. Let us face the challenge squarely. We invite the top physicists in the country to join us in the Convention and help us in steering our course right. They have this vision, and they have the maturity and experience. We need all these.

For those who are directly involved in teaching and who will be entrusted with the execution of the plans, this Convention will be a great opportunity to enter a highly productive work of national importance. It will give them professional satisfaction of the highest order, and a place of honour in the field of physics education. We invite them for this new and exhilarating experience.

Let us meet the challenge and let us grab the opportunity. Sitting on the sidelines does not help. Blaming others does not help. The nation needs concerted efforts from all; from the brilliant and conscientious ones the expectations are much higher. Let us therefore go in for a nationwide concerted effort towards upgrading the teaching of Physics and related areas at all levels.

Edited and published by D.P. Khadkankar on behalf of Indian Association of Physics Teachers, c/o Physics department I.I.T. Kanpur. Printed at Eldora Printers, Sonbargarh, Kanpur-1 (Ph. 4652) Managing Editor : A.N. Dixit.

Fruits: The Expectations

Ruby Jubilee National Convention of Indian Association of Physics Teachers 2026 reminds me of the first convention which was held in IIT Kanpur in 1984 in the presence of stalwarts of IAPT, Prof. DP Khandelwal as member Secretary and Prof. Babu Lal Saraf as President. They must be feeling proud, wherever they are. They had a clear and broad vision not restricted to physics alone but encompassing whole of science. Reaching this milestone is fulfilling of their faith which they put in the wisdom of community. Today that idea has become a movement. In 1984, when our founders, led by DP Khandelwal and a handful of dedicated Physics teachers, dreamt of an association, they did not dream of a large auditorium or a Ruby Jubilee souvenir. Their vision was simpler and far more profound: that no physics teacher in India should feel alone in the classroom. They wanted a family where a teacher from a rural school, a teacher from a small town college and a Professor from university could sit together to share a demonstration, design an innovative experiment, argue over curriculum and return home recharged and renewed. The annual convention is that community get together. First convention was a small gathering but big in ideas. The underlining idea was physics is not a job but a mission.

When we look at the three pictures accompanying this editorial- a humble appeal to participate, a first circular printed in a letter press and a tentative three-day programme-it is difficult to believe that they contained the blueprint for forty years.

Today, as we hold the 40th convention, that idea has become a movement deeply rooted across the length and breadth of the country through a vibrant network of regional and sub-regional councils. Every day in some corners of the country, IAPT is engaging, enhancing and inspiring mission of quality physics education.

From that single circular to thousands of members, from that tentative programme to hundreds of parallel academic sessions from that appeal to *participate* to today's appeal to *lead*- we have travelled from a single step to a milestone.

Ruby Jubilee is, therefore, not just a celebration of 40 conventions, it is a *Pranam* to that first step. It is a thank you to all those who kept walking. Thanks to a suggestion by our most respected member Professor Mukund Oglapurkar, on this occasion, we have decided to launch a project to trace every footprint from those who walked with us once to those who walked with us for 40 years and publish a role of honour as special supplement to the IAPT Bulletin. They are the true rubies of IAPT. We will soon launch a campaign to connect with each one of fellow travelers.

As you attend this three day convention, and as you look at the technical programme in your hand, do pause and look again at the first tentative programme shared here. You will definitely realize- the spirit is the same. Numbers have grown, competitive spirit on the rise, dedicated focused theme networks have emerged, thanks to technology we are creating and sharing resources. And we are only a meet away from each other requiring only a click of the mouse button or tap on your mobile screen. Sharing is our mantra. Vision is not local, it is global. We have ticked all the themes which founders envisioned and have expanded upon them to meet contemporary challenges of 21st century.

The founders lit a small *Jyoti*. It is now our responsibility to keep it glowing for eternity.

Long live IAPT- Steadfast in Mission of Quality Physics Education.

PK Ahluwalia
President IAPT

Physics News

Physicists extend the search for quantum black holes at the LHC

Physicists at UC Santa Barbara have extended the search for evidence of microscopic black holes produced at the Large Hadron Collider (LHC) at the European Organization for Nuclear Research (CERN). One of the mysteries of our universe is that we exist at a scale much lower than the one fundamental energy scale we know of, the Planck scale. This could be explained by new physics or a symmetry we have yet to detect, and theorists have determined that this new physics could appear at the energy scales accessible to the LHC. The notion of black holes at the LHC began a couple of decades ago, when it was suggested that at high enough energies, and with the possibility of extra spatial dimensions (which are already required in string theory), quantum black holes could potentially form among the trillions of proton-proton collisions generated by the LHC particle accelerator. The researchers did not find these hypothetical processes in their search, thereby setting limits on the fraction of interactions that could possibly be producing sphaleron transitions.

Read more at: <https://phys.org/news/2026-09-physicists-quantum-black-holes-lhc.html>

Original Paper: Progress in High Energy Physics PHEP (2026). DOI: 10.31526/phep.2026.21

Experimental evidence of altermagnetism in a layered material opens a promising path toward future spintronics

To build the ultrafast computers of the future, scientists are looking beyond the electrical charge of electrons to another property: their spin. While conventional hardware relies on the movement of charge to process data, tapping into this intrinsic quantum property could enable researchers to reinvent how information travels through a circuit. Ferromagnetism produces the behavior most people associate with everyday magnets. In these materials, magnetic moments align in the same direction, creating a magnetic field. That property can be useful in electronics, but the resulting stray magnetic fields can interfere with nearby components. Antiferromagnets behave differently. Their magnetic moments point in opposing directions and cancel one another out, largely avoiding stray fields. Because scientists can modify $\text{Co}_{1/4}\text{TaSe}_2$ and observe how its properties change, the material provides researchers with a new experimental platform for investigating unanswered questions and exploring how altermagnetism interacts with other magnetic and electronic phenomena.

Read more at: <https://phys.org/news/2026-09-experimental-evidence-altermagnetism-layered-material.html>

Original Paper: Nature Communications (2026). DOI: 10.1038/s41467-026-76784-x

Quantum computer boldly goes where no quantum computer has gone before: Space

There's big news from the quantum world. A quantum computer has been used in space for the first time. The device was aboard a spacecraft in low Earth orbit and demonstrated technology that could eventually help solve a problem that has been bugging satellites for years. But taking the idea from the drawing board to orbit was not without its challenges. Quantum photonic systems are delicate, and radiation, large temperature changes and the vacuum of space could damage their components or disrupt their operation. The quantum photonic processor, which consisted of a photon-pair source, a six-mode integrated glass circuit chip, single-photon detectors and control electronics, was loaded aboard a SpaceX Falcon 9 rocket. It was launched into low Earth orbit on June 23, 2025. Reaching that goal will also require ensuring instruments can handle the extreme stresses they will face. The next step is to close the loop between sensor and processor, encoding Earth-observation data directly into the unitary programmed on the circuit.

Read more at: <https://phys.org/news/2026-09-quantum-boldly-space.html>

Original Paper: arXiv (2026). DOI: 10.48550/arxiv.2609.25248

Soumya Sarkar
Duke University, US

October: This Month in the History of Physics

1889: Thomas Alva Edison, the prolific inventor shows his first motion picture

Edison gained world renown for his inventions, including the phonograph; incandescent lighting; and the Kinetoscope, an early motion picture camera. He participated in the Universal Exposition of 1889 in Paris, which also saw inauguration of the Eiffel Tower.

Edison's inventions were the highlight of the exposition's "Gallery of Machines," with one pavilion devoted to his electric light and another to his recently improved phonograph. The wax cylinders on the table (shown in the picture below) were used for recording. Although Edison patented the first version of the device in 1877, earning himself the title of the "Wizard of Menlo Park," eleven years passed before he achieved sufficient clarity of sound to make it commercially viable. He developed Menlo Park, in Middlesex County of New Jersey – now considered the first industrial research laboratory.



It may not be known to many that Edison developed hearing problems at the age of 12. The young Alva, as he was known at the time, concocted elaborate fictitious stories about the cause of his deafness. He was completely deaf in one ear and barely hearing in the other. As an adult, he believed his hearing loss allowed him to avoid distraction and concentrate more easily on his work. Thomas Alva Edison was born on February 11, 1847 and died on October 18, 1931

1925: Invention of Television and first successful transmission of image

2 October and 26 January happen to be two important dates in Indian history. It is a strange coincidence that these two are also landmark dates in the history of invention of Television. On 2 October 1925, Baird successfully transmitted the first television picture with a greyscale image: the head of a ventriloquist's dummy nicknamed "Stooky Bill" in a 32-line vertically scanned image, at five pictures per second. Baird fetched an office worker, 20-year-old William

Edward Taynton, to see what a human face would look like, and Taynton became the first person to be televised in a full tonal range.

On 26 January 1926, Baird gave the first public demonstration of true television images for members of the Royal Institution and a reporter from The Times in his laboratory. Baird initially used a scan rate of 5 pictures per second, improving this to 12.5 pictures per second. It was the first demonstration of a television system that could scan and display live moving images with tonal graduation. Essential steps for a successful transmission and reception of television signal were:

Scanning Disc: A spinning mechanical disk with 30 holes arranged in a spiral scanned the target object line by line.



Baird in 1926 with his televisior equipment and dummies "James" and "Stooky Bill"

Light and Signals: Light passing through the disk hit a light-sensitive cell, creating an electrical signal sent to a receiver.

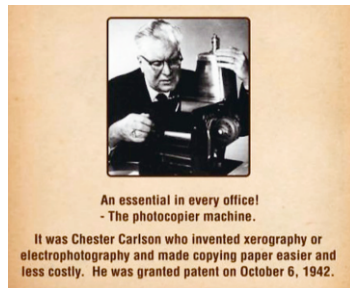
Image Reconstruction: A matching spinning disk at the receiving end turned the signal back into a faint, flickering image.

1941: Electric photography, now referred to as photocopying

"Electric photography"—which inventor **Chester Carlson** originally named **electrophotography**—is the foundational process for what we know today as **xerography** or **photocopying**. While Carlson first successfully demonstrated the dry printing process in a makeshift laboratory on **October 22, 1938**, he was officially granted his foundational patent for the technology on **October 6, 1941** (often cited as officially issued in 1942)

How the Invention Evolved

- **1938 Breakthrough:** Working with his assistant Otto Kornei, Carlson created the first copy by applying a static charge to a sulphur-coated zinc plate, exposing it to light through a glass slide,



and using powder to reveal the image.

- **The Patent (1941):** Carlson secured his patent for "electrophotography," protecting the six-step process that relied on photoelectric physics and electrostatic attraction.
- **The Rebrand to Xerography:** In 1946–1947, a small photo-paper manufacturer called the **Haloid Comapny** licensed Carlson's work. Finding "electrophotography" too long and complicated, they consulted a classics professor who recommended **xerography**—derived from the Greek words *xeros* (dry) and *graphein*.
- **The Birth of Xerox:** Haloid eventually launched the first automated commercial copier – the Xerox 914 (so named because it could copy sheets as large as 9 by 14 inches) in 1959. The technology became so massively successful that the company officially changed its name to the **Xerox Corporation**.

Even to this day, photocopy of a document is commonly and popularly referred to as a Xerox copy – or simply as “Xerox”!

1969: The first-ever computer-to-computer link is established on ARPANET, the precursor to the Internet

The internet evolved from a Cold War military project into a global network through decades of key milestones. From its humble beginnings as a military project to the global web it is now, the **history of the internet** is a tale of human ingenuity, collaboration, and the relentless pursuit of connectivity and a fascinating journey of innovation, collaboration, and

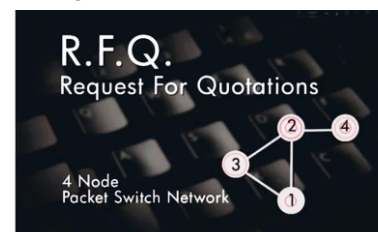
rapid technological advancement.

Key Milestones in Internet History

- **October 29, 1969:** Launch of **ARPANET** (Advanced Research Projects Agency Network), the first operational packet-switching network – between UCLA (University of California at Los Angeles) and SRI (Stanford University Research Institute). Later on, extended to include UC at Santa Barbara and University of Utah and four Node Packet switch network was introduced
- **1971:** Engineer **Ray Tomlinson** invents network email and introduces the "@" symbol to route messages.
- **1983:** Adoption of **TCP (Transmission Control Protocol)/IP (Internet Protocol)** as the standard protocols for ARPANET.
- **1989-1990:** **Tim Berners-Lee** invents the **World Wide Web** and introduces the "@" symbol to route messages.
- **1993:** The first graphical web browser, **Mosaic**, is released.
- **1998:** **Google** is founded, revolutionizing search engines.
- **2007:** The **iPhone** introduces widespread mobile Internet access.
- **2010s:** Rise of **cloud computing, social media, and streaming services**.



Packet-switching network between UCLA & SRI



Four Node Packet switch network

Achintya Pal

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Glueball: Theoretical Predictions and Experimental Searches

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Abstract: For last fifty years physicists have been searching for 'glueballs', the hypothetical exotic particles predicted by the theory that describes strong interactions, the Standard Model. Glueball is envisaged to be the only particle in nature composed entirely of force mediators gluons, carrying strong interaction between quarks, the fundamental constituents of matter. The search for this miniscule entity is going-on in the high-energy physics experiments using gigantic accelerators and particle detectors, recording these exotic phenomena. The latest results have been published by the BESIII collaboration on 2 September 2026, establishing X(2370) consistent with a pseudoscalar glueball. This article gives a very basic insight into the theory and ongoing experimental searches.

Introduction

The Standard Model of particle physics [1,2] is known to be one of the most successful theories in the history of science. The ultimate understanding of the constituents of matter at the fundamental level comes from the Standard Model of particle physics which includes Quantum Chromodynamics (QCD) [3] as the

most important theoretical framework to describe the strong interaction dynamics of quarks and gluons to create the matter we know of. Standard model of particle physics can be described by a mini periodic table which contains the arrangements and combinations of quarks and leptons, as shown in Fig.1

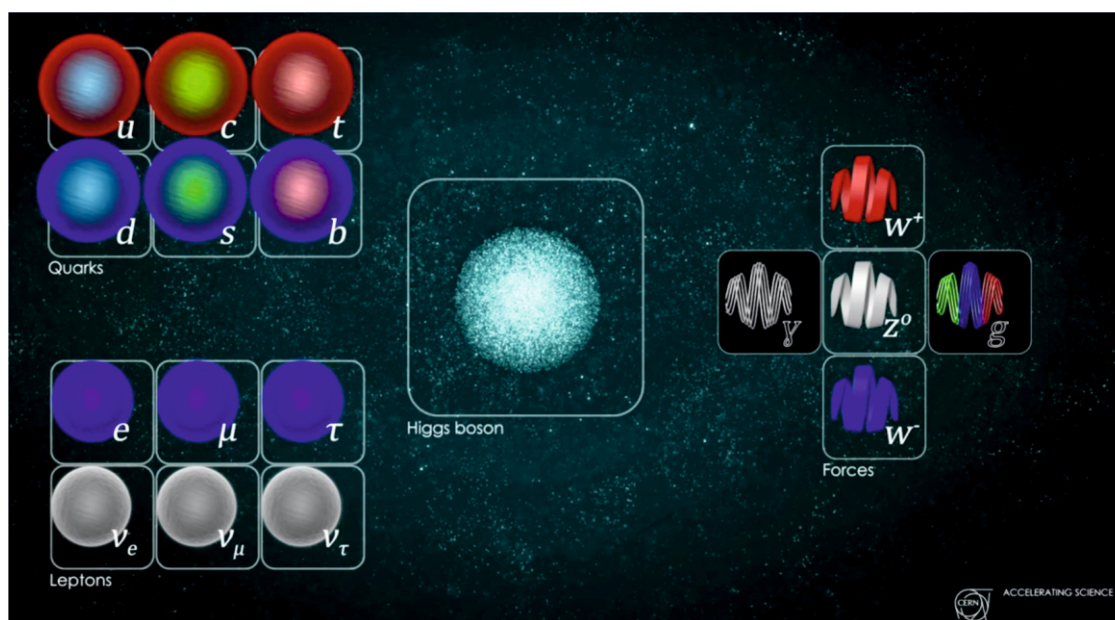


Fig.1

Credit:

<https://cds.cern.ch/record/2002395/files/STDM%20higgs%20and%20field%20D.png?subformat=icon-1440>

The matter particles in the universe can be divided into two types:

- Fermions that follow Fermi Dirac statistics
- Bosons which obey Bose-Einstein statistics.

At the fundamental level, matter particles are formed from quarks and leptons which are fermions, the particles with half-integral spin. The second group of particle, the bosons are the integral-spin particles. They are the force carriers and mediators of interactions between the fermions.

Fig.1 shows there are six flavours (type) of quarks; up(u), down(d), charm(c), strange(s), top (t) and bottom(b).

All quarks(q) are fractionally charged; u, c, t with $(+2/3)e$ of charge and d, s, b with $(-1/3)e$ of charge. Each flavour occurs in three colours; red (r), blue(b), green(g).

The colours are notional but three colours add up to a colourless state. Colour is a quantum number which distinguishes between a quark of a single flavour in a combined state with another quark of the same flavour. For example, proton carries three quarks (uud). To distinguish between the two u-quarks, colour is needed. Each quark has associated antiquark which has opposite charge and colour. Thus the total number of quarks is 36.

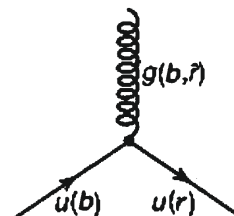
There are six flavours of leptons; electron (e), muon(μ), tau (τ), electron-neutrino (ν_e), muon-neutrino (ν_μ), and tau-neutrino (ν_τ). Along with six anti-leptons, there are total of 12 leptons.

Out of the four forces of the nature, namely
i) Gravitation ii) Strong iii) Weak and
iv) Electromagnetic force.

The Standard Model does not include gravitation in its formulation. Remaining three forces are however very well explained by the Standard Model.

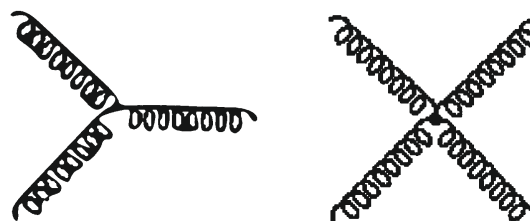
Strong interaction between the quarks is mediated by the exchange of a gluon(g). At the

fundamental level, a quark can radiate a gluon ($q \rightarrow q + g$). The colour of the quark (not the flavour) may change. For example a blue up-quark (u_b) may convert into a red up-quark (u_r). Since the colour, like charge, is always conserved, the difference of colour ($b\bar{r}$) is carried by the gluon, as shown in the diagram:



Gluons then, are 'bicolored', carrying one positive unit of color and one negative unit. With three colour and three anti-colours, there are 9 possibilities, i.e. nine type of gluons. For technical reasons, there are actually only eight gluons in the SM.

Since the gluons themselves carry colour, they can couple directly to other gluons thereby forming gluon-gluon vertices(combined states), such as three gluon vertices (TGV) and four-gluon vertices (FGV) as shown:



This direct gluon-gluon coupling makes possible the bound states of interacting gluons with no quarks inside! These are known as “glueballs”, can be depicted as shown in Fig.2.

Leptons can undergo electromagnetic interactions mediated by massless photons (γ) and weak interactions mediated by massive W^+ , W^- and Z^0 bosons. An essential part of the Standard Model is the Higgs Boson which is responsible for giving fundamental particles their mass through the Higgs mechanism. The Standard Model describes the matter in the universe in terms of the fundamental particles,

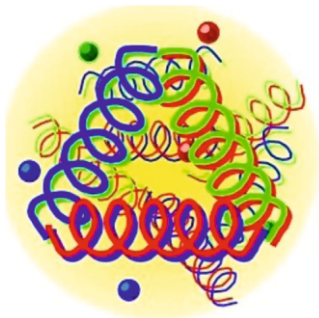


Fig.2

Credit:

<https://www.energy.gov/science/np/articles/searching-signs-glueballs-proton-proton-smashups>

12 fermions and 5 bosons. With their antiparticles these are altogether 61 particles (36 quarks + 8 gluons + 12 leptons + 5 bosons) needed to construct the entire known matter in the universe. All the visible stable matter is formed with protons, neutron and electrons (the constituents of atom). The particles are mainly formed from a bound state of three quarks called a Baryon and quark-antiquark combinations known a Meson.

Out of the three fundamental forces (S, EM, W), the strong interaction with its inherent complexities was the last to be understood in its modern form. QCD occupies a special position in its understanding. QCD being a non-abelian gauge theory, which allows gluons direct gluon self-couplings resulting in three-gluon and four-gluon vertices. It implies that gluons alone, with no quarks required, should be able to bind together into color-singlet composite states.

Such purely gluonic bound states are called glueballs, and more than 50 years have gone into their searches.

The Glueball Puzzle

The theoretical ground for the existence of glueball is subtle. The glueball is one of the most direct and unambiguous predictions of non-abelian gauge dynamics of QCD describing the strong interaction. Because gluons interact among themselves, then a bound state composed entirely of gluons with no quarks around is allowed.

And yet, more than fifty years after the formulation of QCD, no glueball has been unambiguously identified in any experiment. In spite of the most widely accepted theory of Strong interactions, intensively computed and tested, increasingly precise experimentation over five decades, it has remained elusive and unconfirmed.

At the outset, the reasons for the ambiguity can be understood as;

i) QCD is non-perturbative (cannot be understood by within standard perturbation theory) at the energy scales where particles (baryons and mesons) form. The predicted glueball masses and properties can only be derived from numerically intensive lattice QCD calculations rather than analytic perturbation theory.

ii) The quantum numbers carried by a glueball, can also be carried by a quark-antiquark meson! Thus, there is possible mixing with these mesons of the same quantum numbers with the glueballs in near vicinity.

The physically observed cases in experiments are therefore expected to be admixtures of glueball and quark-antiquark configurations. This mixing is the lone greatest stumbling block to a confirmed glueball discovery.

Experimentally then, the search cannot be focussed on searching for a distinct new particle. It is then focussed on searching for a distinct distortion in the theoretically understood and predicted meson spectrum. This can be an extra peak in the spectrum for an extra state or an anomalous production or a decay pattern, or an anomalous mass shift etc.

For obtaining the convincing evidence, rigorous efforts are being made on all theoretical and experimental fronts;

i) Glueball dynamics are inherently non-perturbative. Thus the most reliable predictions for their spectrum come from lattice QCD, in which spacetime is discretized on a hypercubic lattice and the QCD path integral evaluated numerically via Monte Carlo

methods. Lattice calculations predict where glueball states should lie.

ii) Effective models that describe how the glueball states might mix and decay. Many effective models have been developed to provide physical intuition for glueball structure and to make predictions for production and decay properties that lattice calculations alone cannot resolve.

iii) And the experiments being designed to distinguish them unambiguously from ordinary mesons. These decay signatures and the mass predictions obtained from theory and models serve as the experimental search strategies.

Glueball Classification

Glueballs are classified as scalar, vector, and tensor based on their properties such as total angular momentum (J), charge-conjugation (C), parity (P) and other quantum numbers.

Charge conjugation is a discrete symmetry transformation that replaces all physical particles with their corresponding antiparticles.

- Scalar glueball has $J^{PC} = 0^{++}$
- Vector glueball has $J^{PC} = 1^{--}$
- Scalar glueball has $J^{PC} = 2^{++}$

Broad experimental search strategies

The main difficulty to glueball discovery is not merely producing a massive or a rare state, but disentangling it from the huge background of mesons carrying the same quantum numbers.

The two broad experimental strategies have been used to probe this mixing.

i) The first is a spectroscopic search for overly populated regions within a given mass range and set of quantum numbers, where the quark model predicts a fixed number of quark-antiquark states ($3^2=9$). If more states are observed experimentally than allowed, the excess is treated a candidate for a state of non- $q\bar{q}$ origin. This can be potentially a glueball.

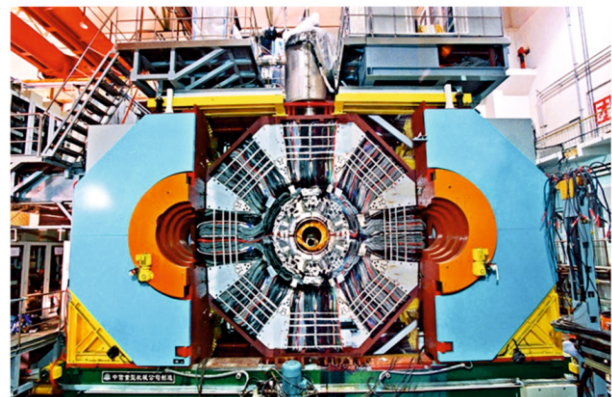
ii) The second is selecting production mechanisms believed to be gluon-rich and quark-suppressed. This is based on the expectation that such channels should preferentially populate glueball states relative to ordinary mesons.

Both strategies have their strengths and weaknesses. Neither of the two alone has proven decisive. In general it becomes necessary to combine together evidence from multiple production channels and decay patterns.

How these signatures have actually been pursued experimentally

Some of the experimental programs around the world are searching for glueballs using complementary mechanisms. The latest results are from the BESIII Collaboration;

i) Radiative Charmonium decay of J/ψ



The Beijing Spectrometer III (BESIII)

Credit: <https://cerncourier.com/a/besiii-and-the-xyz-mystery/>

The events are observed at the Beijing Electron-Positron Collider II (BEPC), a major Chinese particle accelerator running since 2008. The center of mass energy of e^+e^- collisions can go up to 4.6 GeV.

On 2 September 2026, BESIII collaboration of ~700 researchers from 15 countries have published the results. With a study of ~ 10 billion (10^{10}) events of J/ψ meson ($c\bar{c}$ bound state) decay, known as

radiative charmonium decay, into channels:

$$J/\psi \rightarrow \gamma K_S^0 K_S^0 \pi^0$$

$$J/\psi \rightarrow \gamma K_S^0 K_S^0 \pi^0$$

and measured its transition rate to $J/\psi \rightarrow \text{glueball}$. They observed the mass and spin parity of the $X(2370)$ consistent with the predictions of the lightest pseudoscalar glueball.

The findings show complete agreement between their experimental values and predictions. Details are given in [4,5]

ii) Photoproduction at GlueX

Located in experimental Hall D of the Thomas Jefferson National Accelerator Facility (Jefferson Lab) in Newport News, Virgin, US, the primary purpose of the GlueX experiment [6] is the quantitative understanding of quark and gluon dynamics in QCD. The experiment measures the photoproduction, a process in which a ~ 9 GeV linearly polarized real photon beam strikes a fixed target liquid hydrogen target ($\gamma p \rightarrow p + G$). Production of a glueball via this process occurs through specific dynamic channels.

GlueX's multi-billion event photoproduction dataset offers complementary and strictly independent verification. To differentiate glueball-dominated states from ordinary mesons, **GlueX** focuses on exclusive final states to tightly constrain kinematics and backgrounds. While searching for specific exotic candidate particles via photoproduction, the GlueX Collaboration unexpectedly discovered **new exotic hadrons** (particles called XYZ states [7] that don't fit into standard particle frameworks and likely contain significant multi-quark or gluonic structural components. The results are published in Physical Review Letters 123, 072001(2023) [<https://link.aps.org/accepted/10.1103/PhysRevLett.123.072001>] and [<https://doi.org/10.48550/arXiv.2609.03579>]

iii) Exclusive production at COMPASS

The COMPASS (Common Muon and Proton Apparatus for Structure and Spectroscopy [8]), a fixed target experiment at the CERN SPS(Super Proton Synchrotron), studies central exclusive

production to search for hypothetical glueballs in interactions of 190 GeV protons/pions hitting a liquid hydrogen target. A central production process in proton-proton collisions at the COMPASS experiment is a reaction where two interacting protons scatter and emerge intact (or with small momentum transfer), while a new neutral system of particles (M_{center}) is produced at mid-rapidity with large rapidity gaps separating it from the outgoing fast and slow protons. Rapidity describes a particle's angle and momentum relative to a colliding beam's axis and remains invariant under transformations.

COMPASS collected the world's largest dataset of diffractive and central production processes, crucial for disentangling standard mesons from exotic configurations. COMPASS has focused on isolating pure glueball states through this high-statistics partial-wave analysis. But it has not claimed a definitive discovery of a pure glueball.

iv) Central exclusive production at the LHCb

The **LHCb (Large Hadron Collider beauty)** experiment is a particle physics detector collecting data at the LHC (Large Hadron Collider). The LHCb detector [9] covers a forward region characterized by high gluon densities, making it theoretically ideal for studying gluon-rich formations.

However, The LHCb Collaboration has not reported a definitive discovery of a glueball, though its forward kinematic range and high gluon-density capabilities are actively used to search for glueball candidates and exotic states like $\chi_{c1}(3872)$. Thus the experimental evidence for pure glueball remains elusive at the LHC!

v) Central exclusive production at RHIC

Physicists at the STAR [10] experiment at the Relativistic Heavy-ion Collider (RHIC) at Brookhaven National Laboratory, USA have analyzed polarized proton-proton collisions at energies up to 510 GeV.

The spectrum calculated from the RHIC observations revealed only hints of the glueballs' signature, no conclusive evidence! So the search continues.

However, the findings do show that the techniques the search strategy used, works and can be used to examine future RHIC data.

There are some more experiments which have attempted to search for glueballs, without definite positive results. However the search for glueballs will continue with the currently ongoing as well as future experiments especially at the future electron-ion collider (EIC) [11] at the Brookhaven National Laboratory, USA and the PANDA experiment[12] at the Facility for Antiproton and Ion Research (FAIR), DESY, Germany.

Conclusion

The recent discovery of the glueball candidate at the Beijing Electron-Positron Collider II (BEPC), a major Chinese particle accelerator, confirming that the X(2370) particle is dominated by a pseudoscalar glueball component, experimental and theoretical particle physicists are motivated toward identifying remaining scalar, tensor, and dark-sector glueball. The future of glueball searches has entered a definitive era of precision measurements and new search strategies.

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A Simple Demonstration of Temperature-Dependent Reverse Leakage Current in a PN Junction Diode: Experiential Learning

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Abstract: The temperature dependence of semiconductor resistivity is often difficult to demonstrate in undergraduate physics classrooms because the associated currents are very small. This article presents a simple, low-cost, and visually engaging demonstration using a silicon PN junction diode in reverse bias. A high-efficiency LED serves as a sensitive visual indicator of leakage current. While the LED glows under forward bias, it remains off or nearly invisible in reverse bias at room temperature. On gently heating the diode, thermally generated charge carriers increase, leading to higher reverse leakage current and a visible LED response. The experiment effectively connects microscopic semiconductor phenomena with observable classroom demonstrations.

1. Introduction

Demonstration experiments play an important role in physics education by enabling students to connect abstract theoretical concepts with directly observable phenomena. This is particularly valuable in semiconductor physics, where processes such as carrier generation, diffusion, recombination, and depletion-region formation occur at microscopic scales and are not directly visible. A PN junction diode provides a simple platform for exploring these concepts. In forward bias, the diode conducts appreciable current, whereas in reverse bias it strongly restricts current. However, the reverse current is not exactly zero; a small leakage current exists below the breakdown region. This leakage current is strongly temperature dependent. As the temperature of the semiconductor junction increases, thermally generated charge carriers increase, resulting in an enhanced reverse leakage current. Thus, although a reverse-biased diode appears to behave like an open circuit at room temperature, its electrical behaviour changes noticeably upon heating.

The present article demonstrates this otherwise invisible phenomenon using a high-efficiency LED as a visual indicator in a simple circuit. The experiment uses inexpensive, readily available components and provides an effective, engaging, and accessible approach to semiconductor physics.

2. Physics Behind the Demonstration

A PN junction is formed by joining p-type and n-type semiconductors, creating a depletion region and

potential barrier. Forward bias reduces the barrier and allows significant current flow, while reverse bias widens the depletion region and suppresses conduction. However, a small reverse leakage current remains due mainly to thermally generated minority carriers. The reverse current is therefore strongly temperature dependent. A simplified diode equation can be written as;

$$I = I_s [\exp\left(\frac{qV}{\eta kT}\right) - 1] \quad (1)$$

Here, I_s , q , k , and T are the reverse saturation current, the electronic charge, Boltzmann's constant, and the absolute temperature, respectively, and η is the ideality factor. For a diode operating in the normal reverse-bias region (well below breakdown), reverse saturation current I_s is approximately equal to the reverse current/leakage current I_r . From Eq. (1), under normal reverse-bias conditions, the exponential term becomes very small and the current approaches $I \sim -I_s$. The important point for this demonstration is that I_s itself is highly temperature dependent and expressed as;

$$I_s = T^3 \exp\left(\frac{-E_g}{kT}\right) \quad (2)$$

Here, E_g is the energy band gap. Therefore, as T increases, the magnitude of the reverse leakage current increases. This can also be expressed in terms of an effective resistance:

$$R_{\text{eff}} = \frac{V_R}{I_R} \quad (3)$$

For a fixed reverse voltage, higher leakage current means lower effective reverse resistance. Thus, the demonstration shows that reverse resistance is finite and decreases as temperature increases, rather than

indicating that the diode becomes a good conductor.

3. Experimental Objective and Material Required

The primary objective is to demonstrate a simple experiment to show the increase in reverse leakage current of a PN junction diode with temperature. Using only a breadboard, DC source, resistors, PN junction diode (1N4148), wires, and an LED (visual indicator), the setup is accessible for undergraduate and resource-constrained laboratories.

4. Experimental Arrangement

The basic circuit (Figure 1) consists of a DC source/battery, current-limiting resistor, LED, and PN junction diode in series. For the reverse-bias demonstration, the diode is connected with its anode and cathode reversed, ensuring that it is reverse-biased and preventing accidental forward conduction.

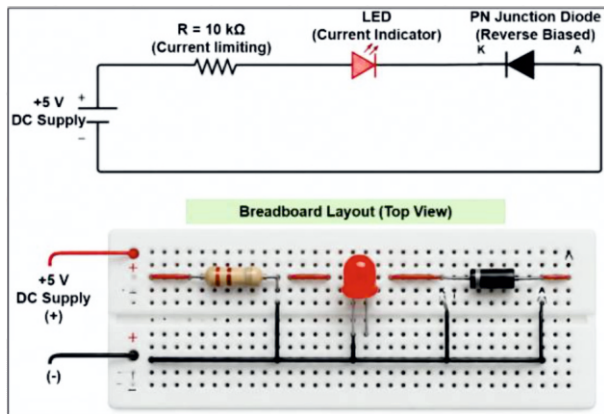


Figure 1. Circuit for demonstrating the increase in reverse leakage current of a PN junction diode with increasing temperature.

5. Experimental Procedure

- i. **Initial observation:** Connect the diode in forward bias and switch on the low-voltage supply; the LED glows. On reversing the diode, the leakage current at room temperature is very small, so the LED remains off.
- ii. **Heating the junction:** Gently heat the body of the diode using a hot-air blower. For a classroom demonstration, care should be taken while heating. The electrical terminals should remain protected.
- iii. **Observe the response:** As the diode temperature increases, observe the LED; it will glow. The expected qualitative observation is:

$$T \uparrow \implies I_R \uparrow \implies R_{\text{eff}} \downarrow$$

- iv. **Cooling:** Allow the diode to cool naturally. The

reverse leakage current should decrease again, demonstrating that the observed change is associated with temperature rather than a permanent change in the circuit.

6. Common Classroom Misconception and Safety Precautions

A common statement made by students is: “A reverse-biased diode has infinite resistance.” This is an idealization. A more accurate statement is: “A reverse-biased PN junction has a very high resistance and a small reverse leakage current before breakdown.”

The experiment challenges the idealized concept of reverse saturation current by showing that leakage current increases noticeably with temperature. It uses low-voltage operation and requires the following precautions:

- i. Use a low-voltage DC source with a current-limiting resistor.
- ii. Avoid excessive heating and remain within the diode's rated temperature.
- iii. Never operate the diode in reverse breakdown.
- iv. Use a high-efficiency LED for better visibility.
- v. Allow the diode to cool to room temperature before repeating measurements.

7. Educational Value and Conclusion

A simple PN junction diode provides an effective demonstration of the temperature dependence of semiconductor conduction. In reverse bias, the leakage current increases with temperature due to thermally generated charge carriers. By incorporating a high-efficiency LED into a low-cost breadboard circuit, this small electrical change can be converted into a visible optical response, connecting semiconductor theory with an observable phenomenon. The experiment requires only a breadboard, low-voltage source, diode, LED, and resistors, making it inexpensive, portable, repeatable, and particularly suitable for undergraduate institutions with limited laboratory resources. It demonstrates that effective physics teaching need not depend on sophisticated equipment and can be extended into a quantitative experiment by measuring temperature, voltage, and reverse leakage current.

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Online Seminar on Hands-On Demonstration of Pscale Software

On 2 September 2026, the Indian Association of Physics Teachers Regional Council 15 (IAPT RC15) organised an online meeting-cum-seminar on the hands-on demonstration of Pscale software, bringing together students, school teachers, college and university teachers, and senior physics academicians, including Dr Surajit Chakrabarti, Dr Debapriyo Syam, Dr Saswati Dasgupta, Dr Achintya Pal, and many others. The session was conducted by Mrinal Kanti Pal, an M.Sc. Physics graduate qualified in CSIR-NET JRF and GATE and the developer of Pscale.in. The seminar began with an introduction to the fundamentals of digital imaging, including converting light into pixel-based image data and the role of EXIF metadata in documenting camera and image parameters for reproducible measurements. Pal then demonstrated the software's calibration procedures, including 2D reference-plane calibration for parallel images and 3D plane calibration with perspective correction for angled photographs. The demonstration also covered point tracking, colour-code identification, linear and angular measurements, area and perimeter determination, automated boundary detection, colour-spectrum analysis, image-clarity and contrast controls, and negative-colour filters. Projects can be saved in the Pscale format for subsequent editing and analysis.

The practical utility of the software was illustrated through a water-droplet experiment, in which sequential photographs of a falling droplet were calibrated using graph paper and analysed to determine its dimensions at different stages. The Pscale-Compare feature was also demonstrated for analysing multiple images obtained under identical experimental conditions, applying a common calibration, generating graphs, and exporting measurement data in CSV or Excel format. An interactive discussion followed, with teachers, students, and senior academicians raising questions concerning measurement accuracy and possible laboratory applications. Pal explained that Pscale is designed as a responsive, cross-platform web application that can continue to function offline after loading. The seminar highlighted the potential of such freely accessible digital tools to support quantitative, image-based experimentation in physics education and laboratory work. Participants also offered suggestions and feedback for further developing the Pscale ecosystem.

Pradipta Panchadhyayee
Shinjinee Das Gupta

IAPT–APhO Cell Organises One-Day Experimental Physics Workshop

The IAPT–APhO Cell successfully organised a one-day Experimental Physics Workshop at Dhanauri P.G. College, Haridwar, on 16 September 2026. The workshop was aimed at providing school students with hands-on exposure to experimental physics and developing their understanding of concepts relevant to Physics Olympiad-level experiments. A total of 110 students participated in the workshop, including 70 students from National Inter College and 40 students from Santram Public School, Teliwala, Haridwar. During the workshop, the students actively performed

a variety of physics experiments under the guidance of the resource persons. The hands-on activities enabled them to explore important physical concepts through experimentation, observation, measurement, data analysis, and interpretation.

The workshop particularly focused on developing experimental skills, scientific thinking, problem-solving abilities, and a deeper conceptual understanding of physics, in line with the requirements of Physics Olympiad-level experimentation. The workshop was conducted by Dr. Vijay Kumar,

Coordinator, IAPT–APhO Cell, along with faculty members of the College. Dhanauri P.G. College, Haridwar, who served as the resource persons. The programme provided an enriching platform for young students to learn physics beyond the conventional classroom environment and encouraged them to



develop interest in experimental physics and scientific inquiry. The enthusiastic participation of the students and their active engagement with the experiments made the workshop a meaningful and successful academic initiative.



Vijay Kumar
Coordinator, IAPT-APhO Cell

Report (RC-12A)

Hands-On Physics Session

1. Introduction

A hands-on Physics session was conducted for 40 PUC I and II students of MES MPL Sastry College, Bengaluru on 15th September, 2026. The session, convened by Ms Sumana S Rao, aimed to spark curiosity and deepen conceptual understanding through experiential learning.

Students began with a short pre-test on centre of mass, motion, torque, and energy transformation. The activities that followed were designed to move them from observation to questioning, from construction to experimentation, and finally to explanation. The low-cost Somersault Monkey model served as the central tool to explore core mechanics concepts in an engaging and inquiry-driven manner.

2. Objectives

The session sought to:

- Build intuitive understanding of **centre of gravity/centre of mass**.
- Help students identify and differentiate **types of motion**.
- Demonstrate **torque** and its role in rotational motion.
- Explore the mechanism behind

flipping/somersaulting motion.

- Connect **energy transformation** to observable movement.
- Investigate how **capsule length** and **internal mass** affect motion.
- Strengthen skills in **observation, prediction, measurement, and reasoning**.
- Foster curiosity by linking theoretical Physics to real-world phenomena.

3. Methodology

The session adopted an inquiry-based, activity-oriented approach. Instead of beginning with definitions, students were encouraged to:

- Observe a phenomenon
- Predict outcomes
- Construct models
- Experiment with variables
- Interpret results using Physics concepts

This structure nurtured curiosity and empowered students to discover principles through hands-on exploration.

4. Activities and Student Impact

4.1 Oscillating Toy – First Spark of Curiosity

A simple oscillating toy was demonstrated to initiate discussion. Students immediately began asking:

- Why does it not fall?
- Why does it return to its original position?

Constructing their own toy using a balloon, marble, and rubber band heightened engagement. Students experienced how **mass distribution affects stability**, and this simple activity set the tone for deeper exploration.

4.2 Somersault Monkey – Curiosity Peaks

The Somersault Monkey model captured students' attention instantly. They debated whether it would slide, roll, rotate, or flip on an incline. This prediction-based engagement created a natural entry point to explore **centre of mass, motion, and torque**.

4.3 Understanding Centre of Gravity

By comparing models with different mass distributions, students observed how shifting the internal marble changed the behaviour of the system. This concrete experience helped them internalize an abstract concept.

4.4 Model Construction – Ownership of Learning

Students built their own Somersault Monkey models in groups. The excitement of seeing their models move, rotate, or flip reinforced the connection between **design, mass distribution, and motion**.

4.5 Inclined Plane & Average Speed – Curiosity Meets Measurement

Students varied the height of the inclined plane and measured time for a fixed distance. They calculated average speed using:

Average Speed = Total Distance / Total Time

This activity strengthened their skills in **data collection, comparison, and interpretation**, while revealing how **gravitational potential energy** influences motion.

4.6 Types of Motion – Conceptual Clarity

Students identified oscillatory, translational, rotational, and flipping motions from their own observations. This self-discovery approach made the concepts memorable.

4.7 Torque & Flipping Motion – Connecting

Theory to Action

Students observed how the internal mass and point of contact created a turning effect. This helped them understand torque not as a formula, but as a *felt* and *seen* phenomenon.

4.8 Energy Transformation – Visualizing Physics

Students clearly saw how:

Gravitational Potential Energy → Translational & Rotational Kinetic Energy

The discussion on friction and energy loss grounded the concept in real-world behaviour.

4.9 Effect of Capsule Length & Internal Mass – Experimental Curiosity

Students experimented with capsules of different lengths and marbles of different masses (26 g and 67 g). They observed changes in:

- Speed
- Stability
- Rotational behaviour
- Somersaulting tendency

This strengthened their understanding of **variables in an experiment** and encouraged scientific thinking.

5. Key Concepts Reinforced

- Centre of gravity / centre of mass
- Mass vs weight
- Stability
- Oscillatory, translational, rotational, flipping motion
- Inclined plane
- Gravity
- Torque
- Potential & kinetic energy
- Energy transformation
- Friction
- Average speed
- Effect of capsule length
- Effect of internal mass

6. Student Engagement and Curiosity Development

The session witnessed exceptional student involvement. Students

- Asked spontaneous questions
- Made predictions with confidence
- Built models enthusiastically
- Measured and recorded data carefully
- Compared outcomes thoughtfully
- Explained observations using Physics concept.

The activities transformed passive learners into active explorers. Curiosity was evident in the way students repeatedly modified their models, tested new variables, and discussed reasons behind each change in motion.

7. Conclusion

The hands-on Physics session successfully ignited curiosity and strengthened conceptual understanding among 40 PUC students. Through simple, low-cost materials and inquiry-driven activities, students



connected theoretical Physics with observable phenomena.

The progression from oscillating toys to Somersault Monkey experiments enabled students to internalize concepts such as centre of mass, torque, energy transformation, and types of motion. Their active participation demonstrated genuine interest and growing confidence in scientific reasoning.

A post-test was conducted to assess conceptual gains. The results will be shared with organisers and submitted to Physics education journals.

8. Resource Persons

S. K. Ayeesha Ignator – Teacher Training Program
Agastya International Foundation

S. Purushotham Executive Agastya International Foundation.



Sarmistha Sahu

Awareness Program on First Step Towards International Science Olympiads 2026-27

Report (SRC-08C)

To raise awareness about the various International Science Olympiad Examinations 2026-27 (NSE's) conducted at the school and junior college level by the Indian Association of Physics Teachers (IAPT), lectures were organized at four different high schools and junior colleges in Dhule, Maharashtra. Dr. R. M. Shewale, an EC of the IAPT Regional Council-08, served as the expert speaker. The first lecture took place on September 8, 2026, at JaiHind High School and Junior College, Deopur, Dhule, with 110 teachers and students in attendance.





The second lecture was held on September 11, 2026, at the Shri Shivaji Vidya Prasarak Sanstha's Late Karmveer Dr P. R. Ghogrey Junior Science College Dhule, attended by around 100 teachers and students.

The third lecture was organized on September 15, 2026, at Jai Hind English Medium School, Deopur, Dhule, drawing an audience of about 160 students and teachers. Concluding the series, the final fourth lecture was held on September 16, 2026, at PM SHRI Kendriya Vidyalaya, Deopur, Dhule, with 120 students and teachers present. Financial support for these events was provided by the IAPT Sub-Regional Council 08-C Pune. Additionally, invaluable guidance and cooperation were received from the headmasters, principals, teachers, and non-teaching staff of all the participating schools and junior colleges. The lectures received an enthusiastic response from the students and teachers, which helped facilitate registrations for the Olympiad examinations to be conducted in this year.

R M Shewale
Coordinator

Report (RC-04)

National Space Day Quiz- 2026

Aiming at a small contribution to the NEP-2020's vision of formative, continuous, and competency-based assessments, The Department of Physics, Bareilly College, Bareilly, in association with RC-04, organized a “**National Space Day Quiz**” on 25th August 2026 to commemorate National Space Day and to highlight India's remarkable achievements in space science and technology. The quiz was enthusiastically participated by 25 postgraduate students. It comprised 25 multiple-choice questions, with a time limit of 25 minutes. The questions focused mainly on India's space research achievements, the progress of the national space programme, and the contributions of eminent Indian space scientists and

organizations involved in space research.

The quiz aimed to acquaint students with India's inspiring journey in space research, scientific accomplishments, and the contributions of scientists to the country's space programme, while fostering interest in space science and a scientific outlook among students. The programme was conducted in the presence of Prof. Ritu Agarwal, Head, Department of Physics; Prof V.P. Singh; Prof Sundar Singh, representative on the IAPT Executive Council. The event provided the students an opportunity to take pride in India's space achievements and to appreciate the future possibilities of space science and research.



Glimpses of the National Space Day Quiz conducted at Bareilly College

Online Workshop

Intellectual Property Rights: Importance of Patent in Transforming Ideas into Innovation

Keeping in mind the vision of NEP-2020 to integrate the intellectual property rights into the academic framework to foster a vibrant culture of creativity, research, and innovation in India, The Bareilly College, Bareilly, in association with RC-04, organized an online workshop on “Intellectual Property Rights: Importance of Patent in Transforming Ideas into Innovation” on 31 August 2026 through the Zoom platform

The expert speaker for the workshop was Dr. Kumar Kartikey Yadav, Assistant Controller of Patents and Designs, Government of India. He provided valuable insights into the fundamentals of Intellectual Property Rights (IPR), the importance of patents in protecting innovative ideas, the patent filing process, and the role of intellectual property in promoting research, entrepreneurship, and technological development.

Prof. Sundar Singh, Department of Physics, Bareilly College, Bareilly acted as convener of the workshop. Shri Devmurti, Secretary Managing Committee, Bareilly College and Prof. O. P. Rai, Principal, Bareilly College provided the Patronage and access to all kinds of resources needed for its successful conduction. The programme witnessed enthusiastic

participation from more than 150 participants, including faculty members, research scholars, students, and academicians from different institutions across the country. IAPT General Secretary, Prof. Rekha Ghorpade also blessed the organizers by her active and gracious presence during the workshop. The participants actively interacted with the expert and gained awareness about converting innovative ideas into protected intellectual property. The Organizing Secretary, Dr Arpit Yadav Asst. Professor, Dept. of Law introduced the speaker and Prof. Jaspal Singh, Co-organizing secretary of the workshop, headed the technical team for the conduction of workshop.

The programme highlighted the significance of creating an innovation-friendly environment in higher education institutions and encouraged young researchers to understand patent procedures and commercialization opportunities. The session concluded with a vote of thanks proposed by Prof. Sundar Singh to the distinguished speaker, IAPT members, and all participants for making the workshop a successful academic initiative.

Sundar Singh

Report (RC-12A)

An Industrial Visit to ETA Technology, Peenya, Bengaluru

Purpose and background

The IAPT has long held that physics is learned most securely when the student can see a principle at work outside the laboratory notebook. Acting on that conviction, RC-12A organized, for the first time, a structured industrial visit for undergraduate physics students to a working manufacturing campus in Bengaluru on 19th Sept. 2026

Thirteen B.Sc. students drawn from Maharani Cluster University and B.M.S. College for Women, together with two accompanying teachers Dr Wajeeha S. and Sri Pramod Kumar K spent a day at ETA Technology Pvt. Ltd. in Peenya, one of the city's principal

industrial estates. The visit was conceived not as a ceremonial walk-through but as a guided reading of machines: every major process the students were shown was traced back to a topic they already meet in the B.Sc. syllabus.

The contact with the company was made possible by Dr Arvind Kulkarni, whose introduction opened the door. The Chairperson of the Department of Physics at Maharani Cluster University, Dr Karnam Madhavi, the Registrar of Maharani Cluster University, and the Principal of B.M.S. College for Women kindly permitted their students and faculty to take part.

The host industry

ETA Technology was founded in 1991 at Peenya by Sri P. S. Nair and has grown into a specialized builder of machines for solid-phase joining. From a single campus in Bengaluru the firm designs and manufactures rotary friction welding machines, friction-stir welding systems, linear friction welders, electrical up setters (metal-gathering machines), special-purpose machines for the engine-valve industry, and a range of test rigs. More than 1,300 machines have been delivered to manufacturers in over twenty countries, serving the automotive, aerospace, oil-and-gas, railway and energy sectors.

What makes the campus particularly useful to a physics teacher is that the processes themselves are transparent applications of mechanics, heat, electricity and fluids. Friction welding joins two workpieces without a molten pool: heat is generated by rubbing, the interface becomes plastic, and a forge force consolidates the joint. Electrical upsetting heats a bar locally by a heavy current and then gathers the softened metal. Hydraulic systems apply the large axial loads. Rotating spindles store and deliver angular momentum. The shop floor is, in that sense, an extended undergraduate laboratory

Physics on the manufacturing floor

The technical team of ETA Technology walked the group through the principal lines and paused at each station to name the physics. The following correspondences were made explicit.

Physics principle	Where the students saw it at work
Moment of inertia and rotational dynamics	Spindle drives of rotary friction welders accelerate heavy workpieces to a prescribed angular velocity. The torque required, the stored rotational energy $\frac{1}{2} I\omega^2$, and the braking of the spindle are direct applications of rigid-body rotation.
Heat generated by friction	At the weld interface two surfaces rub under axial load. Mechanical work is converted into heat, raising the interface to the hot-working range without melting the parent metal — a living illustration of the first law and of dissipative forces.
Pascal's law and hydraulics	Forge force is applied through hydraulic cylinders. Pressure transmitted uniformly through the confined fluid (Pascal's principle) is converted into the large axial load that consolidates the plasticized joint.
Joule heating (I^2R)	Electrical upsetting (metal-gathering) machines heat a localized length of bar by passing a heavy current through it. Resistive heating softens the metal so that it can be gathered into a precise preform — the same I^2R effect taught in current electricity.
Sliding versus rolling friction	Demonstration models contrasted kinetic friction in sliding contact with the much smaller resistance of rolling. The distinction is essential to understanding why a rotating workpiece generates heat rapidly at a face, while bearings are designed to roll.
Conditions of equilibrium	Static models of concurrent and parallel forces, and of bodies in translational and rotational equilibrium, were used to analyse clamps, slides and load-bearing frames on the shop floor.
Bernoulli's principle	A flow model was shown to recall how speed and pressure are related in a fluid stream — a reminder that several auxiliary systems on industrial machines (coolant, hydraulics, pneumatics) rest on elementary fluid mechanics.

The five stages of rotary friction welding — contact, friction heating, plasticization, forge, and the finished joint, were explained as a single continuous argument from mechanics into thermal physics and materials. Because the parent metal never melts, the joint is free of the porosity and solidification defects of fusion welds; students could see why a process that looks, at first glance, like “just rubbing two rods together” is in fact a carefully instrumented application of energy conversion and plastic flow.

Demonstration models

In addition to the production machines, several purpose-built physics models were displayed and discussed. Models of equilibrium of forces, of the distinction between sliding and rolling friction, and of Bernoulli's principle allowed the accompanying teachers to reconnect each industrial observation with the language of the lecture room. The effect was reciprocal: the models made the machines intelligible, and the machines made the models feel necessary rather than ornamental.

The Foucault pendulum

The visit closed on a note that the students will not soon forget. A Foucault pendulum of length 11.3 m, understood to be among the first of its kind in Bengaluru and then nearing completion on the campus, was shown in oscillation. Léon Foucault's 1851 experiment remains the most direct classroom proof that the Earth rotates. The plane of swing appears to drift because the floor turns beneath an inertial oscillation; the angular speed of that apparent precession is $\Omega = \Omega_E \sin \phi$ where Ω_E is the sidereal rotation rate of the Earth (approximately 15.04° per hour) and ϕ is the local latitude. Bengaluru lies near 12.97° N, so $\Omega \approx 15.04^\circ h^{-1} \times \sin(12.97^\circ) \approx 3.38^\circ \text{ per hour}$.

At that rate the plane of oscillation completes one full circle in about 106.5 hours — four days and eleven hours, observer. The simple period of the pendulum, $T = 2\pi \sqrt{L/g}$, is about 6.7 s for $L = 11.3$ m. Watching a heavy bob keep that rhythm while its plane of swing very slowly turned was, for many in the group, the moment at which a textbook diagram became a physical fact.

Response of the students

The students were visibly engaged. Several remarked that principles they had so far met only as derivations, moment of inertia, frictional heating, Pascal's law, Joule heating were here the reasons a machine either worked or failed. The Foucault pendulum in particular held their attention. For an undergraduate cohort that will shortly face examinations in mechanics, thermal physics and electricity, a single afternoon in which all three spoke at once is an uncommon gift.

Acknowledgements

RC-12A places on record its appreciation of the following:

- Sri P. S. Nair, Chairman, ETA Technology Pvt. Ltd., and his technical team, who set aside time to take the students through the plant and to explain the processes with patience and clarity;
- Dr Arvind Kulkarni, who first made the introduction to ETA Technology and thereby made the visit possible;
- Dr Karnam Madhavi, Chairperson, Department of Physics, Maharani Cluster University; the Registrar of Maharani Cluster University; and the Principal, B.M.S. College for Women, Bengaluru, for permitting their students and teachers to join the programme;
- Dr Wajeeha S. and Sri Pramod Kumar K., who accompanied the thirteen students and helped to keep the conversation between the shop floor and the syllabus alive throughout the day.

The Council hopes that this first visit will become a regular feature of its work with undergraduate departments in Bengaluru, and that other manufacturing houses will similarly open their floors to physics students. Industry, seen through the eyes of a teacher, is not a departure from physics; it is physics continued by other means. (The link to the website of ETA Technologies Source: ETA Technology <https://share.google/2qdlOVSWEkb4udsLl>)

A google form was shared with the students to collect feedback to help us improve this activity further. A few responses are shown below along with some Photographs.



Students listening with rapt attention



The Foucault Pendulum



Trying out an Industrial Vernier Calipers LC 0.02mm

- ✓ The industrial visit was very exciting and we are grateful to have that opportunity. Thank one and all
- ✓ Foucault pendulum oscillating one was very fascinating. We got to know about the different types of welding and the basic Physics principles applied in working of machineries. Than only reading theory, seeing it into work brings more interesting in a subject so then and there visits something like this can bring motivation in students.
- ✓ The advent of technology and the core physics around which it is built
- ✓ The visit for eta technology pvt Ltd was wonderful experience,. The staff and the CEO-Nair Sir himself made sure the students get to know the

- principle and application of many physics concept.
- ✓ Good
- ✓ I was really excited about this visit, and it did not disappoint in any way. This was a first-time experience for me, and I was only aware of the physics behind it, seeing it's real life application was really interesting. And learning about how basic principles are usefull was also interesting and exciting in a way. Overall, I had a very great experience and I am glad to have had a good opportunity like this.
- ✓ Pendulum one was more fascinating and And machines in industries were new experience too
- ✓ It was very interesting and very useful visit.

K M Raghavendran

National Space day celebration

RC-21, in association with the Goa Science Centre, Goa celebrated National Space Day on 23rd August 2026 to commemorate the successful landing of Chandrayaan-3 on the Moon in 2023. The day celebrates India's achievements in space science and technology and with the aim to inspire students and young people to develop an interest in space exploration and ongoing journey in space exploration.

As part of the celebrations, the Goa Science Centre hosted a special exhibition titled **“From Ancient Skies to Modern Horizons.”** The exhibition highlighted India's significant achievements in space science and technology, showcasing major milestones of ISRO's space missions, advancements in satellite technology, and landmark missions such as Chandrayaan and Mangalyaan. The exhibition also featured India's ambitious Gaganyaan programme. A model of the Vikram Lander and Pragyan Rover provided visitors with an opportunity to gain a closer understanding of India's lunar exploration efforts.

A Space Exploration Quiz was also organised for school students as part of the celebrations. Mr. Amey Shirodkar of IAPT served as the Quiz Master. The

competition commenced with a written elimination round, in which 68 students from schools across Goa participated. Based on their performance in the preliminary round, the top four teams advanced to the final round. The Bhatikar Model High School emerged as the winner of the competition. Shree Ganesh High School secured the runner-up position, while The Rosary School and Vivekanand Dnyan Mandir High School jointly secured the third position.

A special presentation on the Indian Space Programme was also organised for the students. The presentation traced the evolution of India's space programme from its early beginnings to the country's recent successful missions. It highlighted the significant contributions and achievements of ISRO while also introducing students to upcoming missions and India's future ambitions in space exploration.

The programme concluded with a prize distribution ceremony attended by Shri Abhimanyu Bhelave, Centre Head, Goa Science Centre; Dr. Satish Keluskar, President, Goa Regional Council; and Dr. Reshma Raut Dessai. The winning teams were felicitated and presented with prizes by the dignitaries..



Prize Winners and Organizers at the National Space Day Celebration

Reshma Raut Dessai

National Competition In Computational Physics - 2026
(An Online Physics Simulations & Software-Based Physics Experiments Competition)
(NCICP 2026)

The result of the National Competition, NCICP 2026, was published on September 08, 2026.

The National Competition in Computational Physics (NCICP-2026) aims to:

Promote computational thinking, simulation-based analysis, and AI-driven problem solving in physics.

Encourage students and researchers to develop innovative solutions for real-world physics challenges.

Foster deeper engagement with computational physics through hands-on simulations and software-based experiments.

Enhance modern scientific exploration by leveraging technology-driven methodologies. This competition serves as a platform for participants to explore cutting-edge computational techniques, drive innovation, and contribute to the future of physics research and education.

Participant Categories, Subthemes and Scope

NCICP-2026 will have three (03) categories:

1. Undergraduate (UG)
2. Postgraduate (PG) & Research Scholars
3. Educators

Category 1: Undergraduate (UG) – Foundations of Computational Physics

- a) Oscillatory systems,
- b) Orbital dynamics (planets/satellites),
- c) Interactions of matter and electromagnetic radiation,

- d) Time evolution of waves (classical and quantum),
- e) Applications of random numbers in physics

Category 2: Postgraduate (PG) & Researchers – Advanced Computational Physics

- a) Nonlinear dynamics
- b) Simulation of molecular dynamics
- c) Statistical mechanics - the Monte Carlo algorithm
- d) Quantum Mechanics: Eigenvalue determination and transition probability
- e) Execution/control and data acquisition for a physics experiment

Category 3: Educators – Computational Physics in Teaching & Learning

- a) Open-source computational lesson plan challenges
- b) Virtual lab and simulation development in home learning
- c) Computational physics for interdisciplinary home projects
- d) Data driven physics education for real world problems
- e) Use of Video, audio and image analysis in experiments for physics teaching

Finally, 13 teams in UG Student-category, 4 in PG Student-category and 2 in Teacher-category participated in the concluding part of the competition. The final result is given below:

Result of NCICP 2026

Category	Single / Group Leader	Institution	Total Marks obtained (450)	Rank for Award
1 (UG)	Bharath Bharadwaj V	Global Academy of Technology, Bengaluru	339	First
1 (UG)	Aritra Kanrar	Asutosh College, Kolkata	335	Second
1 (UG)	Nitigya Nimesh	St. Xavier's College, Ranchi	312	Joint-Third
1 (UG)	Sucheta Pattanayak	Presidency University, Kolkata	312	Joint-Third
2 (PG)	Aryan Shrivastava	National Institute of Science Education and Research (NISER), Bhubaneswar	340	First
2 (PG)	Mrinal Kanti Pal	Prabhat Kumar College, Contai	312	Second

We extend our heartfelt thanks and gratitude to the esteemed Judges —Professor S. Minhaz Hossain, Department of Physics, IEST Shibpur; Dr. Jagdish Kumar, Department of Computational Sciences, Central University of Punjab; and Dr. Mahesh Shetti, Wilson College, Mumbai for their expertise, assessment, and thoughtful judgment. Their wholehearted participation has been invaluable in ensuring that the competition was conducted with the highest standards of academic integrity and excellence. Last but not least, I take this opportunity to convey my deepest gratitude to the members of the Organising Committee (Dr. Shinjinee Das Gupta, Sanjoy Kumar Pal, and Soumen Sarkar, serving as the Secretary and members of the executive body of RC-15, for their unwavering support, wholehearted cooperation, and steadfast commitment, which have been instrumental in the successful organisation of the National Competition on Computational Physics (NCICP-2026).

Beyond the judgment process, our respected experts have generously offered their constructive feedback. Their observations not only acknowledge the strengths of the participating teams but also highlight areas for further growth and innovation. We are pleased to present their feedback below, which will serve as a valuable guide for future initiatives. The experts' feedback are as follows:

Prof. S. Minhaz Hossain: It has been rewarding to be involved in this nationwide Computational Physics competition over the past several years. While participation is growing, the Teacher category was disappointing this year, and we need greater effort, particularly to increase participation in the PG and RS categories. We received several interesting entries combining Physics with computational techniques, simulations, and interfacing. One teacher attempted to develop a computational approach for teaching reflection of light; however, the Teacher-category projects generally did not articulate their aims and objectives adequately.

Encouragingly, a sizable number of UG and PG participants gave due importance to Physics concepts alongside coding, technical implementation, and presentation. In my view, this balance deserves greater

recognition. Computational sophistication should complement, rather than overshadow, meaningful Physics exploration. I think collective brainstorming among evaluators may help develop more standardized criteria that appropriately assess conceptual understanding, innovation, computational implementation, and presentation.

Prof. Jagdish Kumar : The NCICP-2026 demonstrates commendable effort in integrating computational methods with physics concepts. The competition brings together the young minds on a platform where they can explore their creativity and bring ideas from the academic world to evolving applications of computational physics. Competitions such as the National Competition in Computational Physics (NCICP 2026) play a pivotal role in shaping the future of science education and research. They serve as a bridge between theoretical knowledge and practical application, encouraging students, researchers, and educators to explore physics through modern computational tools. The competition like NCICP offers a platform for participants to promote innovation through creative solutions to complex physics problems using simulations, AI, and advanced algorithms. This competition also fosters critical skills for problem solving, coding, data analysis, and visualization that are essential in both academia and industry. By integrating physics with computer science, mathematics, and engineering, participants gain a holistic perspective on scientific inquiry. Open-source tools and reproducible methods make computational physics more inclusive, enabling collaboration across institutions and regions. With physics research increasingly reliant on high-performance computing and machine learning, such competitions prepare the next generation for cutting-edge challenges. It was a privilege to be part of the evaluation team of NCICP-2026.

Dr Mahesh Shetti: NCICP is not just a talent-exploring competition in computation; it also encourages young students to think about various problems and how computational techniques can solve them. As a judge, I found it a great learning experience, especially because it let me compare the problems tackled by students from premier institutions

across the country. I am very thankful to Prof. Ahluwalia and Dr. Panchadhyayee for giving me this opportunity. It is an enriching experience working with Prof Jagdish Kumar and Prof Sayed Minhaz Hussain, especially their comments and questions to participants. Students had selected problems from various areas: some included developing pedagogical tools to learn textbook concepts at UG/PG levels, some were involved in problem solving in areas of physics that are used for fantasies and science fiction, while some were addressing real-life cases to go for extra precision or calculating some approximations to the next order.

On the other hand, the response from the Teacher category did not meet our expectations. Their thinking was good, but the projects presented were not properly aligned with the themes. Many were probably burdened with non-academic responsibilities, or some were guiding their students to participate instead of

entering competitions. But this may be overly optimistic. There is a strong possibility that the larger teaching community is simply reluctant. One suggestion to encourage teachers is to keep a well-drafted theme. Another suggestion is to hold regional-level workshops on specific themes. It is good that most participants mentioned which AI tools they used, either for writing reports or for coding purposes. With this in mind, we may decide on specific conditions while drafting rules for the next competition.

The NCICP-2026 celebrated innovation, collaboration, and creativity in Physics education and research, enriched by expert insights and enthusiastic participation. We look forward to inspiring the next generation of Physics innovators.

Pradipta Panchadhyayee
Coordinator,
NCICP 2026

Report (RC-12A)

Demonstration of Experiments in Chemistry and Physics

Under the aegis of RC- 12A, a lecture-cum-demonstration of experiments drawn from the CBSE curricula for Grades VIII, IX and X was conducted at SJR Public School, Rajajinagar, Bengaluru, on 9 September 2026. The sessions in Chemistry and Physics were conducted by Prof.J.Basavaraj and Prof. K. M. Raghavendran, respectively.

The Chemistry session covered a wide range of topics, including valency, the burning of magnesium, the liberation of hydrogen, acid–base reactions, neutralization and reversible reactions among others. The demonstrations were confirmatory in nature, highly interactive, and the students participated with great interest and enthusiasm.

The Physics session included demonstrations of Bernoulli's principle, electromagnetic induction, Fleming's left-hand rule, Ampère's swimming rule, the working of a DC motor, along with experiment on static electricity. The highlight of the session was the Tesla coil demonstration, in which a CFL glowed without any direct wired connection to the coil. Both the demonstrators followed the Predict, Demonstrate

and Explain format

About 150 students from Grades VIII, IX and X attended the programme, together with the school's science teachers. The students interacted enthusiastically with the resource persons and raised thoughtful and interesting questions, making the programme a highly satisfying experience for everyone involved.

RC 12A places on record its sincere gratitude to the Curator of Vishveswaraiah Industrial and technical Museum Bengaluru Smt Jyoti Mehra and Sri Biswal Science Education officer for lending the experimental kits for Physics demonstration. We also place on record, gratitude to Principal, Smt. Poornima N Kagli, for organizing the programme and extending the necessary support for its successful conduct. RC- 12A also expresses its deep appreciation to Dr Arvind Kulkarni, whose initiative, motivation and encouragement were instrumental in making this programme possible.



Prof K.M. Raghavendran



Prof J. Basavaraj

K. M. Raghavendran

Report (Innovation Hub)

Installation and Operationalization of Innovation Hub

An Innovation Hub in Physics has been established in the Department of Physics with the objective of creating a stimulating environment for curiosity, creativity, scientific thinking, experimentation, and problem-solving. An interactive programme on “Installation of Innovation Hub” was jointly organized by the Department of Physics, S.S.E.S. Amravati's Science College, Nagpur, and RC-06 on 11th August 2026.

The programme was graced by Prof Y K Vijay, Director, Centre for Innovation in Science Teaching (CIST) and Director, Centre for Non-conventional Energy Resources, University of Rajasthan, Jaipur. Approximately 43 experimental setups were installed and demonstrated to the faculty members of the Department.

The occasion was further enriched by the presence of several distinguished former faculty members and eminent personalities associated with the Department of

Physics, who have contributed significantly to its growth and academic legacy. Prof. M. T. Dharmadhikari, Dr. D. K. Burghate (Former Principal), Prof. D. W. Khade (Former Professor & Head), Prof. S. B. Kondawar (Former Pro-Vice-Chancellor, RTM Nagpur University), Prof. S. B. Khasare, and Prof. S. S. Darokar visited the Innovation Hub and interacted with Prof. Y. K. Vijay and the faculty members. Their presence and interaction provided valuable encouragement to the Department and symbolically connected the academic legacy of the Department with its emerging culture of innovation. On 12 August 2026, Prof. Y. K. Vijay conducted an interactive session with the students of the Department of Physics. He discussed various experimental ideas, innovative approaches, and possibilities for developing physics-based projects.



Y. K. Vijay



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Adapting to AI: The Fierce Urgency of the Moment

In this article, we briefly review the report of MIT's Ad Hoc Committee on 'AI Use in Teaching, Learning, and Research Training' published recently and then share some related reflections.

<https://aiandeducation.mit.edu/report/>

The report captures the 'complexity, urgency and nuance of the challenges and opportunities that AI presents for MIT', while providing a framework for the Institute community to come together and respond collectively. It recognizes the extraordinary possibilities AI opens up for students—helping them work with greater capability, engage with ideas in new ways, and access forms of intellectual support that were previously difficult to obtain. Yet the same technology can unsettle some of the very conditions through which meaningful education takes place: the struggle through which understanding is built, the relationships through which teaching becomes possible, and the shared experiences that give institutional life its character. The report therefore approaches AI neither as a technology to be simply embraced nor as a threat to be resisted, but as a profound transformation that requires thoughtful institutional and educational responses. The report can also serve as a stimulus for a similar process of collective, focused reflection in our own context, while taking full account of the realities and constraints of Indian education. Such reflection is imperative precisely because the challenge before us is unprecedented.

Technology has always been a source of disruption in education, but the nature and scale of disruption have varied considerably. The advent of the calculator, for instance, provoked an important pedagogical question: if machines can perform multiplication and other arithmetic operations effortlessly, should students still be required to develop the ability to perform them mentally? Such disruptions, however, were largely bounded, compartmentalised and centered on particular cognitive skills. They could therefore be understood, at least to a considerable extent, through the idea of **cognitive offloading**—the delegation of specific cognitive tasks to external technological artefacts. Based on the offloading lens, it was assumed that the use of calculators would prevent students from learning arithmetic operations, and this assumption led to calculators not being allowed in early school classrooms.

Artificial Intelligence presents a fundamentally different challenge. Unlike the calculator, AI is not a modular technology that replaces or augments a discrete set of skills; it is a **general-purpose cognitive technology**, capable of operating across domains that are mediated by language, mathematics, reasoning and representation. In this sense, the familiar framework of cognitive offloading is inadequate to capture the educational predicament created by AI. A more illuminating analogy may be the transformation brought about by mechanisation, particularly the automobile. The arrival of automobiles did not make walking obsolete; rather, it transformed the environment in which walking took place, requiring human beings to adapt their mobility, habits and social arrangements to a new ecosystem in which automobiles played a crucial role. Also, the response to the automobile was not a choice between walking and driving; it was an acceptance of a significant physical infrastructural change and adaptation to it.

Similarly, the educational response to AI – which represents a fundamental change in the infrastructure of cognition – cannot simply be a matter of deciding which human cognitive tasks should be retained and which should be delegated to machines. AI presents a **deeper challenge – the design of a new cognitive and educational ecosystem in which human intelligence and artificial intelligence coexist, interact and complement one another—and to rethink what, how, and why we learn within that ecosystem.** The daunting task before us, therefore, may not be to preserve the older model of education by placing limits around AI, but to thoughtfully redesign education so that the capabilities of AI are harnessed while human curiosity, judgement, creativity, agency and the capacity for independent sense-making continue to grow. This is ultimately a question not merely of technology adoption, but of reimagining the purposes and architecture of education itself.

K K Mashood
HBCSE - TIFR, Mumbai

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