Bulletin of IAPT @40

ISSN 2277-8950

THE INDIAN ASSOCIATION OF PHYSICS TEACHERS

A MONTHLY JOURNAL OF EDUCATION IN PHYSICS & RELATED AREAS

VOLUME 16 NUMBER 3 MARCH 2024

This NASA/ESA Hubble Space Telescope image features IC 3476, a dwarf galaxy that lies about 54 million light-years from Earth in the constellation Coma Berenices. While this image does not look very dramatic – we might say it looks almost serene – the actual physical events taking place in IC 3476 are highly energetic. In fact, the little galaxy is undergoing a process called ram pressure stripping that is driving unusually high levels of star formation in regions of the galaxy.

The gas and dust that permeates space exerts pressure on a galaxy as it moves. This resistance, called ram pressure, can strip a galaxy of its star-forming gas and dust, reducing or even stopping the creation of new stars. However, ram pressure can also compress gas in other parts of the galaxy, which can boost star formation. This may be happening in IC 3476. The galaxy appears to have absolutely no star formation along its edges, which bear the brunt of the ram pressure stripping, but star formation rates deeper within the galaxy are noticeably above average.

(Link :https://www.nasa.gov/image-article/hubble-views-an-active-star-forming-galaxy)

Bulletin of Indian Association of Physics Teachers

http://www.indapt.org.in

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

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Editorial

ACTIVITIES GALORE: IT IS HEARTENING

Greetings on the occasion of National Science Day, a day to remember Barat Ratna CV Raman.

This January, 2024 IAPT RC's have initiated a year-round program,by circulation, of celebrating life and works of Indian Physicists in the form of a set of invited lectures from experts drawn from across the country. Must Congratulate Sub RC Vidharva 8E and RC 14 Kerela to come out with two programs dedicated respectively to SN Bose and CV Raman. Every Month we will meet a new scientist courtesy different RC's.Also, there were two very exciting theme programs which were organized through the initiative of SubRC12ABangalore on *AI Awareness in Physics* and by RC22 Telangana on *How's and Why's of Teaching Undergraduate Quantum Mechanics*. These were conducted by registering participantswith a registration fee to bring seriousness among the participants and support such initiatives. The organizers of the programs also provided assignments to the participants to enrich their learning experience. The feedback received from the participants at the end of these programs reflect the success of these initiatives which bodes well for the reach out initiatives by different RC's.

As I write this, news of celebrations of National Science Day have started pouring, conducted under the banner of IAPT in offline mode in different RC's and Sub-RC's. The most exhilarating part of these offline programs is the emergence of new dedicated faces emerging to carry forward vision and mission of IAPT. Keep it up we are expecting a lot more from them in the near future.

Our resource generation programs have also started showing green shoots. These are visible in the form of two labs which have come up in Dehradun and Bangalore for Asian Physics Olympiad and International Junior Science Olympiad. IAPT must thank the institutions which have come forward to raise these facilities. Support for hand holding these programs by Homi Bhabha Centre for Science Education Mumbai is highly appreciated to carry forward and nurture these programs at a national scale. As offshoot of these programs reach out and awareness, offline programs in the form of in person Pollex Workshops have been conducted successfully.

Anveshika Buzz the monthly newsletter has taken roots with very good columns on various aspects of school Physics laboratories. Sustaining such initiatives through dedicated contributors and dedicated readers supporting the dedicated editorial team through quality columns, is our immediate concern. National Anveshika Network of India initiativeshas lot of beautiful articles to engage students' attention and hands-on activities.

Dear members, announcement of all the annual competitions conducted by IAPT are out, RC's have started unfolding their calendars for initiating the selection process of entries for national level through RC based competitions. Let us keep reaching the unreached spirit while conducting these programs and raise the quality of entries which we receive. Dear ten thousand plus members your work at the grassroot level is crucial to bring these competitions to the notice of teachers and students in schools, colleges and universities. In fact, IAPT National Competition on Photo Essay is over, with about 40 entries from different parts of the country, this competition is in 2nd year of its running. Prof. KN Joshipura, shared a crisp chat in V IN IAPT WhatsApp group, the way RC Gujrat, Diu and Duman is carrying out this program distributed over whole of the state. For each competition this format can be followed creating RC level winners ready for National level competition.

To bring students directly in touch with IAPT activities, IAPT has initiated IAPT student Chapters in schools, colleges and Universities. For this making Student Ambassadors will be designated who can help the teacher mentors in different institutions to carry out activities for students.IAPT is a work in progress generated by the members, for the members and the students. You Dear member is the key to this work and toCreate the opportunities to reaching the unreached through meaningful programs. An thought-provoking quote from Sir CV Raman:

I think the Chief Thing is to take some pleasure in your work. Sometimes I say, our salvation is in our own hands. If we in this country can focus our minds to do something, we will find something to do and we shall certainly get a place to do it. Stimulus is needed very much. Stimulus is sometimes they say not a spirit of mutual admiration but it is necessary to have criticism, even hostility, provided it is not carried too far, it is good for a man.

P K Ahluwalia

PHYSICS NEWS

Scientists closer to finding quantum gravity theory after measuring gravity on microscopic level

Experts have never fully understood how the force that was discovered by Isaac Newton works in the tiny quantum world.But now physicists at the University of Southampton, working with scientists in Europe, have successfully detected a weak gravitational pull on a tiny particle using a new technique.They claim it could pave the way to finding the elusive quantum gravity theory.Their study used a sophisticated setup involving superconducting devices, known as traps, with magnetic fields, sensitive detectors and advanced vibration isolation. It measured a weak pull, just 30aN, on a tiny particle 0.43mg in size by levitating it in freezing temperatures a hundredth of a degree above absolute zero—about –273 degrees Celsius.

The results open the door for future experiments between even smaller objects and forces, said Professor of Physics Hendrik Ulbricht also at the University of Southampton.Unraveling these mysteries will help us unlock more secrets about the universe's very fabric, from the tiniest particles to the grandest cosmic structures

Read more at: https://phys.org/news/2024-02-scientists-closer-quantum-gravity-theory.html

Original paper: Science Advances (2024) DOI: 10.1126/sciadv.adk2949

In a doughnut in Japan, unlocking the power of the Sun

Fusion energy, the power behind the Sun and the stars, has been a great prize for energy research for decades, ever since it was first attempted in the 1950s and 60s to find some way to reproduce this power of the Sun here on Earth. Not only is (fusion) free from greenhouse gases and free from long-lived nuclear waste, but it's compact, doesn't cover the whole landscape, and can generate industrially useful quantities of power. Fusion involves combining two atomic nuclei instead of splitting one, generating vast amounts of energy.Taking 15 years to build in Naka, northeast of Tokyo, the JT-60SA is 15.5 metrestall and 13.7 metreswide, comprising a so-called tokamak vessel able to contain swirling plasma heated to millions of degrees. The aim is to get nuclei of hydrogen isotopes to fuse into an atom of helium, releasing energy, and mimicking the process that takes place inside the Sun and stars.Nuclear fusion can certainly contribute to a future energy mix. Exactly on what timescale is very hard to say. It will come down ultimately to how much is invested in the field (and) how much society wants to pursue this as a solution

Read more at:https://phys.org/news/2024-02-doughnut-japan-power-sun.html

Explore Further at :https://phys.org/news/2023-12-japanese-experimental-nuclear-fusion-reactor.html

CERN researchers measure speed of sound in the quark–gluon plasma more precisely than ever before

Neutron stars in the universe, ultracold atomic gases in the laboratory, and the quark–gluon plasma created in collisions of atomic nuclei at the Large Hadron Collider (LHC), they may seem totally unrelated but, surprisingly enough, they have something in common. They are all a fluid-like state of matter made up of strongly interacting particles.Using data from lead–lead collisions at an energy of 5.02 trillion electronvolts per pair of nucleons (protons or neutrons), the CMS collaboration has measured for the first time how the temperature varies with the entropy in central heavy-ion collisions, in which the ions collide head-on and overlap almost completely.From this measurement, they obtained a value for the speed of sound in this medium that is nearly half the speed of light and has a record precision. The results match the theoretical expectation and confirm that the quark–gluon plasma acts as a fluid made of particles that carry enormous amounts of energy.

Read more at:https://phys.org/news/2024-02-cern-quarkgluon-plasma-precisely.html

Original paper:arXiv (2024). DOI: 10.48550/arxiv.2401.06896

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ARTICLE

HUNDRED YEARS OF THE DE BROGLIE HYPOTHESIS

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Brief Biography

Louis Victor de Broglie (1892-1987) was a member of aristocratic "Broglie" family of France. Since childhood, de Broglie had a good memory and an interest in political history, presumably due to his family background. He studied theoretical physics and simultaneously pursued a degree in humanities following the family tradition. He was drafted into the army during the First World War (1913-1919) and considered it wasted time.

Often, Louis used to join his elder brother, Maurice, in his laboratory in a mansion in Paris. Maurice was an experimental physicist studying atomic nucleus, but on the contrary the young Louis was more inclined towards theoretical and conceptual angles of physics. According to de Broglie himself he had *"More the state of mind of a pure theoretician than that of an experimenter."*

After a period of severe conflict he declined a research project in French history and chose a subject in physics for his doctoral thesis. That was fortunate since his thesis contained what is now known as the de Broglie hypothesis or also the Wave-Particle Duality and bestowed on him the award of the Noble prize in 1929. It was a triumph of intuition, since this idea catalysed the theory of quantum mechanics developed subsequently by Schrödinger and Heisenberg.

He was also fond of philosophy of science and scientific ethics. According to him, preserving original scientific thought was necessary in the long run for the progress of science. *"There is no reason why the history and philosophy of science should not be taught in such a way as to bring home to all pupils the grandeur of science and the scope of its discoveries."*

~Louis de Broglie (New Perspectives in Physics (1962))

He became an elder and guiding figure of science in France and lived up to the ripe old age of 95. **This is the Centenary year of this Revolutionary Hypothesis.**

The de-Broglie Hypothesis: a brief popular exposition

Louis de Broglie proposed a hypothesis which can only be described as startling. He asserted that a moving particle can be viewed as a wave. This is akin to suggesting that a ***solid*** log of word of mass *m* falling with speed v is also, and, at the same time a ***fuzzy*** wave! He tried to justify this enigmatic point of view in a series of some 5 publications, all appearing in the period 1923-24.

The surprising thing is that the famous formula linking the particle and wave character namely

$\lambda = h/mv$ ***attributed to de Broglie is not to be found in his 5 papers. They are buried deep in a chapter of his thesis and then resurface six years later in his Noble lecture (1929).*** Nevertheless, it has been found to be a ready to use "mantra' to build machines like the electron microscope, neutron diffractometer, multi-billion dollars chip fabrication– the list is endless. It also played a key theoretical role, clarifying the old quantum theory and inspiring Schroedinger to launch his famous wave equation and thus usher in the modern quantum theory.

However the puzzle persists**. Is the self-same entity like an iron ball a solid, or a wave, or both?** The issue led some physicists like Niels Bohr to explore parallels in Eastern Philosopy – "yin-yang" or "ida-pingala" where two opposite principles are supposedly reconciled. The final word belongs to Feynman: "It is safe to conclude that nobody really understands Quantum Mechanics". ***This is the Centenary year of what I would call as the Central Dilemma of physics.***

What Led de Broglie to Propose the Hypothesis

Several parallel observations were behind this revolutionary hypothesis.

Symmetry: I n 1905, Einstein explained the observations of Hertz and Lenard based on his idea of light quanta: assuming discrete energy packets to be localised in space, which can only be absorbed or emitted as complete units. Prior to this idea, the prevailing theory was that light existed as an electromagnetic wave of well-defined wavelength and frequency. However, Einstein did not rule out its wave nature altogether; the discrete energy of a light quantum depended on the frequency of the wave.

$$E = h\nu \qquad [1]$$

Radiation could behave as a wave, or as a particle, depending on how you probe it. Then if light can have a "particle" character, by "**symmetry**" it is conceivable that a particle may have a wave character

Appearance of Integers: Using the principle of quantization first suggested by Planck, Bohr built a model of the hydrogen atom in 1913, in which the electron orbit does not decay, due to the inability to continuously emit radiation. These so called "stationary orbits" of the electron correspond to different energy levels specified by integers, which can only be accessed by the electron as a result of absorption or emission of light. But in classical physics quantities such as momentum and energy are continuous**. Integers appear only when we encounter interference or diffraction patterns in waves.** Perhaps then electrons are also "waves"?

Quantization of Action: In order to explain the stability of the stationary orbits, Arnold Sommerfeld proposed the following generalisation:

In the periodic motion of a particle, the action integral must be a multiple of Planck's quantum of action

$$\oint pdq = nh \qquad [2]$$

where q is a generalized coordinate of the particle, and p is the conjugate momentum.

For a circular orbit in an atom, q is taken to be the azimuthal angle φ, and p is the corresponding angular momentum L. Thus:

$$2\pi \times L = nh$$

$$L = \frac{nh}{2\pi} \qquad [3]$$

which is the required stability condition.

Perhaps the above three aspects of the newly emerging field of microscopic physics made a deep impression on de Broglie.

Heuristic Arguments from de Broglie

In 1923, Louis Victor de Broglie, proposed the following for his thesis: Each material particle has a wave associated with it, which moves at a superluminal speed, and whose frequency depends on the energy of the particle.

Consider a particle of mass 'm' at rest. According to Einstein's theory of special relativity, there is an associated rest energy of the particle, given by

$$E_0 = mc^{\ 2} \qquad [4]$$

Thus, associate with this energy, a frequency given by

$$h\nu_0 = E_0 = mc^2 \qquad [5]$$

One may ask now: what exactly is this frequency? What oscillations does it correspond to?

In order to give a feeling for his propositions, de Broglie asks us to imagine a circular board with masses attached to it via springs, all of which oscillate in phase.

This oscillation has the frequency $\nu_0 = mc^2/h$.

We are now in a different reference frame. The particle moves with the speed v. Consequently, it has energy given by the relativistic formula

$$E = \frac{mc^2}{\sqrt{1 - \frac{v^2}{c^2}}} \qquad [6]$$

de Broglie now associates a wave to the particle, with the corresponding frequency

$$\nu' = \frac{\nu_0}{\sqrt{1 - \frac{v^2}{c^2}}} \qquad [7]$$

Hence, the relation (1) holds for the particle still.

Now, since the oscillations of the particle in our reference frame have a frequency ν' greater than ν_0 as a result of time dilation (division by the Lorentz factor), in order for the phase of the particle oscillations to match with the phase of the wave, de Broglie proves that the wave must move with a speed $V = c^2/v$.

We see that this 'phase velocity' is greater than the speed of light; de Broglie notes explicitly that "the superluminal phase wave doesn't carry energy."

Note that ν' isn't the frequency of the wave; apart from time dilation, the wave goes through Doppler shift, so that its frequency is ν, as defined above.

Now, using the relation (7) with

$$E^2 = p^2c^2 + m^2c^4 (theoryofrelativity) \qquad [8]$$

and

$$V = \lambda\nu (trueforanywave) [9]$$

we can obtain the famous de Broglie relation

$$\lambda = \frac{h}{p} \qquad [10]$$

where p is the relativistic momentum.

In his thesis though, de Broglie proposes the following formalisation: consider a 4-vector associated with the wave, moving in the x direction: (ν/V, 0, 0, ν/c). The momentum 4-vector for a particle is given by (p, 0, 0, E/c). According to our proposition, the time components of these two 4-vectors are related by the relation

$$\frac{E}{c} = \frac{h\nu}{c}$$

de Broglie suggested, we generalise this result also to the space component of the 4-vector pair, and obtain

$$p = \frac{h}{\lambda}$$

Which is the same as relation (10).

If we now put $2\pi\nu = \omega$ & $2\pi/\lambda = k$, we obtain:

$$E = \hbar\omega; p = \hbar k \qquad [11]$$

where ħ is the reduced Planck constant. Thus,

$$\frac{d\omega}{dk} = \frac{dE}{dp} \qquad [12]$$

From the relation (8), we have

$$EdE = c^2 pdp$$

Thus, since E/p = V = c^2/v, the relation (12) reduces to

$$\frac{d\omega}{dk} = v = velocityofparticle$$

Hence, we get a physical interpretation for the phase wave: the group of phase waves associated with the particle, move with the speed of the same. In order to get these wave groups, de Broglie postulates an uncertainty in the velocity of the body δv, due to which there are uncertainties in ω and k given by δω and δk. Thus, v = δω/δk.

Applications and corollaries of the hypothesis

Sommerfeld's stability postulate

de Broglie was able to explain Sommerfeld's quantization condition by a simple argument; in the stationary state of a periodic motion, the corresponding phase wave of a particle must be in the form of a standing wave. In other words, complete cycles of the phase wave must fit within a period of the motion. Therefore, if the motion is characterised by displacement ds, then we must have

$$\oint \frac{ds}{\lambda} = n$$

where n is a natural number. Since h/λ is the linear momentum p, we get

$$\oint pds = nh$$

which is precisely Sommerfeld's postulate.

The Quantum of Light and Wien Distribution

In his thesis, de Broglie attempts to give a new theory of light, as a reconciliation of his wave hypothesis and Einstein's quantum assumption. He assumes the following: light is composed of quanta which move at speeds extremely close to (but smaller than) the constant "c" in electrodynamics, and have an extremely small mass. He thus takes the frequency of radiation to be equal to that of the phase wave associated with the light quantum

$$h\nu_{radiation} = \frac{m_0 c^2}{\sqrt{1 - \frac{v^2}{c^2}}}[13]; v \approx c$$

The light quanta all have the same "rest mass", and only differ in their speeds (and thus, frequencies). From this relation, and the known experimental data, he gives an upper bound to the mass of the light quantum of about 10^{-50} grams. He then he heuristically derives the Wien distribution. We shall not explore this line of thinking in this brief presentation.

Reconciliation of two 'least action' principles in physics

de Broglie's final argument for his hypothesis is as follows: the application of Fermat's principle on the phase wave of a moving particle is equivalent to that of Maupertuis's principle of least action on the particle itself.

Say, the phase wave goes from A to B. Then, the condition for stationary phase will be

$$\delta \int d\varphi = \delta \int \frac{2\pi}{\lambda} ds = 0$$

Or, from the de Broglie relation,

$$\delta \int \frac{h}{\lambda} ds = \delta \int p ds = 0$$

which is the principle of least action in mechanics.

Experimental confirmations and further development

The most famous relation given by de Broglie is the de Broglie wavelength, namely,

λ = h/p. The reality of this wavelength was confirmed by Davisson and Germer in 1927 in USA and G P Thompson in England

Since electrons have an associated wave, we can expect these waves to interfere constructively or destructively. Thus, a beam of electrons scattered by a crystal forms a diffraction pattern of the intensity of the beam. Indeed, such a pattern experimentally confirmed the wave nature of matter, and further, the predictions of de Broglie.

This was received by the scientific community quite awkwardly. After all, what is this phase wave? And how can one describe a particle by such a wave? At the same time, this new theory was supported by experimental evidence, so it definitely had some truth to it.

Heisenberg's matrix mechanics formulation of the quantum theory came a year after de Broglie's thesis was published, but upon the critical work of Schrödinger based on de Broglie's hypothesis, the wave mechanics formulation of the quantum theory was born. The debate regarding the meaning of the theory ensued in the 5th Solvay conference of 1927. Although quantum mechanics has far more developed since then, the hypothesis of de Broglie has not been forgotten yet, due to reasons of pedagogy as well as intuition, in the least the relation λ = h/p The enigma of the dual nature of radiation and of particles continues to this date.

Acknowledgement: One of us (VAS) acknowledges several discussions with Vibhu Pandya.

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A MODEL* FOR TEACHING CONDENSED MATTER

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Teaching condensed matter is essential at all levels schools, colleges and universities. Since we are using variety of materials in our daily life having different phases, like solid, liquid and gases. We are transforming them in different form, sheet, wire, pipes and thin films. Normally we teach through atomic model with binding forces, thermal and mechanical treatments and mixing to achieve different properties. At some stage, we talk about ordering of these atoms and defects in condensed form.

Mostly it is taught through hand waving arguments and illustrations using circular dots and distributions. However, we teach those different properties like melting point, transparent and opaque and crystalline ordering are related to the internal structure. At advance stage we talk about X ray diffraction and AFM and SEM to get information about structure.

We have developed a very simple model having 10,000 steel balls of size 1 mm and placed them between two parallel plates having spacing a little greater than 1 mm, circular diameter of 100 mm. so that they are free to move. When this model is held horizontal, all balls are free to move within the space available representing liquid state of condensed matter. When we keep the model vertical, most of the balls settle and a few remain suspended, representing solid and vapor phase (due to electrostatic charge). In condensed phase one can visualize variety of defects, like vacancies, dislocations and grain boundaries etc. It is fascination to watch repetitively we get different configurations. We can also talk about different crystalline phases, like hexagon closed packed and cubic. Annealing and grain growth can also be demonstrate by mechanical agitation.

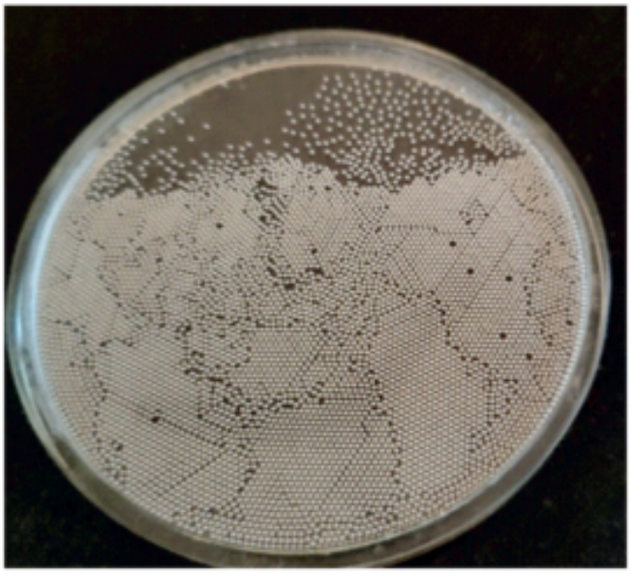

Figure: Photograph of the Model

*This model is available with **IAPT RC-6** at a cost of Rs. 1200/- including shipment. Total Amount payable to IAPT RC-6, Account ICICI Bank, BapuNagar, Jaipur, A/C No. 674701466813 and IFSC Code: ICICI0006747.

ONE HUNDRED YEARS OF A RESEARCH PAPER THAT GAVE THE WORLD 'BOSONS'

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***Abstract**: In June 1924, Albert Einstein in Berlin took keen interest and facilitated the publication of a research paper sent by a young Indian Physicist S N Bose then located at Dhaka. This led to the emergence and B-E statistics or simply Bose Statistics. Only by correspondence through a conventional handwritten letter and a typed four-page paper led to a revolutionary work in physics to come to the fore because of the talent of young Bose and the deep insight of Albert Einstein. Based on Bose's work Einstein dealt with the quantum theory of ideal monatomic gases and theoreticallypredicted the possible existence of a special state of matter that came to be known as BE Condensate. In this article an attempt has been made to take a closer look at the academic relationship between Bose and Einstein that began 100 years back.*

Introduction

Even if you are not a student of physics and you are even having very limited interest in physics, you possibly did not miss a very exciting news that hit the headlines 2012. It dealt with the detection of an elusive particle with a popular nickname of 'god particle.' However, now we know that the true scientific identity of the particle containstwo parts and its scientific name 'Higgs boson' is now well known. And the second part of this name is associated with the work of an Indian physicist Satyendra Nath Bose (1894-1974). And the pathbreaking contribution of Bose completes one hundred years this June.

The Physics Nobel Prize of 2013

A planned experiment at CERN, the European facility for nuclear research that is essentially a multi nation effort leading to the building up of a very special particle accelerator where the teams of scientists, engineers, computer experts, software specialists were all working together could identify an elusive particle. This is because the existence of such a particle that provides mass to all other particles must have the properties of a boson. A section of particles that obey Bose Einstein (BE) statistics or simply Bose Statistics have an integral spin. The first part of the name of the particle came from Peter Higgs, the British physicist who theoretically predicted its existence in 1964. Peter Higgs went on to share the 2013 Nobel Prize in Physics with Belgian particle physicist Francois Englert, the member of another group that also predicted the existence of the particle around the same time. The citation for the Nobel Prize was unusually long possibly to take care of the contribution of the experimentalists who did a great team work to make nearly onehalf a century old theoretical prediction an experimentally established fact. So, the citation read *"for the theoretical discovery of a mechanism that contributes to our understanding of the origin of mass of subatomic particles, and which recently was confirmed through the discovery of the predicted fundamental particle, by the ATLAS and CMS experiments at CERN's Large Hadron Collider".*

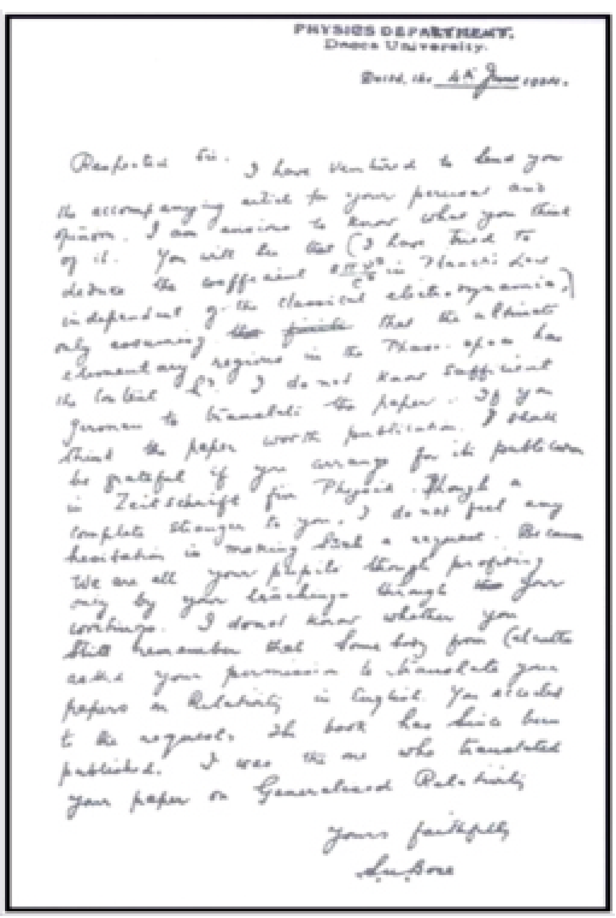
The paper of Bose to Einstein

But what about the 'boson'? Well, if we try to dig out history then we need to travel back by one hundred years to 1924. Satyendra Nath Bose, then a Reader in the Department of physics in the newly established University at Dacca. Dacca now written as Dhaka (and we shall use this spelling here) and is presently the capital of our neighboring nation Bangladesh. It was the part of undivided India at that time in 1924. It is from here Bose wrote a letter on June 08, 1924 and the addressee was none other than Albert Einstein a name known well beyond the scientific community or the physicists, a Nobel Laureate, and a Professor at the University of Berlin in Germany at that time. The letter was accompanied by a four-page scientific paper written by Bose in English.

A look at the Google map on our computer screen tells us that the areal distance between the present -day capital of Bangladesh and that of Germany is about 7000 km. In last one hundred years this distance has not changed but the modes of communication have changed is such a big way.It is difficult for one from the present generation to visualize how people used to communicate among themselves one hundred years back when the distance was formidable. Postal letters handwritten or typed used to move by road, by train or by waterways, referred to as surface mails. The air mail, i.e., the movement of letters by air was still not a reality. Today*, s*ome may like to refer to these types of letters as hard copies and in a way they are right. These used to move through the postal systems with the significant possibility of getting lost on transit. The letters from Dhaka that could manage to reach the addressee at Berlin by taking about three weeks or 21 days.Incidentally Bose's letter was a handwritten one on the letterhead of his department in 'Dacca University' and the accompanying four-page paper was a typed one in English. Bose considered Albert Einstein as the most suitable person to make a critical assessment of the paper that contained a derivation of the Planck's law for the quantum theory of light. And Bose knew that the idea was novel.

In early 20th century when Quantum theory of Planck was proposed many in physics considered it to be a somewhat ad hoc introduction for explaining the spectra ofblack body radiation. Some feel that Planck might have introduced it from thermodynamic consideration. The difficulty of explanation of the nature of the black-body radiation spectrawas also there and around that time some other scientists were trying to solve the puzzle. The wave theory of radiation that was firmly established and could explain so many physical phenomena with full satisfactionfailed to explain the features of the black-body spectra. On the other hand, Planck's famous equation on quantum theory had no formalderivation and it was considered as an ad hoc introduction by many just to 'conveniently' explain the spectra of black-body radiation.

The farsightedness of Albert Einstein


PHYSICS DEPARTMENT.
Dacca University.
Dated, the 4th June 1924.

Respected Sir,

Yours faithfully
S.N. Bose

As far as it is known Bose possibly in 1922 sent the paper for the consideration of publication in the well-known Britishresearch journal Philosophical Magazine published from London. The journal however rejected the paper. Bose then decided to knock the door of Prof Einstein. Incidentally he and Meghnad Saha had some communication with Einstein around 1918 or so. The two classmates were excited about the Einstein's General Theory of Relativity and they wanted teach the theory to the post graduate students of the newly opened physics department of theUniversity of Calcutta.

Bose sent his now well-known letter to Einsteinin Berlin in June 04, 1924. Einsteinreceived the letter and the paper of Bose in about three weeks' time as the letter travelled to Berlin from Dhaka by surface. The most probable dates were June 25 or 26. Despite his very busy schedule the paper did ignite some novel idea in the thought processes of Einstein. He barely took 2-3 days to translate the paper in German and he submitted it to the very well-known research journal Zeitschrift für Physik(shortened name Z. Phys) with a very positive comment about the paper.The text of the letter is given below.

"Respected Sir,

I have ventured to send you the accompanying article for

your perusal and opinion. I am anxious to know what you think of it. You will see that I have tried to deduce the coefficient $8\pi \nu^2/c^3$ in Planck's Law independent of classical electrodynamics, only if the ultimate elementary region in the phase-space has the content h^3. I do not know sufficient German to translate the paper. If you think the paper worth publication, I shall be grateful if you arrange for its publication in Zeitschrift für Physik. Though a complete stranger to you, I do not feel any hesitation in making such a request. Because we are all your pupils though profiting only by your teachings through your writings. I do not know whether you still remember that somebody from Calcutta asked your permission to translate your papers on Relativity in English. You acceded to the request. The book has since been published. I was the one who translated your paper on Generalised Relativity."

Yours faithfully,

S. N. Bose

Carrying out research publications in scientific journals in 1920s

Now we are familiar with the peer-review system for the publication of a paper in a research journal. But some one hundred years back considering the lack of fastness in the types of communications available at that time, particularly, if that demanded atwo-way communication some other approacheswere adopted for judging the quality of papers. We need to remember that the size of the scientific community was much smaller and they had a very localized concentration in mainly insome parts of Europe and of North America. The scientific journals used to accept the research papers for publication if those were routed through some reputed scientists with suitable comments. And Einstein did exactly that for the Bose paper. The title of the paper, if we look at the English translation of it, was "Planck's law and Light-Quantum Hypothesis" published in Z. Phys, vol 26, pp 168-171, in August 1924. That way this paper got published remarkably quickly in the August issue of the journal. The comment of Einstein at the end of this paper was significant. He wrote "This is a very significant work and a beautiful step forward. I shall show this elsewhere." This is no doubt a very positive comment coming from none other than Albert Einstein. And the comments of the scientist forwarding a paper to the editors of a journal was of immense importance. We shall come back to this comment again later.

What Einstein could see in the paper of Bose

Moreover, it appears the paper immediately showed Einsteina way to place before the scientific community some ideas that were very much within him but he was possibly not getting the right kind of platform to launch that through ascientific paper. Based on the ideas dealt in this paper of Bose, Einstein wrote a two-part paper that got published in September1924 (1st part) and in January1925 (2nd part). And as he promised the journal was not Z. Phys but 'elsewhere.'

It is now clear that Einstein hinted at two things through his end-comments of the Bose paper. First, that he will publish some scientific idea that will have the backing of the Bose paper and second,he would not publish that in this journal i.e., in Z Phys, but in a different journal. In fact, his first paper where he acknowledged and used the idea of Bose was published in another well-known German research journal whose name when translated in English is 'The Proceedings of the Prussian Academy of Science.' The Einstein paper had two parts one published in September 1924 and the second part came out in the same journal in January 1925. Here Einstein through his calculations, where he used the ideas of Bose, could theoretically predict a special quantum state when a system can attain the condition for virtually dealing with the single atoms. It emerged from the calculations of Einstein that at a very low temperature close to absolute zero and at a very low pressure the quantum state of matter may be made visible in the macro state when one can have a cluster of a few atoms. This was viewed as another possible state of matter different from the four, i.e., solid,liquid,gas and plasma were already known. Now this state is better known as Bose-Einstein (or B-E) Condensate.

In fact, like many theoretical ideas of Einstein the idea of B-E condensate took time to be experimentally verified. The production of very low temperature and a very high order of vacuum always remained a technological and scientific challenge. So only in 1995 the two different groups in USA could design experimental set ups to observe

what came to be known as B-E condensate. The three members from those two groups from USA, Carl Weimannand Eric Allin Cornell (both from (JILA, and NIST Colorado, Boulder) and Wolfgang Ketterle (MIT), shared the 2001 Physics Nobel Prize for this work. And the citation declared that they are awarded 2001 Physics Nobel Prize *"for the achievement of Bose-Einstein condensation in dilute gases of alkali atoms, and for early fundamental studies of the properties of the condensates"*.So,through the 2001 physics Nobel Prize, in a way, a cycle got completed.

Publication of the paper and the evidence of the hurriedness of Einstein

So, the paper of Bose was indeed a very quick publication even by the standard of that time. But it raised several eyebrows because of various reasons. There were ample signs of hurriedness from the side of Einstein for getting this paper published as soon as possible. First, the paper had the name of the author as Bose, yes only Bose, and no first name or initialswere there. Second, the affiliation of the author was also given in an unusual way. It was shown as Dacca-University, India. But how did a hyphen come in between Dacca and University? What about the department that S.N. Bose belonged to? After all, Bose wrote on a letterhead of the Physics Department and that was prominently shown on the right-hand corner along with the name of the University. And finally, the paper did not have a single reference, not even of the original paler by Max Planck proposing the quantum theory of light. Unfortunately, the original paper sent by Bose could not be traced either in the Einstein archive nor a typed copy of the paper was available with Bose. So, it is difficult to ascertain if there were any reference or not in the original paper from Bose or whether Einstein just did not include them, once again a sign of 'hurriedness' that has been conjectured by many. But it is very likely that the paper had a few references as Bose did this work based on the work of Planck and it is indeed very likely that at least this reference was there in the original English version sent by Bose.

And the obvious question comes, why was Einstein in a hurry? The reason for this hurriedness may be tracedback in the comments that he made as a translator and as a recommender at the end of the Bosepaper. What Einstein wrote as translator's remark is like this in English, “In my opinion Bose's deduction signifies an important advance. The method used here gives the quantum theory of an ideal gas as I will work out elsewhere.” The last phrase of the second sentence is really very important.

The questions for Einstein and their defense

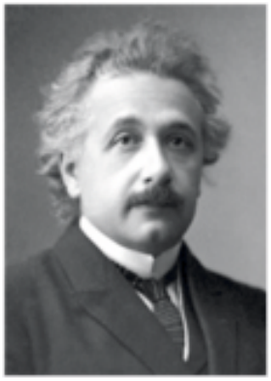
This 'Translator's remarks' provides us the clue for the obvious hurriedness of Einstein. The deduction of Bose triggered some ideas in him and he immediately felt that based on the work of Bose he could work out the quantum theory of the ideal gas. As it has been already mentioned Einstein, unlike Bose, was surrounded by an active scientific community in Berlin. And he did face questions from his friends and colleagues why he was accepting the idea of Bose that is “obviously wrong” and looks quite ad hoc. Einstein had just one argument to counter these. He felt that there must be some hidden truthsomewhere deep inside because this 'obviously' wrong idea was leading to the correct result. Einstein's intuition was right and now we know Bose while handling the derivation of Planck's law dealt with photons and he considered them to be indistinguishable. And this was a key concept. Einstein persuaded with the 'queer' idea and could help him to theoretically draw some conclusions that were even more remarkable and was completely new to the physics community.

The first part of the Einstein paper (translated English title “Quantum theory of a Monatomic Ideal Gas') came out in September 1924.Once again Einstein's keenness to publish his ideas based on Bose's work was evident. In the first part of the Einstein paper leading to the concept of B-E Condensate, he referred to Bose's workas has been the work of one D Bose. In fact, the first two sentences of the first part of the Einstein paper when translated into English reads like “A quantum theory of ideal gases free from arbitrary Ansatzen (assumptions) does not exist yet today. This gap will be filled in the following using a new approach proposed by Mr. D. Bose from which the author has obtained a most remarkable derivation of Planck's radiation formula.” It is very surprising why Einstein

has written the name of Bose with D as his first name. Was it because Bose wrote from a city the name of which starts with D?

These two papers(parts 1 and 2) of Einstein were highly mathematical and led to the theoretical prediction of a special state of matter now known as Bose Einstein Condensate. Starting with the single paper by Bose the genius of Einstein could give us the BE statistics and bosons. The theoretically predicted BE condensate was also got very strongly connected with the paper and the Bose-Einstein condensate became a very natural name for the concept that may be loosely referred to as the fifth state of matter. This goes to show how fundamental a concept wasintroduced by Bose.

Einstein's reply mail and Bose's journey to Europe



Let us go back to 1924againbecause the story of that year is not yet over. Bose received a reply ofhis June 04 letter from Einstein sometime in late July. This reply came in a post-card written in German by Einstein by his own handwriting and was dated July 02, 1924 in response tothe Bose's paper sent on June 04, 1924. Basically, a part of this letter paved the way for Bose for ascholarship from Dacca University leading to Bose's academic trip to Europe. Let us look at the English version of this letter.

Albert Einstein

2.7.24

Dear Colleague,

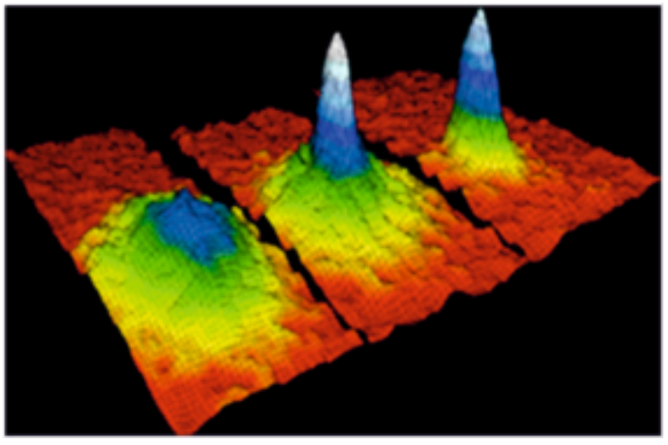
I have translated your work and communicated it to Zeitschrift für Physik for publication. It signifies an important step forward and I liked it very much. In fact I find your objections against my work not correct. For Wien's displacement law does not assume the wave (undulation) theory and Bohr's correspondence principle is not at all applicable. However, this does not matter. You are the first to derive the factor quantum theoretically, even though because of the polarization factor 2 not wholly rigorously. It is a beautiful step forward.

With friendly greeting,
Yours
A Einstein

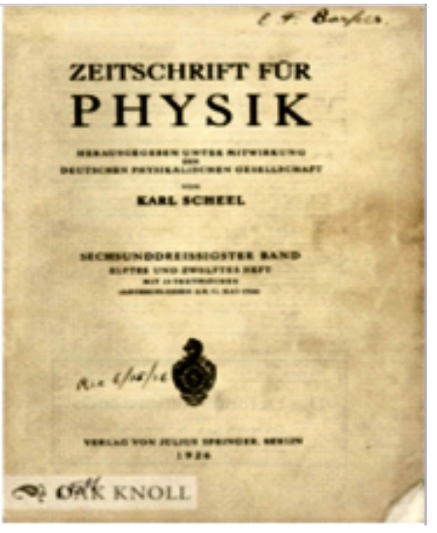
One can easily understand that such a letter from a physicist like Einstein who may not merely be designated as a Physics Nobel laureate, to a young university teacher in a colonial country was something very special. This letter was in a way an acknowledgement of the idea of Bose based on which he made a deduction of Planck's law and a letter of appreciation, and may be a letter of recommendation all rolled into one

Bose in 1924

Bose did not have a Ph.D. or doctorate. During the early part of the last century our country virtuallydid not have system in place for doing Ph.D. or doctoratein an area like physics. It could only be done, abroad, mainly from England and Germany and France. Since India was then a British colony brilliant Indian students could mostly go to England with this objective. Some students could move to France and Germany as well. The financial support in the form of the scholarship used come from some suitable funds from some big universities like the University of Calcutta or from the government coffer. Bose could not avail of such a scholarship and neither could go abroad for additional training or for having a Ph.D. that his other bright classmates and contemporaries like Meghnad Saha, P.C. Mahalanabis, Jnan Chandra Ghosh could do. This letter from Einstein to Bose worked as a letter of recommendation and with the initiative of the then Vice chancellor of Dacca University Mr. Hertog, Bose could have the financial support from the university to go abroad. However, this was not a scholarship for obtaining his Ph.D. from abroad, but it was meant for having an exposure to the high-end experimental laboratories in Europe. The University authorities had an objective of establishing similar laboratories for the training of the students in Dhaka. And that took Bose to Europe in October of the same year i.e., 1924 and Bose arrived at Paris on October 06, 1924.



Bose Einstein Condensate



Concluding remarks

From Paris, however Bose took one long year to go to Berlin and meet Einstein. The meeting between the took apparently could not generate much bonhomie that possibly Bose expected. In this connection this needs to be mentioned that Bose actually sent another paper (entitled 'Thermal equilibrium in the radiation field in the presence of matter')to Einstein from Dacca on June, 14, 1924. This was even before Bose could know the fate of his first paper sent Einstein just ten days ago on June 04. This paper also got published in the journal Z. Phys. after getting translated and forwarded by Einstein. But it is more or less evident from the end comment of this second paper from Bose that Einstein was not that impressed with its contents. So, when Bose met Einstein in Berlin in October 1925, it appears Einstein by that time was looking for something original and in his own opinion that was not forthcoming from Bose. So that way no possibility of any future collaboration could see the light of the day. And in a way the Bose Einstein connection came to an abrupt halt. But we know that Boson and BE condensate are very much with physics and the name of S N Bose have remained ever entangled with the name of Albert Einstein.

References

1. S.N.Bose: The Man and His Work, (in two volumes) Part I Collected Scientific Papers: Published by SNBNCBS, Calcutta, 1994 www.bose.res.in
2. Official website of Nobel Prize; www.nobelprize.org
3. https://www.nobelprize.org/prizes/physics/2001/popular-information/
4. Different entries from http://en.wikipedia.org

REPORT (RC-3)

INVITED TALK ON "BASICS OF QUANTUM FIELD THEORY"

Organized by: BOSONS Club, GGDSD College, Sec 32 Chandigarh

Venue: Department of Physics, **Date:** February 17, 2024

Resource Person: Prof. C.N. Kumar, Department of Physics, PU Chd.

Activity In charge: Dr. Neelu Mahajan

BOSONS Club of PG Department of Physics, in collaboration with RC-03 organized an expert talk on 17th Feb. 2024. Prof. C.N. Kumar, President RC3), delivered a talk on the topic "Basics of Quantum Field Theory". Dr. Ajay Sharma, Principal,of the College extended a green welcome to the speaker. The interactive talk was initiated with the introduction of basic Classical and Quantum mechanics. He discussed the Relativistic Field theory, String theory, and Covariant Perturbation theory to elaborate the particle creation and destruction while propagating in space-time. Around 56 faculty and postgraduate students participated in the event with full zeal and vigour. Dr. Neelu Mahajan, HOD appreciated the students for their active participation.

Amit Goyal
Treasurer IAPT-RC3

REPORT

PERFORMANCE BASED OLYMPIAD LEVEL EXPERIMENTS (POLLEX-XI)

The IAPT-APhO Cell organised a 3-day workshop on "POLLEX-XI (Performance based Olympiad Level Experiments - XI) from December 6 to 8, 2023 at Graphic Era Hill University Bhimtal, Nainital Campus. Senior secondary students from Government Inter College, Bhumiadhar, Nainital, and Govt. Inter College, Naukuchiatal, Nainital actively participated along with their respective teachers.

The technical session, led by Prof. R.S. Bhattacharya (Ex-Cordinator, IAPT-APhO Cell) and Prof. Vijay Kumar (Cordinator, IAPT-APhO Cell), featured student's interactions with resource persons Mrs. Rocky Chaudhary, Ms. Vishakha, and Mr. Vishesh Sharma. They engaged students with experiments demonstrating the effects of magnetic fields on the oscillations of a simple pendulum.

Students were exposed to various experiments such as magnetic levitation, electromagnetic induction and the Raman Effect with practical implications in daily life.

Prof. Vijay Kumar, HOD Physics, Dean Allied Sciences, engaged with faculty members from the university and

schools, demonstrating experiments related to the scattering of light and its applications in determining the concentration of chemical solutions, specific rotations, and various length parameters.

Local organizers Dr. Mehul Manu, Coordinator and Head of Allied Sciences, and Dr. Deependra Singh Rawat, Asstt. Professor of Physics, interacted with students, addressing their queries. The active participation of first-semester B.Tech. students from Graphic Era Hill University, Bhimtal Campus, was highly enthusiastic, contributing significantly in achieving the technical session's objectives.

Meanwhile, Prof. M.C. Lohani, Campus Director, visited the technical session and commended the smooth conduct of the workshop.

Vijay Kumar
Coordinator APhO Cell,
Secretary IAPT RC – 5(Uttarakhand)

REPORT (RC-13)

ONE DAY WORKSHOP ON LABORATORY TEACHING

One day workshop was conducted by the Department of Physics, Central University of Tamil Nadu & RC-13(TN and Puducherry).

This was the third CUTN-IAPT Workshop of the department of Physics, and the second teacher's training program. The program was conducted on 24 January, 2024, partially sponsored by PICO and focused on latest and innovative trends in teaching Physics laboratory courses. A total of 32 participants took part in the workshop.

The workshop was inaugurated by Prof. T S Natarajan, President of RC-13, and the Head of the Department of CUTN, Prof. P Ravindran, representing CUTN. The brief inaugural, set the stage for the need and the genesis of the event.

The morning session consisted of two talks. The first was on the use of Artificial Intelligence (AI) in Physics classrooms, by Prof. V Madhurima, department of Physics, CUTN, convener of the event and VP, IAPT RC-13. She spoke on the need for teachers to upgrade their teaching methodology from pedagogy to heutogogy, for students to be trained to be independent thinkers, and examples of software and methods in which AI tools can be used in classrooms and laboratories. The second forenoon session was by Dr K C Sekhar, CUTN, who discussed

and taught various error analysis methods needed for Physics laboratory courses. After these two sessions, a visit to all laboratories in the department of Physics, CUTN, was conducted by Dr. K Mohan Raj and Mr Sulthan Ibrahim of the same department. This visit was much appreciated by the participants.

The afternoon session consisted entirely of hands-on session by Prof. T S Natarajan who demonstrated various do-it-yourself experiments and felicitated the participants to perform the same. He was assisted by Mr. Prem Kumar of Kid-Start. In all about 30 experiments were demonstrated/ performed. The enthusiasm of the participants was palpable in this event.

The event ended with a valedictory function. The feedback from the participants (both oral and written) was overwhelmingly positive. They asked for (a) more of such program–at least twice a year and (b) more programs in vernacular (Tamil), for the benefit of local schools and colleges. Certificates were distributed to all participants, resource persons and volunteers.

The program ended with a vote of thanks by the convener.

V Madhurima

REPORT (AMMANNI ANVESHIKA)

Activity-1

Organized by: Agastya International Foundation

Venue: Teacher Training Program - Physics Lab

Date: 5 Dec 2023 **Time:** 11.00am – 1.30 pm

Observer: Sarmistha Sahu

A novel activity, toothpicks floating in water can be attracted by a magnet! Plenty to think about, discuss, and conclude. Each group of teachers was given plenty of material to connect the idea with the knowledge. The scheme is to realized, to assimilate and accommodate the conceptual understanding.

Activity-2.

Date: 5 Dec 2023 **Time:** 2.00am – 3.30 pm

No. of teachers from Odisha Batch 3 - 38

Resource person: Sarmistha Sahu

Puzzles are puzzling. Creating one, giving it shape and playing is even more challenging. Teachers brainstormed to get the maximum number of units of tetrominoes. Each one of Mran Mukul bore, Dhiraj, Arup, Paban, Tika, Jihusua Daimari and Mohit volunteered to draw one for the others to gauge its uniqueness. Creating the puzzle neatly to beat the stuff available onAmazon was the greatest satisfaction. Once the puzzle was ready, they had different games to play, each one a level higher.

Activity-3

Date: 6 Dec 2023 **Time:** 11.00am – 1.30 pm

Resource persons: Ms Ayesha and Mr Jayakumar

Open the discarded laser, open the nozzle, retrieve the lens with gasket, and create your handheld microscope to peep into the micro-world..

Activity-4

Halaguru (RC12 ABL**)**

Organized by: Mr Muniraju and Lions club and RC12A

Venue: Maregowdarahalli GHS

Date: 11 Dec2023

Time: 10.00am – 1.30 pm

No. of students-13

Resource Person: Sarmistha Sahu and Ms Uma MK

Constructivist teaching-learning skill sets need not be enumerated, they are captured in the activities the teachers do happily, getting the flavour of a new classroom atmosphere.

Activities that elevate the mood of science learning done with the students- can you balance 10 nails on 1 nail head? What keeps the spring in the air, hanging? What is magnetic levitation, where can you use this concept? Can friction glue the pages? How does the monkey somersault? What makes the cone roll uphill? And many similar activities kept the students glued to their chairs for 3 complete hours..

Activity-5

Maregowdarahalli G HS ,Halaguru (RC12 ABL)

Kannada section

Venue: Government High School, Maragowdanahalli, HalagurHobli, Malavali Taluk, Mandya District -571421

100 students of Kannada Section.

Date: 13 Dec 2023**Time:** 11.00am – 1.30 pm

Observer: Sarmistha Sahu

A classic challenge for the 8 groups, take cardboard, cello-tape, pencil and design a top to rotate indefinitely. All the planning, operation, execution, success story, and all in 20 min. only!

I was in my world of imagination, but creativity and teamwork were demonstrated vigorously by all the groups, each one with a unique machine and fantastic coordination among the team members. The trainers (Bhuvana and Jayakumar) had kept theirs ready, should it be better than the rest??Mr Manjunath questioned and cajoled the teachers to put their best foot forward.

Activity-6

Date: 14 Dec 2023 **Time :** 3.00 pm-4.30 pm

Resource person: Sarmistha Sahu

Topic: Puzzles- tetrominoes galore

Give the students the tools, and they will create the Lever of n^{th} order!

Ms Vijay Shanthi got the essence of Engage, Explore, Explain, Elaborate, and Evaluate from the previous activities with the teachers. The understanding was crystal clear but the message of practicing in the classroom needed clarification. Mr Sudhakar executed systematically, the DIY-I am-there-by-your-side style.A 5E class for 20 KGF English Medium school, teaching them about water pollution, the sources, how to reduce, and what can be done to make it portable is the message to the teacher-observers. Materials were given to the student group to discuss, work on the material, find its characteristic, and learn the art of creating a filter candle with a plastic bottle, gravel, brick, coal, sand, filter paper and coloured, smelly, sticky water.

Activity-7

Date: 14 Dec 2023

Time: 2.00am – 3.10 pm

No. of teachers from Raichur batch 11 - 43

Resource Person: Sarmistha Sahu

Encounter swimming lessons in childhood, and narrate with equal enthusiasm now, an interesting story for the group to live through. Of course, the breathing style during swimming was emphasized to feel the loss in weight! Floating is natural, an ecstasy not of Archimedes alone!

Will foil float? What if it is crumbled? How about pushing it in? Let's try crumbling it in water. What's the difference? When does it float? Where does it shed its weight? Wondering if this could be a technique for losing weight! How does the empty volume matter? Such questions and more set the theme of inquiry and self-creation of knowledge. The knowledge is theirs; no one can steal it. The outcome is worth the effort!

"Define the target, and I shall achieve it right!"

Sarmistha Sahu

Coordinator

To our readers

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Kalyanpur, Kanpur-208017
Email : iaptknp@rediffmail.com
Mob. : 09935432990

ANNOUNCEMENT

NATIONAL COMPETITION IN COMPUTATIONAL PHYSICS-2024

Physics Simulations & Software-Based Physics Experiments (NCICP – 2024)

The annual IAPT competition **NCICP 2024** will be held online before the Annual IAPT Convention. The details of the venue and dates of the IAPT Convention-2024 will be announced in due course of time.

Important Dates

1	Last Date of Registration	30-04-2024
2	Submission of Title and One-Page Abstract	31-5-2024
3	Online Interaction between the Experts and the Participants	15-6-2024 to 21-6-2024
4	Final Submission	31-07-2024
5	Final Presentation (online) and Interaction for Evaluation	20-08-2024 to 31-08-2024
6	Demonstration of Projects by Awards winners, and Special invitees	During the IAPT Convention-2024

About the Competition

This competition will be held in Three (03) categories: 1 - School, 2 - UG Section, 3 - PG Section. Each category has two sub-categories: (A) Student, and (B) Teacher.

The following heads will be considered for final judgment: Novelty & Innovativeness, Literature Survey, Bibliography & Resources, Presentation & Interaction, Software/ Methodology, Analysis of Results, Discussion, Scope of Future work & Conclusions.

The work to be presented should be the original one.

The **best three presentations** in **each sub-category** will be awarded with prizes, and a certificate. Each candidate will get an e-certificate. ***THE DECISION OF THE JUDGES WILL BE FINAL.***

Theme of the Competition

INNOVATION (*i.e. new idea, new method, new device, and new algorithm involving physics*) is the main theme. The following kinds of Physics-based Simulations/Experiments are included in this competition:

For Category 1:

Smartphone Sensorbased Experiments (*using phyphox or other equivalent applications*)

***For Category2: Any one from* (*a*),(*b*), and (*c*)**

(a) *Experiments using ARDUINO coupled with Android phone / PC / ExpEYES / Any other Interfacing device.*

(b) *Experiments with transducer / sensor / actuator / PID interfaced with Microcontroller / Microprocessors / PC*

(c) *Smartphone Sensor based Experiments* (*using phyphox or other equivalent applications*)

***For Category 3: Any one from* (*a*),(*b*), and (*c*)**

(a) *Experiments with software-based modeling using Android phone / PC / smartphone etc*

(b) *Solving physics problems by simulations or adopting numerical techniques* (*using Psilab / Matlab / Mathematica, Spreadsheets, Fortran, C++, Python etc.*) */ any other software*

(c) *Smartphone Sensor based Experiments* (*using phyphox or other equivalent applications*)

For each category, exceptional submissions on topics other than those listed may also be accepted if the committee decides.

How to register & What to do next

Follow the web site: www.indapt.org.in

Your cooperation in abiding by the last date will be highly appreciated.

For any query:

Dr. Pradipta Panchadhyayee, Coordinator, NCICP-2024
Associate Professor, Department of Physics (UG & PG)
Prabhat Kumar College, Contai; PO: Karkuli DSO, Dist-PurbaMedinipur,WB, 721404
Mailid: ppcontai@gmail.com **WhatsApp :(+91)9476161100**

List of New Member From 01.01.2023 to 31.12.2023
Member from 14024 - L9006 To 14340 - L9262

OMNO	Membership No.	Name	City	Pincode
		DELHI		
14249	L9186	Ms Chanchal Yadav	New Delhi	110007
14058	L9039	Dr. Thounaojam Umeshkanta Singh	Delhi	110009
14051	L9032	Dr. Richa Jain	New Delhi	110017
14313	*2311	Sanjeev Nanda	Delhi	110024
14339	L9261	Dr. L . Thansanga	New Delhi	110027
14139	L9097	Manpreet Kaur	Delhi	110032
14131	*2305	Ram Ji Pandey	New Delhi	110034
14270	L9206	Neena Chawla	Delhi	110051
14127	L9089	Dr. Anjula Bhardwaj	New Delhi	110058
14191	L9140	Dr. Manisha Verma	New Delhi	110058
14252	L9189	Dr. Poonam Suri	New Delhi	110058
14120	L9084	Nitin Kumar	Delhi	110059
14083	L9061	Devinder Kumar	New Delhi	110063
14114	*S2405	Yogesh Chauhan	New Delhi	110067
14157	L9110	Dr. Meenu Mohil	New Delhi	110075
14331	L9253	Santosh Kumar Tripathi	New Delhi	110085
14070	L9051	Dr. Swati Raman	Delhi	110092
		HARYANA		
14130	*2305	Mani Gupta	Faridabad	121004
14085	L9062	Vijay Chawan	Gurgaon	122002
14273	L9209	Dr. Manjeet Kumar Yadav	Rewari	123401
14119	L9083	Ramesh Bishnoi	Hisar	125052
14207	L9154	Dr. Gurpreet Kaur	Kalka	133302
14115	*S2405	Harpreet Singh	krukshetra	136129
		PUNJAB		
14192	L9141	Dr. Pushpendra P Singh	Rupnagar	140001
14324	L9250	Ramandeep Singh Johal	S A Nagar	140306
14090	*2304	Sushil Kumar	Dera Bassi	140507
14088	L9064	Yogyata Pathania	Zirakpur	140603
14304	L9236	Meetu Singh	Taran Taran	143401
14112	L9080	Sangeeta Prasher	Jalandhar	144004
14125	L9087	Dr. Surbhi Sharma	Jalandhar	144004
14134	L9092	Dr. Sandeep Kaur	Jalandhar	144004
14107	L9078	Shivani Singla	Dhillon Nagar	148101
14126	L9088	Indu Gupta	Mohali	160055
14081	L9059	Dr. Amandeep Kaur Kalsi	Mohali	160062
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Sanjay Kr. Sharma
Secretary

TRENDS AND THEMES IN PHYSICS EDUCATION RESEARCH

Physics Education Research (PER) as a discipline is still in a state of infancy in our country. However it holds great potential owing to our large and aspiring student and teacher population. The new National Education Policy (NEP 2020) envisages radical transformations in our education scenario, which in turn demands careful thinking through and conceptualization. As such a renewed commitment to systematic and scientific approaches to issues pertaining to teaching and learning of physics, which constitutes the core mandate of PER, is timely. This column will review trends and themes in PER, with particular attention to the realities and needs of our education contexts.

In this issue, we briefly discuss the following paper that analyzes the interplay between mathematics and physics in one of the iconic episodes in the history of physics - Planck's introduction of discreteness and quantization in the context of blackbody radiation.

Branchetti, L., Cattabriga, A., & Levrini, O. (2019). Interplay between mathematics and physics to catch the nature of a scientific breakthrough: The case of the blackbody. *Physical Review Physics Education Research*, *15*(2), 020130. https://journals.aps.org/prper/pdf/10.1103/PhysRevPhysEducRes.15.020130

Authors analyzed original papers by Max Planck with the goal of reconstructing the reasoning employed by him in achieving the breakthrough pertaining to quantization. Specifically, three papers - first one discussing the mathematical conjecture which enabled the distribution law for spectral density, second one wherein Planck provided his theoretical interpretation for this law and the third one where a more detailed discussion and rigorous derivation of the law is presented - are analyzed. The goal is to provide a nuanced understanding of the nature of knowledge construction in physics and the different role played by mathematics in it. The creative power of mathematics, how it instigates pivotal reasoning moves leading to scientific breakthroughs etc. are highlighted. Paper follows an argumentative style, walking the readers through the critical details underlying the reasoning processes employed, in contrast to the often employed textbook style of providing facts, information and a chronological narrative. The discussion is interspersed with quotes revealing philosophical dispositions and epistemological commitments of Planck, bringing to the fore the human dimension of the enterprise of scientific inquiry. The analysis of the papers is followed by the development and administration of a tutorial consisting of passages interspersed with mathematical tasks. The analysis of student responses to the tutorial revealed a positive impact on student understanding.

Implications and take-home points from the paper for our contexts:

1) Derivations constitute a core component of physics education in our country. However they are often taught and learned as a sequence of mathematical manipulations and procedures. Little emphasis is laid on understanding the nature of thinking underlying these derivations - how they are constructed, what are the challenges faced and resources marshaled by the scientist in this process etc. The paper we discussed provides insights on how to interleave the formal content of physics we find in textbooks with insights from history and philosophy of the subject. The teaching and learning of derivations can thus be enriched to give students a flavor of how scientific discoveries are made. This will prepare them to understand the nature of physics better and can positively impact their ability to tackle novel problems.
2) The paper by analyzing the original papers of Max Planck is essentially studying practice of science by a professional scientist. Such an approach is consistent with a model that considers professional practice as the gold standard for designing education. This approach has broad implications to us, as we live in a time where the nature of scientific practices are changing rapidly. To bring our classrooms and curricula in phase with this transformation is a huge educational challenge. A design approach to education is very likely necessary, by studying the practices of working scientists and then incorporating the seeds of them in our curricula so that our students are prepared to embrace the changes happening at the frontiers.

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Postal Regd. No. Kanpur City-28/2021-23 Date of printing-01-03-2024 Date of posting-08-03-2024 RNI No. UPENG/2009/29982 ₹ 25/-

BULLETIN OF INDIAN ASSOCIATION OF PHYSICS TEACHERS

FOUNDED BY (LATE) DR. D.P. KHANDELWAL

VOLUME 16 NUMBER 3 MARCH 2024

IN THIS ISSUE

If underlivered please return to :

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Flat No. 206, Adarsh Complex,

Awas Vikas-1, Keshavpuram, Kalyanpur, Kanpur-208017

Published by Dr. Sanjay Kr. Sharma on behalf of Indian Association of Physics Teachers. For circulation amongst IAPT members/subscribers only.
Flat No. 206, Adarsh Complex, Awas Vikas-1, Keshavpuram, Kalyanpur, Kanpur-208 017, Mob. 9415404969.
Printed at Sharda Graphics Pvt. Ltd., 123/766, Factory Area, Fazalganj, Kanpur-208012, Ph. 9336845329
Chief Editor: Prof. Manjit Kaur