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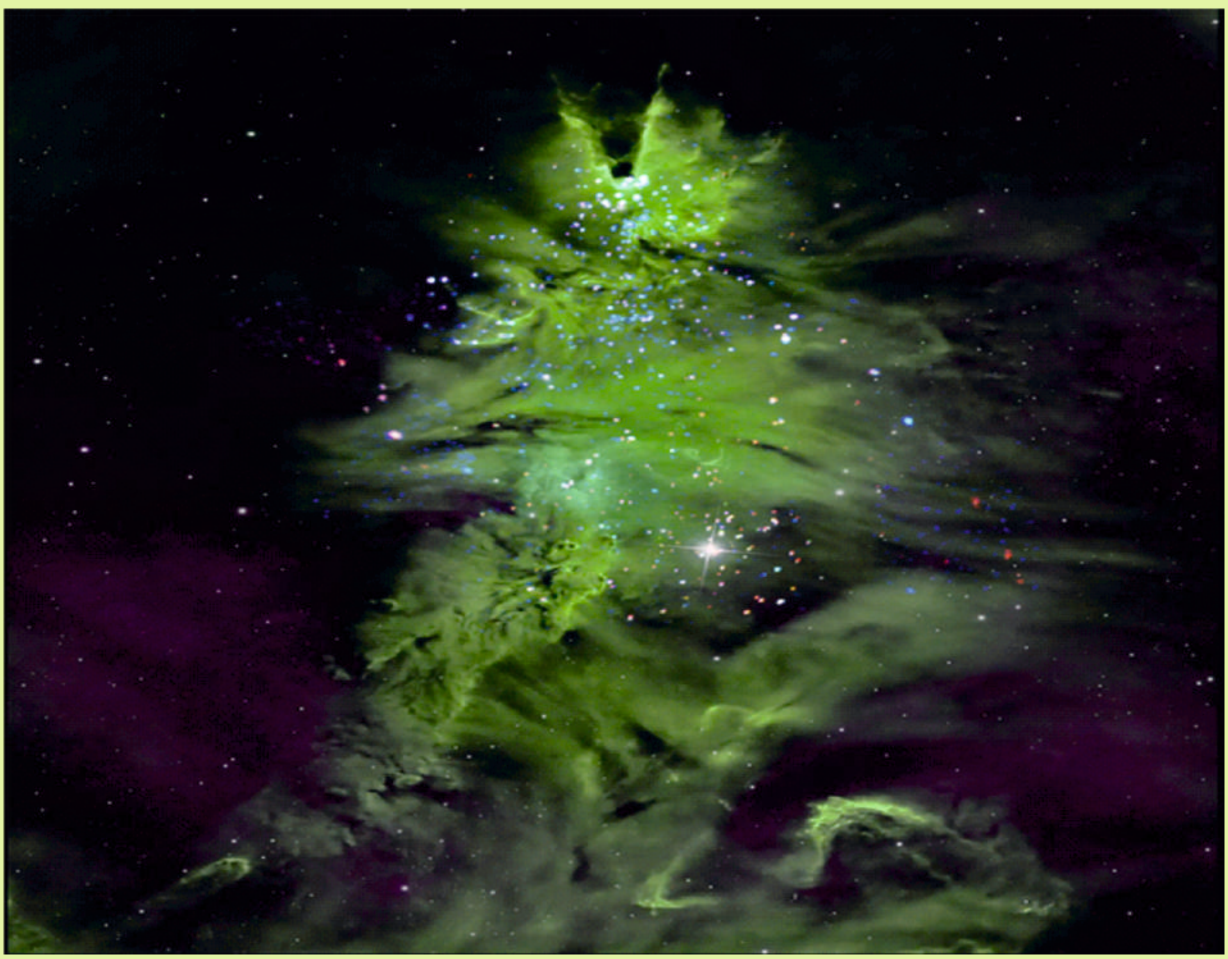

This new view of the “Christmas tree cluster” NGC 2264, released on Dec. 17, 2024, combines data from NASA's Chandra X-ray Observatory and optical data from astrophotographer Michael Clow's telescope in Arizona. Chandra data is represented in red, purple, blue, and white, while optical data is in green and violet.

Located about 2,500 light-years from Earth, NGC 2264 is a cluster of young stars between one and five million years old. The stars are seen here as blue and white lights surrounded by swirls of gas—the “pine needles” of the tree—with green representing light in the visible spectrum.

Link: https://www.nasa.gov/image-article/hang-a-shining-star-upon-the-highest-bough/

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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

Lev Landau : The Mentor Who Shaped Generations of Physics

Lev Landau was a pioneering physicist whose work spanned quantum mechanics, condensed matter physics, and fluid dynamics, earning him the 1962 Nobel Prize in Physics for his groundbreaking theory of superfluidity. His *Course of Theoretical Physics*, co-authored with E.M. Lifshitz, remains a cornerstone for physics students, offering deep insights across various areas of theoretical physics. As we celebrate Landau's 116th birthday on January 22, this month provides an opportunity to reflect not only on his monumental contributions to the field but also on his distinctive approach to physics teaching and training.

One of Landau's most enduring legacies as a teacher is his *Theoretical Minimum Exam*—a rigorous, intellectually demanding test designed to assess not just a student's knowledge but their ability to think critically, derive results, and solve problems independently. Landau's reputation as an exceptionally demanding teacher made passing his exam a mark of excellence, signifying the student's exceptional theoretical capability. Many who passed this exam, include Nobel laureates Vitaly Ginzburg and Alexei Abrikosov.

Landau was known to approach research papers in an unconventional way: after reading the introduction, he would jump directly to the main results. He would then re-derive the central equations or results himself, ensuring the logic and derivations were correct. It is often said that he gave the same set of questions in his *Theoretical Minimum Exam* to every candidate, rather than crafting unique sets of questions each time.

Landau's approach to education was radical in its focus on deep understanding over mechanical memorization. His exams required students to derive fundamental results from first principles, rather than simply recalling facts or applying established formulas. This method was designed to cultivate an independent and rigorous mindset, one that could not only solve standard problems but also tackle complex and unfamiliar challenges. In this sense, Landau's system emphasized creativity over conformity.

Lev Davidovich *Landau*

In contrast, today's exam systems often prioritize breadth over depth, testing students' ability to apply learned solutions to a range of problems rather than fostering true innovation. Modern education systems, particularly in many parts of the world, have become heavily reliant on exams that assess factual knowledge and standardized problem-solving skills. While these exams provide a snapshot of academic achievements, they often fail to measure students' conceptual understanding or critical thinking capabilities.

This issue is further exacerbated by the growing problem of question paper leaks, often caused by lapses in security, corruption, or negligence. These leaks undermine the fairness of exams and create an environment of inequality and unfair advantage.

In an age where knowledge is easily accessible, the true value lies in the ability to synthesize information, innovate, and approach problems from multiple perspectives-skills that Landau's system fostered through rigorous intellectual challenges.

In conclusion, while Landau's method may be better suited for graduate-level studies or advanced courses, it is important to find appropriate methods, such as active learning, that ensure education not only produces knowledgeable individuals but also creative, independent thinkers who can approach any challenge with rigor, integrity, and innovation.

Wishing all a brighter and more innovative New Year

K. M. Udyanandan

Physics News

Low-frequency photonic simulator breaks barriers

A research team from University of Science and Technology of China (USTC) has achieved a breakthrough in quantum photonics. They developed an on-chip photonic simulator capable of simulating arbitrary-range coupled frequency lattices with gauge potential. The quest for effective simulators that can replicate the dynamics of real systems has been a driving force in quantum physics. Photonic systems, with their ability to control properties like polarization and frequency, have emerged as versatile candidates for quantum simulation. However, the challenge lies in creating frequency lattices that can simulate complex structures like atom chains and nanotubes, which are crucial for understanding low-dimensional materials. This work not only greatly alleviates the difficulties posed by high frequencies in on-chip synthetic dimensions but also maintains the scalability of traditional implementation methods, allowing it to be extended to higher-dimensional models.

Read more at: https://phys.org/news/2024-12-frequency-photonic-simulator-barriers.html

Original Paper: Physical Review Letters (2024). DOI: 10.1103/PhysRevLett.133.233805

Can entangled particles communicate faster than light?

Entanglement is perhaps one of the most confusing aspects of quantum mechanics. On its surface, entanglement allows particles to communicate over vast distances instantly, apparently violating the speed of light. But while entangled particles are connected, they don't necessarily share information between them. But what if the second particle was on the other side of the room? Or across the galaxy? According to quantum theory, as soon as one "choice" is made, the partner particle instantly "knows" what spin to be. It appears that communication can be achieved faster than light. While the two particles are connected, nobody gets to know anything in advance. I know what your particle is doing, but I only get to inform you at a speed slower than light—or you just figure it out for yourself. So, while the process of entanglement happens instantaneously, the revelation of it does not. We have to use good old-fashioned no-faster-than-light communication methods to piece together the correlations that quantum entanglement demand.

Read more at: https://phys.org/news/2024-12-entangled-particles-communicate-faster.html

Provided By: Universe Today

Twisted Edison: Filaments curling at the nanoscale produce light waves that twirl as they travel

Bright, twisted light can be produced with technology similar to an Edison light bulb, researchers at the University of Michigan have shown. The finding adds nuance to fundamental physics while offering a new avenue for robotic vision systems and other applications for light that traces out a helix in space. Twisted light is also called "chiral" because the clockwise and counterclockwise rotations are mirror images of one another. The study was undertaken to demonstrate the premise of a more applied project that the Michigan team would like to pursue: using chiral blackbody radiation to identify objects. They envision robots and self-driving cars that can see like mantis shrimp, differentiating among light waves with different directions of twirl and degrees of twistedness While brightness is the main advantage of this method for producing twisted light, up to 100 times brighter than other approaches, the light includes a broad spectrum of both wavelengths and twists. The team has ideas about how to address this, including exploring the possibility of building a laser that relies on twisted light-emitting structures.

Read more at: https://phys.org/news/2024-12-edison-filaments-nanoscale-twirl.html

Original paper: Science (2024). DOI: 10.1126/science.adq4068

Soumya Sarkar
IISER PUNE

An Interview with Sir Anthony Leggett

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Professor Anthony James Leggett is regarded as one of the most eminent personalities in the domains of physics and intellectual inquiry of our time. Globally esteemed for his expertise in low temperature physics, he was awarded the Nobel Prize in Physics in 2003 for his seminal contributions in the theory of superfluidity. Pioneering novel directions of research, he has substantially advanced our understanding of the basic features of Quantum Mechanics governing large-scale dissipative systems and has utilized the condensed matter systems like Josephson devices as tools for testing fundamental principles of Quantum Mechanics in the macroscopic domain of systems much more massive and bigger than the microphysical systems like atoms and molecules. Along with his then research student Anupam Garg, Professor Leggett had formulated in 1985 the famous 'Leggett-Garg inequality'[1] whose experimental test has opened up an earlier unexplored avenue for critically testing the incompatibility between Quantum Mechanics and the notion of realism embedded in our everyday worldview; in other words, this landmark work has paved the way for the experimental tests of the celebrated Schrödinger's Cat Paradox in terms of what may be called 'Laboratory Cousins of Schrödinger's Cat'[2-3].

The following piece has grown out of the engaging conversation **Anindya De** had with Professor Leggett during his last visit to India in connection with the conference celebrating his 80th birthday held at Raman Research Institute, Bengaluru.

Interviewer: Let me begin by recalling that you had graduated in classics, specifically in Latin and Greek languages and literature. How did you end up studying physics?

Leggett: Let me first clarify that I did have some exposure to modern mathematics in high school, and even considered becoming a pure mathematician. However, I distinctly remember telling myself that I did not want to pursue a career in mathematics. Why? Because in the field of mathematics, being wrong means you are considered stupid. I would like to be able to make mistakes and learn from them, without being labelled as unintelligent. That's why physics fascinated me - I could make non-trivial conjectures about the way the world works and, importantly, with the help of my colleagues, test them with experiments.

Interviewer: In this context, I am interested in learning more about how your background in philosophy has shaped your perspectives on physics.

Leggett: I do not think philosophy has helped me better understand specific ideas of physics, but it has made me a lot more sceptical about things that are usually taken for granted. I am probably a lot more conscious than many of my physicist colleagues of the provisional nature of our current scheme of things and perhaps much more inclined to believe that two to three hundred years from now, our whole picture of the physical world will completely change.

Interviewer: Many of us are curious to know what it is that makes some people come up with momentous discoveries and others, who work as hard as the discoverers, do not achieve that.

Leggett: A large element is luck. Somehow, the people who do make the great discoveries are ones who manage to free themselves from conventional ways of thinking and to see the subject from a fresh perspective. But, I would not know how to quantify that.

Interviewer: Is it also good luck if something does not work as you expect?

Leggett: Well, some of the most stimulating experiments, to a theorist, are those which do not come out as you confidently expected them to.

Interviewer: What are the sources of inspiration in your scientific pursuit?

Leggett: I think that is a rather difficult question to answer. In scientific discovery luck plays an enormous role. But, I think, one can be fairly sure that if you have not been thinking about the problem continuously and perhaps even when you are lying awake at night, then it is unlikely that you will get the sudden flash of discovery that makes it work. I always find that the main stimulus to theory is some curious experimental result that seems totally outrageous and unnatural, and one tries to understand it.

Interviewer: So somehow usually experiment is ahead of theory.

Leggett: Often it is. But if one is lucky, one may be able to make predictions about some experiment which has not been done, one would like it to be done and come out the way you say.

Interviewer: But, if we consider superconductivity, we cannot predict the superconductors that would work in high temperatures, like room temperature. What do you think about this?

Leggett: Well, there are about a hundred elements known to us. If you consider a compound which, say, involves six of these elements, then, crudely speaking, there are a trillion of such compounds. Nature has never made most of these compounds. We will certainly not be able to make most of them in any reasonable time. I would take a large bet that somewhere out, there are substances that will be superconducting at room temperature. We just do not know where they are in this immense space. Once we have a generally accepted theory of cuprate superconductivity, I think we may be in a much better position to look for them.

Interviewer: Looking back, which physicist has had the most impact on you?

Leggett: From a purely physics standpoint, I feel a strong resonance with Lev Landau, even though I have never met him in person. Another individual who has had a significant impact on my work is Paul Dirac.

Interviewer: When faced with a complex problem, Dirac preferred to approach it as a whole, whereas Heisenberg tried to break it down into smaller parts and solve each part separately. We are curious to know which methodology you have preferred in your research work.

Leggett: With regard to the research on Helium-3, it was tough to break down the curious issues into smaller components. Therefore, I thought that quantum dissipation-based approach is perhaps the more useful holistic way around. However, we did make an effort to separate the study on Helium-3 into smaller parts and tackle them individually as much as possible. Overall, I believe I have used both the approaches in my career.

Interviewer: In your Nobel lecture[4], you had mentioned a happy coincidence around 1972–73 that led to the finding of the explanation of the puzzling experimental results of Helium-3 which eventually resulted in your Nobel Prize. Can you please recall here that coincidence?

Prof. Leggett receiving his
Nobel Prize (2003)
Courtesy: The Nobel Foundation

Leggett: In July 1972, while I was on a mountaineering excursion in Scotland, I heard that Bob Richardson, an experimental physicist at Cornell University in the US, was visiting the University of Sussex and wanted to speak with me. Although I was enjoying my holiday, when in the following morning it rained, I decided to head home early. As a result, I was able to spend several hours talking to Bob. He told me about the interesting experiments he was conducting on liquid helium. This conversation changed the course of my research career and, thirty years later, led to my presence at the Nobel Prize

Ceremony in Stockholm. If I had not talked to Bob that day, I would have never found out about those experiments before they were published, and my career might have taken a different path.

Interviewer: In the famous 2005 Berkeley Debate[5], you expressed support for physicists trying to change quantum theory. Borrowing your own theme, I would like to ask 'Is Quantum Mechanics the whole truth'?[6]

Leggett: The answer is probably no. I believe that as we try to really understand coherently the quantum measurement paradox or Schrödinger's cat paradox (viz. the puzzle as to how a definite outcome, say a dead or alive cat, occurs in any measurement process, while quantum description of the process predicts a superposition of states, say a live and dead cat, corresponding to different outcomes) by applying quantum mechanics all the way as we move up from electrons to our conscious experience of the outcome, there will come a point where our current understanding will break down. We do not know when or how this will happen, but I am quite certain that it will[7].

Interviewer: We have observed the phenomenon of quantum entanglement to be true, but we do not yet fully understand its physical nature. You had mentioned your intuition that if a solution is ever discovered, it will require a significant revision of our understanding of the arrow of time. Will you please expand a bit on this?

Leggett: One of the assumptions necessary to derive the Bell-CHSH inequality based on the ideas of locality (no action-at-a-distance) and realism (pre-existing definite properties of any object, independent of measurement) is that the properties of ensembles are determined entirely by their initial conditions. Thus, one way of reconciling the apparent contradiction between the idea of local realism and experimental refutation of the Bell-CHSH inequality using entanglement would be to reject this assumption, i.e. to postulate that our usual assumption that the past can affect the present and the present can affect the future but not vice versa, is incorrect. I have never been able to understand Hawking's arguments[8] about why this point of view is unviable. There is a good discussion about this point in Huw Price's book 'Time's Arrow and Archimedes' Point' (Oxford University Press, 1996).

> "I always make a parable that if while climbing a particular rock face, you think you are the first person ever to have done it — it doesn't really matter if you find out later that you weren't". -
> A. J. Leggett (Oral History Interview, American Institute of Physics)
> Link:https://www.aip.org/history-programs/niels-bohr-library/oral-histories/47503

Interviewer: It has been said, for example, that a phenomenon like superfluidity exhibits at the macroscopic level the evidence for the validity of quantum mechanics. What is your comment on this?

Leggett: I think one has to be a little careful about such a statement, because the comment that "one can see the evidence of quantum mechanics on a macroscopic scale" is quite ambiguous in its meaning. It is certainly true that in a superfluid, or in a superconductor, you have a very large number of atoms or electrons which are all behaving coherently. So, the effects which normally occur at atomic level are enormously amplified. However, there is a much more dramatic prediction, namely that, under certain circumstances if you apply quantum mechanics consistently, you reach a description of the world in which there is a quantum superposition of two macroscopically different states. The famous example, of course, is a cat inside a closed box. If you apply quantum mechanics consistently to the situation, you appear to arrive at a description in which the cat is neither alive nor dead, but in a quantum superposition of the two states, until some further observation is made.

However, it is difficult to express the above feature in classical terms. If you take the interpretation of quantum mechanics seriously and if you apply the same interpretation at the level of the cat, as you do at the level of the atom, then you do seem to reach the conclusion that it is not definitely in one state or the other until observed. That is the famous quantum measurement paradox or Schrödinger's paradox. But it is a very different situation from what one normally gets in the sort of standard applications of superconductivity and superfluidity.

Interviewer: Is it not bizarre to have such a superposition somehow at a macroscopic level?

Leggett: The existence of liquid helium at low temperatures that does not solidify at ambient pressure is essentially a quantum phenomenon. Such an object should not exist according to classical laws. I think that it is one of a number of cases one could quote in which one sees, in one sense or another, the macroscopic effects of quantum mechanics. But then, here one regards the difference between a liquid and a solid as a macroscopic difference. I do think there is a big difference between this kind of case and the genuine Schrödinger's cat kind of situation, which is one which we have not yet been really able to probe directly in experiments, although we are working towards it.

Interviewer: In order to investigate the applicability of quantum formalism at the macroscopic level, you had suggested utilizing condensed matter systems, such as Josephson devices. What progress has been made toward success in this area?

Leggett: I would say that the level of success we have achieved is surprisingly high. Back in 1980, when I first proposed this idea, there was a lot of scepticism, especially from the quantum measurement community. Even as recently as 1999, a very senior theorist solemnly told his experimental colleague, who was beginning to build such a device, that he was wasting taxpayer's money, saying it would never work. However, we have now reached a point where Josephson devices are routinely referred to as 'artificial atoms' in scientific papers. In fact, many of the atomic level phenomena that we observe can also be seen in these devices. Recently, we were even able to conduct an experiment that not only tests quantum mechanics at a reasonably macroscopic level involving superposition of oppositely circulating currents in a superconducting ring, but also provides rigorous experimental constraints on the notion of macrorealism.

Interviewer: Accepting weirdness of quantum mechanics has been a daunting issue even for the colossal scientist Albert Einstein. He could never reconcile himself to quantum mechanics, because it was too bizarre for him. What is your perspective on this issue?

Leggett: I personally think it is entirely possible that in the year 3000 we will still believe that quantum mechanics is the whole truth about the world. But then, I guess that our attitude towards the physical world at the everyday level will be radically different from what it is today. We will then really have had to face up to this weirdness, which by that time, I am confident, will have been amplified to the everyday level. I think it is at least equally probable and perhaps more so, that as we go from the level of the atom to the level of the cat, we will find that somewhere along the line quantum mechanics breaks down and some new theory, of which we can have no conception at present, will take over. I am personally hopeful that it is the second thing that happens.

Interviewer: Suppose the quantum superposition of macroscopically distinct states of a macro-object is found to be empirically well verified up to the level of macro-measuring devices, what would be in your view the Quantum Mechanical measurement problem - how then to reconcile the apparent inconsistency between the formalism of Quantum Mechanics and the actualization of definite measurement outcomes subsequent to measurement interaction?

Leggett: In a sense we have already empirically verified 'quantum superposition of macroscopically distinct states of a macro-object', see e.g. Section 6 of my latest paper[9]. I think a more important milestone would be to verify its occurrence at the level of macroscopically distinct states of the human brain. Were this to be achieved, while the subject still registered the consciousness of a definite outcome, the only way I would know of interpreting the situation would be to regard the whole of quantum mechanical formalism as merely an abstract prescription or calculus which corresponds to nothing at all in the real world, but is simply a formal procedure for calculating the probabilities of directly observed outcomes. A trenchant defence of this interpretation has been given by L. E. Ballentine[10] and I would merely defer the 'realization' process to a point much closer to our everyday experience than he needed to in 1970. But I would not feel comfortable with it!

Interviewer: What about quantum computers?

Leggett: Well, if quantum mechanics does describe the whole universe at all levels, then it seems that there is no reason, in principle, why one should not build a functioning quantum computer. I think, however, one may well find that the practical difficulties of doing that are just so enormous that in the end people will conclude that it is just not worth it.

Interviewer: So, how would you summarise the present state of studies on quantum computers?

Leggett: I would think it is probably fair to say that, at least right now, the challenge of quantum computing is not throwing up any very deep new conceptual questions. It is a matter of, in some sense, engineering, and so it is a matter of taste, whether you regard that as interesting or not.

Interviewer: It is suggested that reality and information are, in a deep sense, closely linked. Professor John Wheeler described it as: “it from bit”[11]. What is your view?

Leggett: From the exposition of the “it from bit” thesis quoted in Wikipedia from one of Wheeler's last writings on the subject, I infer that what he was really proposing is that the history of the universe is determined at least in part by the set of experiments we (or Nature) choose to conduct and the answers which are obtained. This seems to me a not necessarily unviable point of view (a valuable discussion on this topic also can be found in Huw Price's book), but it does not seem to me well summarized by statements like “physics derived entirely from information” unless we postulate that the experimental outcomes (or other macroscopic realizations) have to be consciously registered by a human observer. But then the subject of information is about the outcomes, which are observer-independent. (If we believe that a human observer is essential, we can ask, following John Bell, whether he/she has to have a Ph.D. in physics. I do not think Wheeler ever answered that question).

Interviewer: We are very fortunate that you have written an updated preface for the Bengali translation of your book 'The Problems of Physics'[12], which will appear soon. In this piece you have mentioned what you consider to be very important works during the last thirty years, including the intriguing discovery that the universe's expansion appears to be accelerating in the late 1990s. The most widely accepted explanation for this phenomenon involves the existence of Dark Energy. However, with regard to Dark Energy, you wrote that “.... this idea may turn out to be no more than a band-aid”. Could you please elaborate on why do you think this way?

Leggett: I am not an expert in cosmology, just an outside observer. However, from what I have gathered, there seems to be a growing desperation to explain the accelerating expansion of the universe within our current framework of ideas. So my bet would be, for what it is worth, that in the next thirty years or so there is going to be a major revolution in cosmology. While we cannot predict the nature of this revolution, I am inclined to believe that it will happen.

Interviewer: What are your views on the role of science with respect to social issues in the contemporary world, and the significance of the interplay between science and liberal arts?

Leggett: I believe it is a fallacy to consider science, specifically physics, as a model for social science. Instead, we should view them as separate entities and analyse them independently.

As regards the interplay between science and liberal arts, one can try to envisage possible useful interactions between the practitioners of these two fields. However, I doubt that merely bringing a scientist and a liberal arts person together will result in significant progress. We have to remember that some interdisciplinary efforts can seem forced and contrived.

Interviewer: In 2014, you co-authored an article with Pickett and Chu titled 'Science Diplomacy in Iran'[13]. What is your opinion on the role of Science Diplomacy in today's world?

Leggett: I think the exchange of knowledge and ideas between the West and the former Soviet Union during the Cold War was very important. Many individuals had the opportunity to establish both scientific and personal relationships with leading Soviet scientists, which helped dispel the notion that the Soviet Union was an entirely evil entity.

During the Cold War era, roughly between 1965 and 1990, I crossed the Iron Curtain several times and entered Poland a number of times as well. Though it was not exactly a matter of science diplomacy, I never felt that the inhabitants of these states were somehow different from us. I observed the usual human virtues and faults in them. In fact, I have a number of friends and contacts on the other side of the Iron Curtain.

I believe that a similar situation has occurred with Iran. Many people in the United States have held a stereotypical view of Iran, but by visiting there and speaking with leading scientists and politicians, we were able to develop a more nuanced perspective. This new perspective could then be shared with our colleagues who have not had the opportunity to visit Iran themselves. Overall, I believe that such visits are very useful for gaining a better understanding of a country.

Interviewer: You have been visiting China often and during the visits you must have interacted with Chinese people at various levels. In this context, it would be very useful if you could please comment on the scope of science diplomacy and interactions with China in present world.

Leggett: I have indeed visited China much more than I have visited Iran. In fact, I had a summer appointment at Shanghai Jiao Tong University for the period 2014-2021 (though because of the pandemic I had to do the last two years remotely). So I got to know a number of my Chinese physics colleagues pretty well. On the other hand, in the case of Iran, my visit was deliberately organized as partially an exercise in science diplomacy. But, in the case of China, with the exception of a meeting in 2014, I did not get to meet any of the Chinese political leadership, so any opportunities for science diplomacy were limited and indirect (as I think they were for the Western scientists who visited the Soviet Union during the Cold War). I still think that just in that case they were very worthwhile.

Interviewer: The relationship between religion and science is a topic of ongoing debate. What is your opinion on this issue?

Leggett: I am inclined to think that one's religious beliefs do not necessarily impact their abilities as a physicist. From my experience, I have encountered many exceptional physicists who are atheists, as well as many others who are devoutly religious. In my opinion, one's faith does not make much difference in one's professional abilities.

Interviewer: What would be your suggestion for fostering scientific attitudes among present-day school-going children?

Leggett: I believe for this purpose it is particularly important for teachers to be willing to admit when they do not know something. In India, this may be difficult because teachers are often viewed by their students as having all the answers. I have been asked by Indian school teachers what to do when a student asks a question they do not know the answer to. My recommendation is to simply say, "I am sorry, I don't know, but I will try to find out. In case I am able to find out the correct answer, I shall certainly tell you".

> "Always try to follow your own curiosity, and don't worry too much if other people say, "Well, you know, everyone knows that. It's well understood." If you don't understand it, then beaver away at it, and don't stop until you think you've got something which really satisfies you." -
> A. J. Leggett (Oral History Interview, American Institute of Physics)
> Link: https://www.aip.org/history-programs/niels-bohr-library/oral-histories/47503

Interviewer: As a science teacher, I would like to know your views on the desirable method of teaching science at the school level.

Leggett: I am not entirely certain that there is an ideal method of teaching science. Similarly, I do not believe in the existence of ideal courses, since what may work perfectly for one set of students may not be successful for another. However, there are some simple rules that one can follow, such as explaining concepts in the simplest possible way and using easy-to-understand experiments. Besides that, I do not have any special recipe to share.

Interviewer: Would you encourage your grandchildren to go into science?

Leggett: I would encourage my grandchildren to pursue a career in science, but I would discourage them from choosing physics. I believe that there are more exciting and promising areas in science, such as neuro-psychology and others, that would provide more challenging opportunities for intellectual growth.

Interviewer: In school, you participated in long-distance running, excelled in chess, indulged in long hikes and bicycle rides into the countryside, and fell in love with mountaineering. How do you like to relax now?

Leggett: Nowadays, my schedule is extremely hectic and I have numerous deadlines to meet. A lot of the time, the best answer would be to simply get some rest. Despite this, I still enjoy hiking and engaging in some light mountaineering. However, my wife prefers that I avoid highly demanding pursuits, so I have not gone rock climbing in many years. I also enjoy watching films and reading the odd thrillers, though nothing too intense.

Interviewer: You had written an unusual article titled 'Notes on the Writing of Scientific English for Japanese Physicists'[14]. In that article, there are a number of lucidly explained valuable suggestions concerning the structuring of scientific papers, construction of sentences, use of appropriate words, the optimal length of a sentence, and so on. Why do you think this article made such an impact on Japanese physicists?

Leggett: For what it is worth, my own feeling is that, the most important and possibly most novel feature of my essay on scientific English and the reason it seems to have struck a resonance in Japan lies not in my comments on the kind of relatively 'microscopic' points which you mention, but rather in my attempt to identify the ways in which the deep differences between Japanese and English 'ways of thinking' are reflected in the writing of scientific papers. I would be very interested to know whether you think that there are similar 'deep' differences between English and other Indian, such as Bengali, ways of thinking which affect the writing of scientific papers (I tend to suspect not; I think this kind of difference may be peculiar to Japanese. But, of course I do not know a word of Bengali or any other Indian language).

Interviewer: Thankyou very much for raising this intriguing question. Surely, this will motivate many of our readers to mull over this issue in the context of their respective languages.

The interviewer thanks Professor Dipankar Home of Bose Institute, Kolkata for his valuable help in planning this interview.

Thanks are also due to the organisers of the conference celebrating Sir Anthony Leggett's 80th Birth Anniversary at Raman Research Institute, Bengaluru (https://wwws.rri.res.in/tony80/index.php)

for their support enabling this conversation.

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Article

Matter Waves in Physics

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1 Introduction

Newton believed that light was a stream of particles[1]. Before the days of Newton, light was speculated to propagate as a wave. Maxwell theorized light as an electromagnetic wave[2]. The equality between the speed of light and the speed of an electromagnetic wave appeared to settle the issue in favour of the wave characteristics of light. Finally, the wave nature of light was demonstrated by Young in the double slit experiment[3].

Planck re-enlivened the particle nature of light[4]. Light was assumed to be emitted by matter in the form of quantum of energy. Each quantum is a photon. The assumption could explain the unsolved problem of energy distribution in different wavelengths from a cavity. Before applying the quantum theory of light to explain the photoelectric effect, Einstein broadened the idea of Planck. In addition to being emitted as quanta, light moved as quanta and absorbed as quanta.

2 Duality of matter and radiation

The Young's experiment and the photoelectric had given light two characteristics. The first experiment was interpreted as light moving as waves. The second experiment settled light as moving as particles. Light assumed a dual character. de Broglie, in his doctoral thesis, extended the dual character of light to matter[5]. As a consequence, an electron, for example, had to be considered both as a particle and as a wave.

Davisson and Germer scattered a beam of electrons by a nickel crystal[6]. The resultant pattern of concentric rings with alternate darkness was interpreted as diffraction. This was immediately taken as another proof of electrons behaving as waves. The nature of electrons as particles was blurred by their waves. The experiment further strengthened duality of matter as proposed by de Broglie. We learned these lessons of physics as students to be passed on to our students for about last hundred years.

3 Structure of an atom

A spectrum is a signature of an atom. Since the days of analysis of light by a stroboscope, the spectrum of light has remained the identity of an atom. Bohr calculated the energy levels of atom assuming the orbits to be circular. Wilson-Sommerfeld introduced the elliptical orbits raising the quantum numbers and multiplicity of orbits. The relativistic consideration further modified the electronic motion within the atom[7].

A spinning electron was revealed after Dirac solved the relativistic equation for electron. The up and down spins have taken the quantum numbers to four[8]. Pauli finally reserves a set of four quantum numbers for one atomic electron only[9]. A notable idea emerging from the magnetic properties of an electron in a magnetic field is space quantisation[10] with substantial verification by Stern-Gerlach[11].

The structure of an atom defined and described above adequately explains the spectrum of an atom. The process of excitation of an electron to a higher level, its de-excitation to emit a photon, the determination of wavelength of the emitted photon, the splitting of a spectral line by magnetic field, etc. have provided immense confidence to our understanding of an atom since the day an alpha particle was bounced back by an atom in the Cavendish laboratory of Ernst Rutherford. The result was explained without considering the impinging alpha particles as matter waves[12].

The spectrum of an atom was also obtained and explained without considering the atomic electrons as waves. The application of the Schrödinger equation to hydrogen atom, for example, has replaced the picture of the electron revolving in shells and sub-shells by probability cloud[13]. However, the solution of the Schrödinger equation for hydrogen atom explained the magnetic quantum numbers which were introduced classically in the vector model of hydrogen[14].

4 Photon and electromagnetic wave

The process of excitation and de-excitation of an atomic electron involves discrete energy. There are no other process to produce discrete photons except by excitation and de-excitation of an atomic electron. A photon originates only in de-excitation of atoms and molecules. The electromagnetic waves, as un-riddled by Maxwell, are produced continuously by oscillating free charges, for example, in a conducting wire activated by an alternating current. The atomic electron does not produce electromagnetic waves on a continuous basis. A photon and an electromagnetic wave, though they originate differently, are of the same speed, but of different nature. A photon of visible light or x-rays or gamma rays is a discrete packet of electromagnetic energy given by a frequency.

Production of an electromagnetic waves stretching to even a kilometre range is a different proposition. Such a wave fails to eject an electron from a metallic foil. This indicates that an electromagnetic wave does not collapse to a photon on reaching a foil to eject an electron. Only when an electromagnetic wave is quantised, using a mathematical procedure, the photons are the resulting quantum units. A photon may be perceived as an entity distinct from an electromagnetic wave without any loss of physics.

5 Quantum Electrodynamics

Feynman, Schwinger and Tomonaga developed the theory of quantum electrodynamics, QED, which is considered to be the most fundamental and elegant theory of physics. QED is the theory of an electron and a photon in great detail. It explained all the known properties of light assuming it to be only photons. Feynman and others were absolutely convinced that light was not a wave. Light as a wave offer no explanation for clicking of the photomultipliers in the double slit experiment[15]. As we know Feynman replaced the photographic plate by photomultipliers to detect the photons after they pass through the slits.

The double slit experiment re-designed by Feynman has far-reaching consequences for quantum mechanics. The most important result is that a photon, when tracked, passes through only one of the two slits at a time. It doesn't split to pass through both the slits at the same time. The click is heard from either of the two detectors kept at the two slits. Feynman could explain the observed pattern on the screen on the basis of photons passing through the slits, one photon through one slit at a time. Likewise, only one detector on the screen clicks at a time, confirming that light falls on the slit as photons, and moves as photons between the slits and the screen.

The nature of light is, therefore, not dual in the framework of QED. As a consequence, the basis of de Broglie's extension of duality to matter is without any parity with QED. The theory and the success of QED lies in agreement between the theoretical and experimental values of magnetic moment of an electron[16]. The had no requirement of de Broglie's matter waves and Schrödinger's wave equation anywhere. Feynman considered the Schrödinger equation only as a mathematical construct.

6 A plausible new description

An electron in any state of motion possesses an electric field surrounding it due to its charge. The electric field, visualised through lines of forces, is part of an electron. Again, any motion of an electron, linear or angular, is like a small current. A uniform motion of an electron produces a magnetic field with lines of forces curling the direction of the current. The magnetic lines of forces are also part of an electron in motion. Both the electric and the magnetic characteristics of an electron in motion are its permanent features. The two fields do not couple to form an electromagnetic wave in case of an un-accelerated motion of an electron.

Every atomic electron possesses a magnetic moment due to its motion caused by the attraction of the nucleus. An atomic electron also possesses a magnetic moment due to its spin. Both the momenta need to be coupled to explain the finer splitting of the spectral lines. The idea of such coupling is extended to the whole atom to account for the magnetic classification of materials[17]. The existence of two magnetic moments of an atomic electron, therefore, does not lack experimental evidence.

An electron, whirling in an atom, is accompanied by its electric and magnetic fields. However, the two fields do not couple to form a combined electromagnetic field. This follows from the fact that atomic electron is not known to emit energy as electromagnetic waves. This is true for an atom also with its electrical neutrality. The non-emitting character of an atomic electron was a postulate in Bohr's planetary model of an atom. Notwithstanding the changes introduced in the Bohr model, the permanent features of an atomic spectrum still lend credence to the non-spiraling of the accelerated electron into the positive core, the existence of energy levels, the processes of excitation and de-excitation leading to the spectrum.

It seems reasonable, in absence of any emission of energy by an electron whirling in a Bohr's permitted path, to assume that the electric and the magnetic fields of an atomic electron stay with electron in some configuration. It is plausible to assume that the complex configuration forms some sort of an envelope around the matter-only core part of the electron. The envelope accompanies the electron all the time. It becomes a permanent part of an electron's 'point-like' description.

The suggested envelope is non-dispersive as it does not emit any energy, stays with the electron and becomes part of its identity. A convenient analogy of an electromagnetic envelope of a matter-only electron may be the atmospheric envelope of the Earth. As a consequence, the dimension of an electron should consist of the matter-only core and the enveloping electromagnetic fields. The purpose of this article is to stress upon this aspect of an atomic electron.

7 Conformity with de Broglie relation

When such an electron moves with momentum p, the minimum distance it moves is equal to its dimension, say d. In traversing d the electron performs the minimum action equal to Planck constant h satisfying the relation $d \times p = h$ [18]. This conforms with what de Broglie proposed for the matter waves. This similarity appears to support the idea of electromagnetic envelope of an electron proposed in this article.

Two experiments are cited as proof of existence of de Broglie matter waves. First, Davisson and Germer scattered electrons by a nickel crystal and obtained a diffraction pattern. $\lambda = \frac{h}{p}$. Second, electrons produce an interference pattern as they pass through the arrangement of two slits lying close together. The explanation of both the experiments requires two ideas. First, the idea that the electrons are matter waves with lengths given by the de Broglie relation, Second, the matter waves should collapse to be detected by the photographic plate, or by a series of photomultipliers as envisaged by Feynman. Feynman abhorred the idea of a wave collapsing, and, in fact, termed it as a 'magic'[19].

It is interesting that the assumption of an electromagnetic envelope around the matter-only electron may offer interpretations of both experiments as the dimension d of the enveloped electron is given by a relation identical with de Broglie relation for matter waves. The idea of enigmatic matter waves and the requirement of their collapse are not worrying factors in the proposed model of matter-only electron surrounded by an electromagnetic non-dispersive envelope.

8 A role of the envelope

The idea of an enveloped electron offers a more plausible mechanism of excitation and de-excitation processes. When an external photon falls on an atomic electron, it falls on the envelope. As the incident photon is a packet of electromagnetic energy and the envelope also possesses non-dispersive electromagnetic entanglement, the envelope may conveniently absorb the photon and transit to a higher energy level.

Once that scenario is presumed, the absorbed photon disengages from the envelope to facilitate de-excitation to the earlier level. Though there is ambiguity about how electrons 'dance around', to use a phrase of Feynman, in an atom the permanency of spectrum of an atom offers credibility to shells and sub-shells in agreement with Pauli's exclusion principle. Pauli's principle adequately explains the unchanging spectrum of an atom.

That an atomic electron possesses an electric field, that the moving electron creates a magnetic field, that the whirling electron does not radiate electromagnetic energy, and, therefore, the fields may form an envelope around the electron, and the matter-only electron and the envelope should stay together to facilitate a new plausible description of an atomic electron.

9 Motivation

The important motivation to think about an alternative approach came from de Broglie himself. The idea of matter waves was introduced by de Broglie in 1924. Physics has no explanation of what the matter waves are till now. In 1964 de Broglie remarked: 'In recent years, I have been led to regard the concept of complementarity with increasing suspicion.' The wave-particle duality resulting from the de Broglie hypothesis is interpreted as particle and wave aspects complementing each other.

The other reason to look for an alternative idea was equally compelling. The Schrödinger equation which produces the mathematical matter waves is not used in the theory of quantum electrodynamics developed by Feynman and others. It is equally noticeable that scientific literature is missing further works of both de Broglie and Schrödinger on application of their own ideas.

10 Conclusion

The idea of a matter-only electron to be surrounded by a complex non-dispersive non-radiating envelope of the electron's own electric and magnetic fields is a distinct possibility. It has the potentiality of offering explanations for the processes which were earlier explained by assuming an electron as a packet of illusive matter waves as stipulated by de Broglie.

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Article

From Physics to Artificial Intelligence

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The 2024 Nobel Prize in Physics took an unexpected yet profoundly fitting turn as it celebrated the minds that brought the worlds of physics and artificial intelligence (AI) together. John J. Hopfield and Geoffrey Hinton, pioneers in machine learning, were honored for their groundbreaking contributions to artificial neural networks [1]. This helps in transforming how machines "think," learn, and interact with the world. This award underscores a growing truth that the boundaries between scientific disciplines are blurring. Physics, often seen as the science of the universe's fundamental forces, is now powering the algorithms behind AI, which is the technology at the heart of everything from self-driving cars to ChatGPT. Artificial Intelligence is a big set comprising subsets including machine learning, neural networks, deep learning, and convolution network learning (Figure 1).

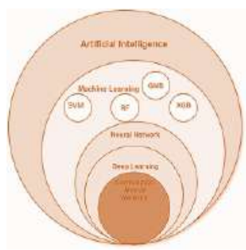

Fig. 1 The connection between the most widely used AI techniques. Reproduced from ref. [2], distributed under the terms of the Creative Commons Attribution License (CC BY).

In the 1980s, John J. Hopfield, a physicist, introduced a revolutionary idea of machines that could be modeled to work like associative memory systems, similar to the human brain. Known as Hopfield Networks, these models use concepts from statistical physics to allow machines to recall patterns, even when information is incomplete or noisy [3]. Hopfield's innovation was inspired by condensed matter physics and has become a cornerstone of early AI, proving that physical principles could teach machines to "remember" and reconstruct complex data patterns [4, 5]. Hopfield's networks were among the first to showcase that ideas from physics such as systems, equilibrium, and energy landscapes could fuel new approaches to computational intelligence.

In parallel, Geoffrey Hinton, often regarded as the *Godfather of AI*, developed the backpropagation algorithm, which revolutionized machine learning. He developed techniques that made machines smarter by helping them "learn" from their mistakes. Hinton's key contribution was the backpropagation algorithm, a method where neural networks fine-tune their performance by comparing predictions to actual results and minimizing errors [6-8]. This learning process, inspired by brain behavior, became fundamental to modern AI. His team's victory in the 2012 ImageNet competition, where a neural network achieved unprecedented success in image recognition, marked the dawn of AI as we know it today. Hinton's work has since fuelled technologies like speech recognition, computer vision, and natural language processing. Hinton's backpropagation unlocked the full potential of neural networks, leading to breakthroughs in machine learning that are transforming industries and daily life.

As Hopfield and Hinton's work shows, understanding complex systems whether atoms in condensed matter or neurons in artificial networks, requires physics at its core. The statistical mechanics of systems underpins how neural networks operate, balance energy, and make connections.

The Nobel Committee emphasized that the contributions of Hopfield and Hinton illustrate how complex systems, whether physical (atoms and molecules) or computational (artificial neurons), operate under shared fundamental principles. The statistical mechanics governing energy landscapes in physics also describe how neural networks stabilize into optimal configurations to solve problems. This award marks a turning point, highlighting the profound connections between physics and computational intelligence, where insights from one field propel advancements in another, and the boundaries of scientific disciplines increasingly blur.

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Some Scientific News

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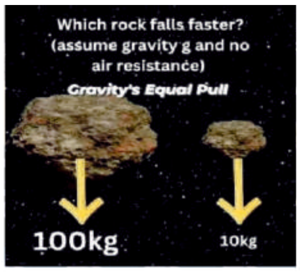
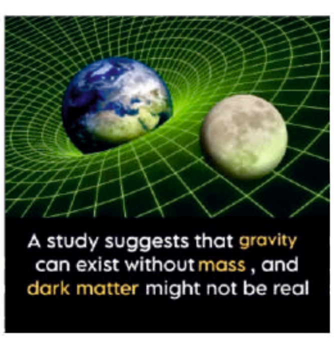


In the absence of air resistance and assuming gravity is the only force acting, both rocks will fall at the same rate regardless of their masses. This is because the acceleration due to gravity is constant at approximately 9.8 m/s^2 near Earth's surface. According to Newton's second law, the force acting on each rock is proportional to its mass, but since the acceleration is the same, both rocks will fall at the same speed. Thus, the 100 kg rock and the 10 kg rock will hit the ground at the same time.

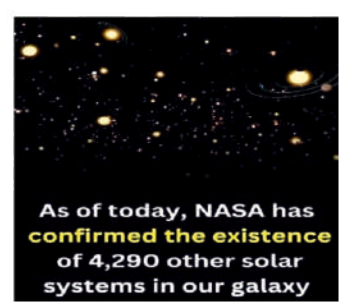
Escape velocity of a black hole is just an assumption because until now no object has done the stunt of moving faster than speed of light. So it may be correct or may not be.



Scientists have made a groundbreaking discovery that challenges our traditional understanding of gravity. According to research published in Physical Review Letters, gravity can exist without mass. This finding contradicts the long-held notion that mass is the sole source of gravitational force.

The study utilized quantum gravity theories and simulations to demonstrate that non-massive particles, such as photons, can generate a gravitational field. Experiments confirmed these theoretical predictions, revealing that gravity's source is not solely dependent on mass.

This breakthrough aligns with Einstein's General Relativity and has significant implications for understanding the cosmos and black holes. The discovery also raises questions about dark matter, potentially redefining our comprehension of the universe.



The research team's innovative approach has opened new avenues for exploring quantum gravity, providing a fresh perspective on gravity's fundamental nature. As scientists continue to unravel the mysteries of gravity, our understanding of the universe and its underlying forces will continue to evolve.

SUMMARY OF ORAL/POSTER
XI IAPT National Student Symposium on Physics (NSSP2024)
ABSTRACT/SUMMARY OF ORAL PRESENTATIONS AWARDEES

ID: O4 **Category: 1st Prize**

SPACE JUNK: A GROWING THREAT TO EARTH'S ORBIT AND ENVIRONMENT – CHALLENGES AND SOLUTIONS

Presented by
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Space junk, also known as orbital debris, refers to defunct human-made objects in Earth's orbit, including non-functional satellites, spent rocket stages, and fragments from disintegration or collisions. The rapid increase in space activities, especially since the launch of Sputnik in 1957, has resulted in a growing accumulation of debris, posing significant threats to space missions, satellites, and even Earth's natural environment.

The proliferation of space junk presents several adverse effects. In space, it poses a serious risk to operational satellites and the International Space Station (ISS), increasing the likelihood of collisions that could generate more debris in a cascading effect known as the Kessler Syndrome. This could make low-Earth orbit (LEO) increasingly hazardous for future space missions and commercial satellites.

On Earth, larger pieces of space debris occasionally re-enter the atmosphere, posing risks to human life and property. While most of the debris burns up on re-entry, larger objects can survive, as seen in past incidents where space debris has landed in populated areas. Additionally, the debris problem contributes to the growing pollution of space, reflecting sunlight and interfering with astronomical observations.

ID: O1 **Category: 2nd Prize**

STUDY ON SPATIAL & TEMPORAL VARIATIONS OF AEROSOL AND WEATHER PARAMETERS OVER 5 LOCATIONS OF NER REGION

Presented by:
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This study investigates the spatial and temporal variations of aerosols and weather parameters across five locations in the North Eastern Region (NER) of India: Dhubri, Guwahati, Jorhat, Dibrugarh, and Silchar. Aerosols, including black carbon (BC), significantly influence climate dynamics and human health. They originate from both natural and anthropogenic sources, impacting atmospheric conditions through interactions with cloud formation, precipitation, and temperature. Using secondary data from 2013 to 2022 on temperature, precipitation, black carbon levels, and aerosol optical depth (AOD), sourced from NASA's EOSDIS Earth Data API and analyzed using MERRA-2 reanalysis data, the study identifies critical trends and interactions.

Key Findings:

1. **Aerosol Optical Depth (AOD):** The analysis reveals an overall increasing trend in AOD in four of the five locations, with Dhubri exhibiting the highest values. This suggests a rise in aerosol concentration, which reduces the amount of direct sunlight reaching the Earth's surface, potentially affecting regional climate conditions.
2. **Black Carbon (BC):** Black carbon, a major component of fine particulate matter (PM2.5), contributes to atmospheric warming due to its high light absorption capacity. A declining trend in BC levels across all five locations indicates potential improvements in air quality or shifts in emission sources.
3. **Temperature:** Aerosols influence temperature by scattering and absorbing solar radiation, resulting in both cooling and warming effects. The study observed a decreasing temperature trend across all sites, which may be linked to increased aerosol concentrations and altered atmospheric dynamics.
4. **Precipitation:** Aerosols impact precipitation patterns by modifying cloud properties and dynamics, leading to either enhancement or suppression of rainfall. The study noted a general decline in precipitation across the locations, with Jorhat experiencing the most significant reduction, which could affect water resources and agricultural productivity.

Conclusion:

The study concludes that rising aerosol levels, particularly AOD, and declining black carbon levels are associated with decreases in both temperature and precipitation in the NER region. These findings highlight the complex interactions between aerosols and weather parameters, emphasizing the need for comprehensive strategies to address the environmental and health impacts of aerosols in the region.

Key Words: Black Carbon (BC), Aerosol Optical Depth (AOD), Temperature, Precipitation & PM 2.5

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ID: O7 **Category: 3rd Prize**

SIMULATION OF A FRICTIONLESS STOCK MARKET USING PRINCIPLES OF GEOMETRIC BROWNIAN MOTION

Presented by

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Brownian motion as a physical phenomenon was discovered in 1827 by botanist Robert Brown after whom it is named. In 1900, French mathematician Louis Bachelier introduced the concept of Brownian motion in financial markets through his thesis *Théorie de la spéculation (Theory of speculation)*. Later, broader applications of Brownian motion in the finance were devised, based on the works of British mathematician Paul Samuelson on Geometric Brownian Motion (GBM). Geometric Brownian Motion is a continuous-time stochastic process used to model the behaviour of stock prices or other financial assets. In this paper, I present a simulation of a frictionless stock market based on the GBM models. The mathematical model applied in this work is based on Stocastic Differential Equation that gives the Drift (average return over time) and Volatility (fluctuations in the market). The stock prices are modelled as analogous to small particles exhibiting Brownian motion. The stochastic differential equation (SDE) that defines GBM is:

$$dS_t = \mu S_t dt + \sigma S_t dW_t$$

where S_t is the price of asset at time t, μ is the drift rate, σ is the Volatility factor, and W_t is the standard Brownian motion (Wiener Process). The code used in simulation is in Python programming language and the plots are done The stock data used is easily available online.

ID: 18 **Category: 3rd Prize**

INVESTIGATING SOLAR ACTIVITY: A SHORT-TERM ANALYSIS OF SUNSPOTS AND WOLF NUMBERS

Presented by

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This study presents a short-term analysis of solar activity by examining the variation in sunspots and Wolf numbers. Sunspots, indicative of magnetic activity on the Sun's surface, directly influence space weather and terrestrial systems. Wolf numbers, derived from sunspot counts, serve as a quantitative measure of solar activity. The investigation involves tracking sunspot patterns and calculating Wolf numbers over a specific period to identify trends, peaks, and anomalies. The results provide insights into the short-term dynamics of solar cycles, contributing to a deeper understanding of solar-terrestrial interactions and enhancing predictive models for space weather events.

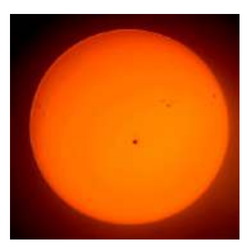

Figure: The optical image of the sun with sunspots captured on 8th October, 2024 with Smartphone attached to a 6 inch Dob-Newtonian telescope at Astro-science Centre & Observatory, USTM.

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Reports of Ammanni IAPT Anveshika

1. Stem Fair 2024

Date: 8/10/2024,**Time:** 10:30 – 12:30

Venue: SJCE Step, Mysore

Number of students: 50 students

Classes 8, 9, and 10,

Different schools in Mysore.

Resource person: M K Uma

Dasara Innovator's Fest was organized by Gravity Foundation and Piefly Aviation Jointly in Mysore on 8th and 9th of October 2024.

On the first day, I witnessed an interactive science session for students from various schools in Mysore.

Demonstrations regarding Newton's three laws of motion involved students' role play.Students participated in the potato race, catching a heavy falling bottle, pushing the wall, balancing a scale vertically and horizontally on fingertips, and making colored water stacks using straws.

Interactive demonstrations and explanations of the activities like burping bottles, regular and reverse Cartesian divers connecting bulbs in series and parallel, balancing coins on one another in a magnetic field, force on an electric current carrying conductor in a magnetic field, exploring the shape of train wheels, Stability of structures, etc. saw wonder and gleam in the eyes of participants. They too wanted to make such simple models to explore the subject.

Pic.1 Ms. Uma M K displayed, and students answered!

Pic. 2. Interactive session.

2. Date: 16 October 2024,**Time:**10:30– 12:30

Venue: Anvaya Public School, H D Kote Road, Mysuru, Karnataka.

No. of students -50 students

Class:8th, 9th, and 10th Standard

Topics covered: Optics and Electricity

Resource Person: Ms. M K Uma and Mr. Ramachandra Murthy

The first part of the session had a demonstration of experiments to make the students understand the concepts of conductors & nonconductors of electricity, Resistance, series and parallel connections of resistors, Power, and effects of electricity.

In the second half, rectilinear propagation of light, reflection through plane and curved mirrors, and refraction through glass slab, prism, and lenses were demonstrated and explained. Total internal reflection interested the curious students.

Slab and curved lenses were made from easily available low-cost materials.

Pic.3 Problem-solving techniques through games.

Pic. 4 Watch the fun!

3. Date:16 December 2024

Time: **14:00 to 16:00**

Number of students: 75 students

Classes: 8, 9 and 10

Venue: Little Lilly English Public School, Vidyaranyapura Bangalore.

Resource person: Ms. M. K. Uma and Ms. Sarmistha Sahu.

Starting with a story by H G Wells to bring out the difference between mass, density, and weight,demonstration and explanation were done on Physics topics: - Motion, Bernoulli's principle, Law of flotation,Electric current and its effects, Ohm law, Resistance and Power in series and parallel, Magnetic shielding, Light propagation, reflection and refraction of light, Total internal reflection, Sound and application of these in today's life. The students were on their toes to participate in the hands-on activities and unlock the wonders of science through experiments.

With guiding questions, the students were encouraged to understand the concepts.

The queries and doubts of the students were answered with appropriate demonstrations. The enthusiasm of the students and positive feedback encouraged the resource person to go deep into concepts.

Pic. 5 Is the green light bending??

Pic. 6 Concave and convex lenses from a discarded bottle.

4. Date: **19 December 2024**

Time: 14:00 to 16:00

Number of students: 120 students

Classes: 8, 9 and 10

Venue: Little Lillys Education Society, Mahalakshmi Layout, Bangalore**.**

Resource person: Ms. M. K. Uma

The session was interactive and meant to familiarize the students with the basic concepts of physics behind their day-to-day experiences. The workshop started with the concept of speed and average speed where the students were engaged in role-play. The importance of average speed was explained by citing how Google Mapsuses the average speed to find how much time it takes to go from one place to another.

The other topics discussed were: - Reaction time, Floatation, Bernoulli's principle, Resistance and its dependence on length and area, series and parallel connections and how they affect the illumination of a bulb, Magnetic effect of electric current, Fleming's rule, Electromagnetic induction. Every concept was explained with a working model.

The students were excited to 'see' the straight-line path of light followed by the bending of light in diffraction. Light can bend along tubes of water, even though they travel in straight lines - the principle of optical fiber!

Inquisitive minds need the right scaffolding at the right time, to bring out their best.

Pic. 7 Kids enjoy hands-on activity.

Pic. 8 The whole class learns by doing.

Coordinator

Ammanni IAPT Anveshika

Report -(RC05)

Nandini Raha Memorial Workshop on Physics Experiments

(Held at BES College, Kolkata, December 3-7, 2024)

The (RC15) of IAPT and the Bhawanipur Educational Society (BES) College, Kolkata jointly organized a Workshop in the memory of Prof Nandini Raha who taught generations of students, first in Bethune College and then after her retirement, in the laboratories of Presidency College/University. The 5-day programme (December 3-7, 2024) was named as Nandini Raha Memorial Workshop on Physics Experiments and it was designated as a short-term Certificate Course for the 1st Semester UG Physics students. The workshop was fully on laboratory experiments where the students had to perform a number of simple yet elegant and well-designed experiments. It was attended by more than 30 students from different UG colleges in Kolkata.

The workshop began with a brief inaugural session where Prof Sukti Maitra, one of the Joint convenors of the Workshop delivered the welcome address. The Teacher incharge of the BES College, Dr S. Gangopadhyay, and the Vice Principal (Science) Dr Pinki Saha Sardar spoke briefly on behalf of the college. Other speakers from IAPT were Prof Manimala Das, Dr Surajit Chakrabarti and Dr Bhupati Chakrabarti. The joint convenors for the Workshop were Dr Arnab Gangopadhyay (BES College), Prof Sukla Chakrabarti (IAPT). Dr Swati Das (IAPT) was the other joint Convenor.

The organizers tried to design the workshop as a coursework which would hopefully prepare the students from scratch without any prerequisite on their previous knowledge from class XII course. Experiments were setup where the students were trained in the basic measurement techniques of length, mass and time scales. An experiment was set up where the students measured the mass and volume of a metallic cylinder using a digital balance and a slide-calipers respectively and calculated the density of the metal. The students were asked to identify the metal and find its atomic weight from data tables available from reliable websites. They were asked to find the specific heat of the metal using a thermos flask and to figure-out how good their results were in comparison to the Dulong-Petit's law. Water flowing out of a polypropylene measuring cylinder with an orifice at the side of the cylinder at the bottom follows the Bernoulli's principle. Under this condition, the level of water comes down at a constant retardation. Measuring the retardation by video-graphy, students were asked to find the diameter of the orifice and then to check by measuring it with a travelling microscope. For this experiment the students had to draw a linear graph. After this they were trained to do a linear fit using GNUPLOT to find the results.

There was an experiment with magnets where two bar magnets were allowed to interact in end-on configuration. The lighter magnet was pulled up by another magnet while the second magnet was slowly brought down keeping the two magnets along the side of a ruler kept against a wall. Students had to find the time periods of angular oscillations of the magnets in earth's magnetic field. They had to find out the moment of inertia of the magnets for this oscillation. From these data they had to find the dipole-moments of the magnets and the horizontal component of earth's magnetic field.

There was an experiment with a bifilar pendulum where the students explored the power relationship through which time-period of oscillation is connected toseveral parameters. Both experiment and dimensional analysis is necessary for this.Another experiment involved the determination of density of solids using only a digital balance and employing the Archimedes Principle. Students determined the refractive index of transparent liquids using a convex lens. There was a task for data analysis for the cooling of water where different data were provided. Experiments were there where the students were trained in drawing nonlinear graphs. They learnt how to fit a power law using GNUPLOT and find the exponent. For these purposes, four desk top computers were arranged for the students with internet facility in a separate room in the laboratory. In two other experiments students were asked to figure out the elements inside an optical and an electrical black box.

Physics Experiments using a Smartphone

In this workshop aparticular stress was put on experiments based on the use of various sensors in smart phones. Experiments were set where the students were asked to make measurements from photographs taken by using the camera of a smartphone.For example, in one experiment students were asked to find out the focal length of the lens of a smartphone camera. This required finding out sizes of one pixel those are of the order of a micron on the camera sensors of the students' smartphones. Students were trained in finding them from the relevant website. In another experiment students could find the refractive index of water just by taking three photographs. The theme was to find the ratio of the real depth of an object in water to its apparent depth.In one experiment students were trained in the use of the accelerometer sensor in the smart phone to find the viscosity of an oil. Students were trained in different Apps available from the Play store, Phyphox for an example. In one experiment students found the velocity of sound using a resonance column with tones generated from Phyphox. In another experiment students worked with the light sensor in the smartphones and a Luxmeter app downloaded freely, to work on the light intensity.

The members of IAPT involved in contributing the experiments attempted to apprise the students about the modern developments in teaching-learning methods using a smartphone as is found all over the world. Samples of relevant research publications from international journals on physics education like The Physics Teacher, brought out by AAPT,USA and

Physics Education, brought-out by IOP, UK,were distributed among the students to provide them with an exposure to the different aspects of modern laboratory trainings. Students were excited with the new-approaches taken in the workshop and they worked hard throughout all 5days of the workshop. Most of the students could finish around 10 experiments with confidence that led to the reasonably good results. Most of the experiments were such that with minimum equipment, students could perform the experiments even at home with the help of their smart-phones and a few easily available materials. For this purpose, a Whatsapp group was formed including all the participants and all the Resource Persons. Students were motivated to perform all the experiments that are possible to do at home and continue interacting with the resource persons through the WA group. In summary, the participating students enjoyed the workshop enormously which was the main aim of the organizers.

Concluding Session

In the concluding session the participants received certificates and some of them briefly shared their experience of the Workshop. Dr C K Ghosh spoke on behalf of IAPT. All the faculty members and the laboratory staff of the Physics Department of The BES College provided an excellent academic support to the programme. The authorities of the College played a big role in running the workshop smoothly by providing all sorts of support. All these led to a great success of the workshop and the students could feel they have undergone a good learning experience in laboratory physics. Moreover, many IAPT Life members visited the BES College during the workshop and encouraged the participants in their work. It was a true tribute to the memory of Nandini di (Prof Nandini Raha) who always stressed the importance of laboratory training in physics.

A section of the participants

A section of the teachers

Surajit Chakrabarti
Bhupati Chakrabarti

Report (RC-23)

Advancing Physics Education: A Landmark Lecture Series on Physics Education Research

Physics Education Research is a sub field in Physics that blends physics, cognitive science, and education theory to explore how students learn physics, the challenges they face, and the best ways to help them overcome these hurdles. By investigating learning mechanisms, teaching strategies, assessment techniques, and curriculum design, PER aims to improve the overall experience of students in physics courses, from introductory classes to advanced university-level physics. In the ever-evolving landscape of higher education, Physics Education Research (PER) plays a crucial role in shaping the way physics is taught and understood by students worldwide.

Over the course of 18 months a comprehensive lecture series was carefully curated by inviting eminent International & National speakers of this field Physics Education Research including Nobel Laureate Carl Wiemann, offering a platform for educators to explore new research-driven techniques and share best practices and highlighted innovative practices that can revolutionize physics education across institutions globally. Dr. Sapna Sharma, Secretary Regional Council RC23, Himachal Pradesh coordinated the web logistics of the whole series by teaming with Central IAPT General Secretary Mrs. Rekha Ghorpade.

The Structure of the Lecture Series

The lecture series extended over 18 months, with each session addressing distinct aspects of Physics Education Research (PER). The lectures featured a blend of theoretical discussions, practical applications, and case studies, all aimed at highlighting key findings and best practices in the field. These talks have been classified into various themes of PER (Table 1) however, it is important to note that some of the content naturally overlaps across multiple categories.These themes collectively address key areas of PER, offering valuable insights into both theoretical and practical aspects of physics teaching and learning:

1. Curriculum Development and Instructional Materials
2. Pedagogical Approaches in the Classroom
3. Development and Assessment of Concept Inventories
4. Technology Integration and Evaluation of Instructional Interventions
5. Conceptual Understanding and Problem-Solving in Physics Education

The talks by speakers were designed not only to disseminate information but also to nurture a sense of community among physics educators. Participants had the opportunity to engage with the speakers, ask questions, and participate. The discussions provided valuable insights into how education in physics can be transformed to meet the needs of modern students. One of the most significant outcomes of the series was the creation of a platform for ongoing collaboration among educators in the field. Many participants expressed an eagerness to apply the new knowledge in their own teaching practices and to continue engaging with the PER community for future growth.

Table 1: Details of Talks Delivered

S.No	Topic	Speaker	Chairperson	Date	Theme
1.	From Physics Derivations to Computational and Interdisciplinary Modeling-Taking the Vision of NEP 2020 Forward	Dr. Mashood KK Faculty at Homi Bhabha Centre for Science Education, TIFR, Mumbai.	Prof. P.K. Ahluwalia, President IAPT	04.03.2023	Curriculum Development, Instructional Materials and Specific pedagogy in classroom.

2.	Facilitating thinking and learning in and beyond the physics classrooms using research-based approaches	Prof. Chandralekha Singh, Professor, Departmentof Physics and Astronomy, and the Founding Director of the Discipline-based Science Education Research Center (dB-SERC) at the University of Pittsburgh	Prof. P.K. Ahluwalia President IAPT	15.05.2023	Curriculum Development, Instructional Materials and Specific pedagogy in classroom.
3.	Implications of pedagogy and its relevance in advanced physics learning	B. N. Meera Professor in the Department of Physics, Bangalore University.	OSKS Sastri Professor, Department of Physics and Astronomical Science CU Himachal Pradesh	10.06.2023	Curriculum Development, Instructional Materials and Specific pedagogy in classroom.
4.	Science Education: Science or Art?	Professor Vijay A. Singh, Former President, Indian Association of Physics Teachers (IAPT), Former National Coordinator, Science Olympiads and the National Initiative on Undergraduate Physics (NIUS)	Prof. Y.K.Vijay Director - Centre for Innovation in Science Teaching (CIST) IIS, Deemed to be University Jaipur	23.07.2023	PER
5.	Developing next generation assessments: Promoting scientific practices and providing actionable feedback	Dr.Amogh SirnoorkarDepartment of Physics, Kansas State University.	Dr. Mashood K.K Faculty at Homi Bhabha Centre for Science Education, TIFR, Mumbai.	20.08.2023	Development & Assessment of Concept Inventories.
6.	From Classroom to Laboratory and Exam: Physics Questions Powered by Smartphone Experiments	Dr. Praveen Pathak Faculty at Homi Bhabha Centre for Science Education, TIFR, Mumbai.	Prof. Arvind. Padamshri & Former Centre Director, Homi Bhabha Centre for Science Education, TIFR, Mumbai.	24.09.2023	Technology & Evaluation of Specific Instructional Intervention
7.	Disciplinary Practices and Physics Education Research	Prof. Arvind, Former, Padamshri & Former Centre Director, Homi Bhabha Centre for Science Education, TIFR, Mumbai.	Prof. Vijay. A. Singh, Former President IAPT	22.10.2023	Conceptual Understanding and Problem Solving.

8.	Role of IAPT in Quality Physics Education & Spreading Physics Pedagogy & PER Practices	Prof. P.K.Ahluwalia National, President IAPT	Prof. P.C. Deshmukh. Professor, IIT Triputi	03.12.2013	PER
9.	Activity Based Modules in Elementary Thermodynamics*	Dr. Shirish Pathare, Faculty, HBCSE, TIFR, Mumbai.	Dr. R.M. Shewale, President IAPT RC08	17.12.2023	Instructional Materials and Specific pedagogy in classroom.
10.	Simulation Methodology	OSKS Sastri Professor, Department of Physics and Astronomical Science CU Himachal Pradesh	Dr. Uthara Dorairajan	17.03.2024	Technology & Evaluation of Specific Instructional Interventions
11.	Taking Scientific Approach to Physics Education	Prof. Carl Wieman, Nobel Laureate &PER Pioneer, Stanford University	Prof. P.K.Ahluwalia, President IAPT	17.04.2024	PER
12.	Interactive Lecture Demonstrations (ILDs): A Research-Validated Strategy to Improve Learning in Introductory Physics Lecture (and virtually)	Prof. David R. Sokoloff, Dept of Physics, University of Oregon & Past President AAPT	Rekha Ghorpade, Secretary IAPT	23.05.2024	Technology & Evaluation of Specific Instructional Interventions
13.	Future proofing physics teacher professional learning in Ireland	Eilish McLoughlin School of Physical Sciences & CASTeL, Dublin City University, Ireland	Dr. Praveen Pathak, faculty member at Homi Bhabha Centre for Science Education	30.06.2024	PER
14.	Role of Experiments in Teaching Physics	Dr. Ajith Kumar	Y.K. Vijay	21.07.2024	Technology & Evaluation of Specific Instructional Interventions
15.	My Experiences in PER: Some Thoughts, Current Trends & My Work	Dr. Ravishankar	K.K. Mashood	25.08.2024	PER
16.	Encouraging Responsive Practices in Science & Mathematics Teaching	Dr. Deepa Chari,	Ms. Rekha Ghorpade	29.09.2024	Curriculum Development, Instructional Materials and Specific pedagogy in classroom

17.	Databot: A New Paradigm for Sensors in Physics Education	Mr. Robert Grover	Dr. Govind	20.10.2024	Technology & Evaluation of Specific Instructional Interventions
18.	Quantum Physics & quantum Technologies: New Teaching Approaches	Prof. Gesche Pospiech	Dr. Arvind Kulkarni	30.11.2024	Technology & Evaluation of Specific Instructional Interventions

Conclusion

The 18-lecture series on Physics Education Research was an invaluable event that deepened the understanding of how physics can be taught more effectively. With cutting-edge insights from renowned physicists, the series offered both theoretical and practical knowledge that will undoubtedly shape the future of physics education. By bringing together experts, educators, and students, the event adopted a collaborative spirit aimed at transforming how physics is taught and learned, ultimately leading to a more inclusive, engaging, and effective educational experience for all.The lecture series emphasized the need for continuous professional development for physics educators. It highlighted that as research in physics education evolves, so must the teaching strategies and resources employed in the classroom. In future the workshops can be planned and conducted on the above said themes.

Sapna Sharma
Secretary (RC-23)

Announcement

Executive Committee for RC-6 for the period 2025-27

New RC is finalized in presence of Returning Officer, Dr K C Swami (L4787) kc.swami@yahoo.co.in

S. No.	RC6 Designation	Name of RC 6 Member	Life Membership	Mail ID
1.	President	Prof. KS Sharma	L0961	ks.sharma@iisuniv.ac.in
2.	Vice President	Dr. Yogesh Bhatnagar	L2322	yohesh_bgjp@yahoo.com
3.	Secretary	Dr. Ritu Jain	L5116	ritujainicg@gmail.com
4.	Treasurer	Dr. Vipin Jain	L5123	vipinjain7678@gmail.com
5.	National EC Member	Prof. Y C Sharma	L5112	yc.sharma.vit@gmail.com
6.	Member	Dr. Pura Ram	L7646	puraram@uniraj.ac.in
7.	Member	Dr. Subodh Shrivastava	L5124	subodhphy@gmail.com
8.	Member	Dr. Balram Tripathi	L5102	balramtripathi1181@gmail.com
9.	Member	Dr. Shyam Sunder Sharma	L5107	sharmass2@gmail.com
10.	Member	Dr. G. S. Sharma	L4825	gsphysics@gmail.com
11.	Co-opted Member	Manish Dev Shrimali	L4366	m.shrimali@gmail.com
12.	Co-opted Member	R. K. Parashari	L3461	parasharisir@gmail.com
13.	Outgoing President	Prof. Y. K. Vijay	L0097	vijay.yk@gmail.com
14	Outgoing Secretary	Ashish Arora	L5109	ashash12345@gmail.com

Ashish Arora
Secretary (RC-06)

IAPT National Competition on Essay Writing in Physics (NCEWP - 2025)

Writing makes one perfect, essay writing more so……

Broad Topic: - A Journey of 100 years of Quantum Mechanics

Max Planck: Originator of quantum theory renounced previous physics and introduced the concept of 'quanta' of energy. These are small 'packets' that can only hold certain, prescribed amounts of energy. In 1959, physicist **Richard Feynman** recognized that quantum mechanics, with its unique properties like entanglement, superposition, decoherence, coherence, tunnelling, and teleportation, held the key to solving complex quantum problems.

In what's considered the first quantum revolution of the 20th century, scientists observed quantum properties that enabled development of technologies such as lasers, the transistor, magnetic resonance imaging, and semiconductors

The second quantum revolution is all about controlling individual quantum systems, such as ion molecules, spins, quantum dots, to a greater extent than before, enabling even more powerful applications in quantum computing and quantum information. UNESCO has declared 2025 as the International Year of Quantum Science and Technology. IAPT being a Physics Society feels privileged to be part of this celebration and this IAPT NCEWP-2025 is dedicated to the pioneers of quantum science and Technology.

NCEWP is one of the four national competitions being held by IAPT every year. The competition is open to participants in two categories viz., students and teachers (including Science Communicators).

Category A - Students of (i) Higher Secondary /Jr. College, (ii) UG and (iii) PG level; **Category B** - Teachers of (i) Higher Secondary/Jr. College, (ii) UG and (iii) PG institutions, also Science Communicators working in recognized institutions.

You may write your entry for the essay competition keeping following points as broad guidelines to make your entry stand out

1. Early Developments
2. Experimental Evidence of hypothesis and theories of quantum mechanics
3. First Quantum revolution
4. Second Quantum revolution
5. Brief description of some recent developments in quantum mechanics e.g., Quantum entanglement, Energy teleportation, Machine learning, Quantum resistance standard, Infrared detectors, Quantum sensing, Laser technique, Superconducting circuits, Qubits, Quantum technology
6. Quantum scientists and their contributions
7. Emergence of quantum technologies for the good of mankind
8. Future Possibilities

Note: It is only a guideline and not a structure for your essay. Imagine a title for your essay, be creative, scientific and innovative. Distil your thoughts on paper.

General Instructions:

(1) The essay will be limited to A4 size 10 pages including figures/tables etc. type-written in the Times New Roman 11-point fonts, with 1.15 spacing. Please do not exceed the page limit.

(2) Hand written and scanned documents are not allowed.

(3) Each participant will be given **e-certificate.**

(4) Participants will provide the following

information with their Essay.
Name……
Class/ Course……… Identity card copy
Name of the School/ College/Institution…….
E-mail……. Contact No….

A format for the essay is given below:

IAPT National Competition on Essay Writing in Physics: 2025 (NCEWP – 2025)

Broad Topic: - A Journey from Classical to Quantum World

I. **Category:** A or B (Tick your category)

II. **Title of the Essay** (Font Size 14) (Choose a suitable title of your essay, short and Crisp)

III. **Count of Words**: 5000 or 10 to 12 A4 size paper

IV. **Author's Details** (with Affiliation & Signature) (Font size 12)

V. **Abstract:** in 150 words (Font Size 10) Key Words (Maximum Five)

VI. **Body of the Essay:** not more than 10 A4 size papers, you can include pictures, graphs, tables, infograph and other structures in your paper. (Font size 11) Add bibliography at the end of the papers, resources, websites, books etc. you have used in writing the essay.

Important Instructions for conduct and participation in IAPT Essay Competition NCEWP-2025

a) ***Who will conduct the Competition?*** All the Regional and Sub Regional Councils (RC's and SRC's) will conduct the regional level essay competition digitally by announcing the last date of submission of paper by 15th July2025

b) ***Who can receive the essays digitally?*** Higher Secondary/UG/PG students can submit their essays through e-mails to President/Secretary/EC member of the respective regional council. Only two entries per institution may be submitted in a category.

c) ***How to send essay?*** Students will send their entries duly forwarded through respective school/college/institute to the appropriate Regional Council (RC) with all contact details of the competitor (Name, email, mobile number etc. clearly).

d) ***How the scrutiny and selection of essays will be done at RC level?*** The RC's will have the initial scrutiny at their level. They will select 2 best essays from each level. Thus, each RC will submit 6 best entries to the national competition. RCs may award certificate etc., for their participants. Even the RCs may issue a certification of Participation to those whose Essays are sent to the National Competition.

e) ***Language for writing the essay?*** For the regional competition, students may write their Essays in Hindi or their regional languages. If such entries are forwarded for the National Competition, then the concerned RCs will translate the Essay in English (with the help of Google translator etc.). Only **English Version** of the submitted essay has to be submitted/forwarded for National Level Competition.

f) ***Whom to send entries of Science Communicators, teachers:*** Teachers & Science Communicators will send their entries through e-mails duly forwarded directly to the Coordinator NCEWP. Retired teachers can self-attest their entry.

g) ***Evaluation Process:*** All entries will be assessed by three evaluators. All entries (in English only) will be scrutinized reviewed and ranked.

h) ***Plagiarism Check:*** **All entries will be subjected to an online plagiarism test. Essays found failing in test will be rejected out rightly.**

i) ***LAST DATE of submission:*** The last date for essay submission is **July 30, 2025.** Final entries for the national competition must be submitted in PDF format by e-mail to any one of the following:

- **Prof. S. K. Joshi, Coordinator, NCEWP-2025**
  joshisantoshk@yahoo.com (M) 09893084286
- Dr. Viresh Thakkar, Member,
  vireshhthakkar@gmail.com
- Dr. Runima Baishya, Member,
  runimabaishya@gmail.com
- Dr. V. Rajeshwar Rao, Member,
  drvvr_kitss@rediffmail.com

Feel of Quality: To get a **feel of the quality of this essay writing competition on Physics**, visit our website NCEWP page:
https://www.indapt.org.in/f/Essay-Writing-NCEWP-19875?source=view to download winning entries of the past competitions available in the form of e-books.

Announcement

IAPT Regional Council 08, Maharashtra

Executive Council (Jan. 01, 2025 –Dec. 31, 2027)

Elections to the posts of IAPT RC-8 office bearers was conducted for the posts of Vice President and Secretary, through ballot papers to reach the RO up to 14th December. Counting of the votes was held on 19th December 2024. Following is the Election result indicated the candidates elected.

Name of Post	Total votes Casted	Name of Candidate	Votes Received by Candidate	Result
Vice President	**620**	Dr Kamalakar Marutirao Jadhav	**440**	Dr Kamalakar Marutirao Jadhav declare Elected
		Prashant Wamanrao Ambekar	**180**	
Secretary	**551**	Rajesh Kashinath Nimat	**367**	Rajesh Kashinath Nimat declare elected.
		Gajanan Lalsing Jadhav	**184**	

Returning Officer (RC-08)
Dr. Rammanohar A. Mishra
Principal, Amolakchand Mahavidyalaya, Yavatmal
Email: mishrarammanohar@gmail.com
Mobile: 9890047278

Announcement

The list of office bearers of IAPT-RC-03 (Chandigarh) for 2025-27

President: Prof. S.K. Tripathi, Professor, Dept. of Physics, Panjab University, Chandigarh-160014, Life Member- L3433, Phone: 9876581267, Email: surya@pu.ac.in

Vice-President: Vacant

Secretary: Prof. Ranjan Kumar, Professor, Dept. of Physics, Panjab University, Chandigarh-160014, Life Member- L4867, Phone: 8283084499, Email: ranjan@pu.ac.in

Treasurer: Dr. Amit Goyal, Asst. Prof., Department of Physics, G.G.D.S.D. College, Sector 32 C, Chandigarh, Life Member- L7179, Email: amit2iitb@gmail.com

Members:

1. Dr. Saroj Bala, Dept. of Physics, Sri Guru Govind Singh College, Sector 26, Chandigarh, Life Member- L7559, Email: dugusaroj23@gmail.com
2. Dr. Rajesh Sharma, Dept. of Physics, P.G. Govt. College, Sector 11, Chandigarh, Life Member - L5226.

3,4,5 - Vacant

Ex-Officio members

1. Immediate past President, Prof. C.N. Kumar
2. Vice-President [North Zone], Prof. Meenakshi Sayal
3. EC member RC-03, Dr. Sheoji Singh

Co-opted members

1. Prof. Manjit Kaur,
2. Dr. Sanjay Kr. Sharma

The incoming RC3 EC is authorized to fill the vacant positions at their first EC meeting.

Dr. Sheoji Singh (Returning Officer),
IAPT – RC-03.

Prof. H.C. Pradhan
An Academician who Provided a Great Leadership

During the festive period of Christmas and the oncoming New Year Prof H C Pradhan left this world putting all of us in IAPT in a state of deep shock and despair. He had some illness that made him confined to home for last couple of months or so, but he remained academically very active and mentally extremely alert even a few months back without getting bogged down by the decease and the associated issues that took his life.

Prof Pradhan was the Dean at HBCSE when I first visited the Centre in connection with the physics Olympiad programme. His pleasing personality could easily draw everyone's attention and I was no exception. And I came to know him first in a quite formal way. Later, when he became the Centre-Director of HBCSE I and some of our senior IAPT colleagues had the better opportunity to talk and interact with him more extensively. Yet I knew him in a limited way.

Prof Pradhan took up the responsibility of the President of IAPT taking his charge on January 01, 2013. With the suggestions and encouragement from some of the very senior members of IAPT and with the assuring words from Prof Pradhan I dared to take up the responsibility of the General Secretary of IAPT on the same date. And soon he could ensure that I work with him and not under him. This is the hallmark of a great academician and a leader and for me it was a journey that made me learn so many things even though I was well-passed my middle age by that time. But very soon I could feel and realise that he is a leader with whom one can work with dignity and comfort. I had the opportunity of observing him from very close quarters and could see how his personality endeared him with the IAPT members, senior or junior, coming from all the corners of the country. The great warmth of his personality could make any IAPT member feel at home when they used to come in contact with Prof Pradhan.

It is not known to many in IAPT that Professor Pradhan never took any travel support from the organization during his six-year tenure as the President. He always mentioned that since he was having a Fellowship and that provides him with some travel support, he was not interested to take any money from IAPT. He used his travel grants for the academic purpose with the IAPT programmes but he could have done it for other academic commitments as well. This goes to show his care for the organization.

Prof Pradhan always wanted to see IAPT to grow more as an academic organization where the academic activities would get the topmost priority. He had a very clear vision about transforming the IAPT into a thorough academic organization. And possibly that led him to stress upon this aspect in many of his talks. He wanted the IAPT examinations should be more systematic by involving more and more suitable members for question setting, vetting, critical academic discussions through some workshops where people can exchange their views and critically analyze the questions and their solutions. Incidentally it was before 2020 and hence the concept of online meetings did not enter our lives in a big way. However, now the things have improved in this regard where we can now have more online meetings through which some academic exchanges are possible. Prof Pradhan also felt that The Bulletin of IAPT should get more academic articles of better quality and should be a useful platform for the members to share their views on various academic issues. At the same time Prof Pradhan has provided excellent guidance for the IAPT work whenever I or anyone else in the EC had approached him with any organizational issue. He provided me significant amount of liberty to go through the organizational issues just providing a few advices and guidelines.

Even after 2018, when our formal responsibilities in IAPT were over I continued to remain in good touch with him. We had telephonic conversations may be once in every two months or so. I used to share the activities of IAPT with him but he had a much wider horizon before him to talk about. Prof Pradhan used to talk on various aspects that not only included physics but overall academic scenario of the country. In all conversations his concern about the quality enhancement not only in the academic activities of IAPT but everywhere else. Moreover, he used to make it a point to visit the HBCSE whenever some programme was organized by Physics cell and some IAPT members from different parts of the country gathered. He had to come down to HBCSE and meet IAPT colleagues and interacted with them with the usual smile and a sense of enjoyment in his expressions. He also came to know wide number of IAPT members from the different parts of the country as he came in touch with them during his tenure as the President of IAPT. Even in April 2024, when he was not keeping very well, he came to HBCSE during the

physics OCSC and met number of IAPT members with the usual enthusiasm.

During his tenure as the IAPT President various regional councils have invited him to visit their places and he was very particular to take up that travel. He went Tripura, one of our NE states and not only interacted with the IAPT members and academicians there but also met the then Chief Minister of the state. He came to Kolkata not only for the IAPT Convention but also for the C K Majumdar Memorial Workshop and delivered excellent talks for the students that the teachers equally enjoyed. He also made it a point to visit the Midnapore-College IAPT Centre for scientific Culture in Midnapore some 130 km from Kolkata.

He was not only a great academician he commanded great respect in the IAPT community. He used to listen to everyone, young or old, small, or big. His smile and a warm approach to anyone in IAPT made him a great leader. No doubt he belonged to that rare breed of people who remained so humble in spite of achieving great heights. His demise is my personal loss as I shall be deprived from the suggestions and observations emanating from his profound knowledge. His demise has made our IAPT community poorer.

Bhupati Chakrabarti

We will Miss You Professor Pradhan

It is shocking to hear that our very dear and esteemed Professor H C Pradhan breathed his on September 26, 2024. An erudite, soft spoken and always smiling was the touch of Professor Pradhan. He was a person to whom we looked up to whenever we wanted to have his advice on how to take IAPT forward and plan programs. And He always smiled. He steered IAPT for six years as President and took number of initiatives to improve the quality of its activities. Institution of IAPT DSM best teacher award was mentored by him. He was a doyen of Science Education Research in the country and contributed a lot to generate innovative resources, books and research studies in this area. He remained Director of TIFR HBCSE and Senior Professor in DAE Homi Bhabha Institute of Science Mumbai. He contributed significantly in Physics Education Research and guided many students for their doctoral studies. He had the distinction of starting participation of India in International Olympiads in Astronomy and Sciences way back in 1998. He remained team leader a number of times for these Olympiads. He was associated with Marathi Vidyan Parishad and remained its Vice President for eight long years. He has been a member of the Maharashtra State Vishwakosh (Encyclopaedia).

Nirmiti Mandal, for which he was the principal editor of their Junior Encyclopaedia in Science and Technology.

Prof. Hemchandra Pradhan

He was a fellow of Maharashtra Science Academy. He was a close associate of Prof. VK Kulkarni the founder Director of HBCSE and Prof. Arvind Kumar. He was a great communicator and a teacher par excellence. He contributed significantly to National Programmes of NCERT in designing curricula, books and school laboratories.

I had an association of more than 25 years with him and got illuminated about various issues of Physics Education and its challenges and how to take IAPT forward.

On behalf of IAPT and on my personal behalf I offer my heartfelt condolences to the bereaved family. My heart goes especially to Mrs. Rekha Pradhan and his daughter Madhura. I pray to give them and other family members strength to bear this irreparable loss. Physics Education community will sorely miss him. May his soul rest in peace.

PK Ahluwalia

President IAPT

Trends and Themes in Physics Education Research (PER)

Concept Inventories - Early history and some popular examples

We have discussed about concept inventories (CIs) earlier in this column. In this issue we review the early history of this thread in PER, along with some popular examples of CIs. The history of concept inventories in science education research can be traced back to the Force Concept Inventory (FCI) published in 1992 along with the Mechanics Baseline Test (MBT). The prequel to these inventories appeared earlier in 1985 in papers published in American Journal of Physics. FCI consists of 30 items probing students preconceptions which are incompatible with ideas in Newtonian mechanics. The subtopics include linear kinematics, Newton's three laws of motion, different types of forces and vector sum of these forces. MBT comprises of 26 items probing student understanding of the formal knowledge of these topics. These two inventories investigate two complementing dimensions of student understanding pertaining to basic mechanics. FCI items and distractors are meaningful even to those who have not learned any physics. In contrast formal knowledge of the topic is a prerequisite to comprehend and answer the MBT items.

The inventories, particularly FCI, played a significant role in stimulating research driven educational reforms in physics. Owing particularly to the limited outreach of PER the pre- inventory period has been characterized as the 'dark ages of post-secondary physics education' in the United States. FCI acted as an eye opener for many traditional instructors. The experience of the Harvard physicist Eric Mazur is an illustrative example. Administration of the inventory to his students gave him a surprisingly bleak picture of their understanding of basic concepts. The experience compelled him to incorporate research driven educational practices in his teaching. In the following excerpt Mazur describes his experience of trying the FCI with his students.

I was entirely oblivious to this problem. I now wonder how I could be fooled into thinking I did a credible job teaching Introductory Physics. While several leading physicists have written on this problem, I believe most instructors are still unaware of it. A first step in remedying this situation is to expose the problem in one's own class. The key, I believe, is to ask simple questions that focus on single concepts. The result is guaranteed to be an eye- opener even for seasoned teachers.

Mazur later developed a pedagogy emphasizing interactive teaching in contrast to passive lecturing. The pedagogy known as 'Peer Instruction' is currently one of the most popularly employed research driven teaching method. The effectiveness and success of FCI further led to the development of inventories in physics as well as other areas of science and engineering.

Some of the major inventories in physics include Test of Understanding Graphs in Kinematics (TUG-K), Force and Motion Conceptual Evaluation (FMCE), Conceptual Survey of Electricity and Magnetism (CSEM), Brief Electricity and Magnetism Assessment (BEMA) and Student Understanding of Rotational and Rolling motion concepts, among others. Though most of the earlier inventories were developed in the United States, there exists many developed in other parts of the world, including India.

Instructors interested in exploring and trying out CIs in their classrooms can access over a hundred inventories on various topics, from the below portal maintained by American Association of Physics Teachers.

https://www.physport.org/assessments/

Some of these are available in languages other than English. FCI is now available in many Indian languages, and IAPT is involved in an ongoing project in this regard.

K K Mashood
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