Bulletin of

INTERNATIONAL YEAR OF Quantum Science and Technology

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THE INDIAN ASSOCIATION OF PHYSICS TEACHERS

A MONTHLY JOURNAL OF EDUCATION IN PHYSICS & RELATED AREAS

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This NASA/ESA Hubble Space Telescope image offers us the chance to see a distant galaxy now some 19.5 billion light-years from Earth (but appearing as it did around 11 billion years ago, when the galaxy was 5.5 billion light-years away and began its trek to us through expanding space). Known as HerS 020941.1+001557, this remote galaxy appears as a red arc partially encircling a foreground elliptical galaxy located some 2.7 billion light-years away. Called SDSS J020941.27+001558.4, the elliptical galaxy appears as a bright dot at the center of the image with a broad haze of stars outward from its core. A third galaxy, called SDSS J020941.23+001600.7, seems to be intersecting part of the curving, red crescent of light created by the distant galaxy.

The alignment of this trio of galaxies creates a type of gravitational lens called an Einstein ring. Gravitational lenses occur when light from a very distant object bends (or is 'lensed') around a massive (or 'lensing') object located between us and the distant lensed galaxy. When the lensed object and the lensing object align, they create an Einstein ring. Einstein rings can appear as a full or partial circle of light around the foreground lensing object, depending on how precise the alignment is. The effects of this phenomenon are much too subtle to see on a local level but can become clearly observable when dealing with curvatures of light on enormous, astronomical scales.

Link: https://www.nasa.gov/image-article/hubble-images-galaxies-near-and-far/

Bulletin of The Indian Association of Physics Teachers

http://www.indapt.org.in

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

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Editorial

Celebrating the Birth Centenary of Quantum Mechanics: A Year of Opportunities and Engagements

We are in the middle of the International Year of Quantum Science and Technology 2025 and there is a buzz all around. Naturally Indian Association of Physics Teachers, as it should, is leading the community in making best of this opportunity in the spirit of the theme of the IYQ, United Nations proclamation of IYQ 2025 has made the following recommendation:

"Recommends that the International Year of Quantum Science and Technology should be observed through activities at all levels aimed at increasing public awareness of the importance of quantum science and applications."

In the spirit of this resolution IAPT started the year in earnest, and we are glad that events have unfolded with participation from all corners of IAPT in the country. The following is the sample of the events

Regional Councils Take the Lead

To ensure that the celebration resonates throughout the year, our Regional Councils have taken on the responsibility of organizing monthly seminars. These seminars will traverse the timeline of quantum mechanics' development, highlighting its impact on human progress through cutting-edge technologies. With five seminars already completed, we've accumulated over 30 expert lectures, and we're aiming for 72 hours of video resource material covering the complete timeline of the development of old quantum Theory and Quantum Mechanics. This series is turning out to be a course on History of Quantum Science and Technology. This treasured trove of knowledge will be a valuable resource for physics enthusiasts and educators in times to come. The recorded videos are available on IAPT's YouTube channel.

Photo Essay Competition:

Our Photo Essay Competition, themed "Quantum Mechanics and Quantum Technologies of the 20th and 21st Centuries," drew an overwhelming response from students and teachers alike. The jury was spoiled for choice, but the effort was worth it – each entry was a testament to the innovative spirit of our participants. The winning videos are now available on IAPT's Central Channel, offering a glimpse into the fascinating world of quantum technologies.

Engaging the Community Through Quizzes

Our year-long weekly Mega Quantum Quiz has been a resounding success, with participants from far and wide joining every weekend to attempt and test their knowledge. The quiz, conducted through Google Forms, has been designed to engage participants with leading physicists and technologists who have unraveled the mysteries of nature at the microscopic level and brought us to a stage where on the threshold of quantum revolution two. With wonderful analytics emerging from participants attempts, this quiz has been a labor of love for IAPT team. If you have missed the bus till date, it's never too late to join in! Quiz is also an indicator of the awareness level of the community about quantum science and technology.

Physics Bharat Yatra: Taking Physics to Every District

In May, IAPT's National Anveshika Network launched the Physics Bharat Yatra, an ambitious program aimed at touching every district in the country. With physics stage shows, enrichment lectures, and quantum exhibitions, this program promises to ignite curiosity and passion for physics among students and educators alike. This is a new program and an effort to reach the unreached with engagement with stake holders at grassroot level.

Looking Ahead to Conferences and Publications

Our Annual Convention is set to take place in Goa, while the IAPT National Student Symposium will return to Chandigarh at Panjab University. The biggest event of the year, however, is the International

Conference of Physics Education 2025, jointly hosted by IIT Ropar, IISER Mohali, and IAPT. With a theme that explores the Future of Physics Education in the Age of Virtual Labs, AI, and Quantum Technologies, this conference promises to be a landmark event in the calendar of the Physics Education in the country.

Thematic Publications: A Call for Contributions

IAPT is also working on thematic publications on quantum mechanics, including books and special issues of the IAPT bulletin and Journal of Physics Education. We invite you to contribute to these publications and share your insights about developments in quantum Science and Technologies with the physics community.

Join the Celebration!

As IAPT goes ahead on this year-long journey, we invite each one of you to participate, engage, and contribute. Let's work together to raise the bar of quality physics education and celebrate the wonders of quantum mechanics. Whether you're a student, educator, or simply a physics enthusiast, there's something for everyone in this celebration. So, join us on this roadshow of activities and let's make this year unforgettable! If you have more suggestions, you are welcome to share.

PK Ahluwalia
President

PS: To track the events visit our official website, www.indapt.org.in

For the membership of IAPT please visit our Dynamic Website:

http://www.indapt.org.in

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Dr. Sanjay Kr. Sharma
[Secretary IAPT]
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Email: sksharma777@gmail.com

Physics News

Observing one-dimensional anyons: Exotic quasiparticles in the coldest corners of the universe

The quantum statistical property has drastic consequences for the behavior of either fermionic or bosonic quantum many-body systems. However, in low-dimensional systems, a fascinating new class of particles emerges: anyons. Unlike traditional particles, anyons do not exist independently but arise as excitations within quantum states of matter. While anyons have been observed in two-dimensional media, their presence in one-dimensional (1D) systems has remained elusive—until now. A study published in *Nature* reports the first observation of emergent anyonic behavior in a 1D ultracold bosonic gas. This remarkable feat is achieved by injecting and accelerating a mobile impurity into a strongly interacting bosonic gas, meticulously analyzing its momentum distribution. This elegantly simple experimental framework opens new avenues for studying anyons in highly controlled quantum gases. This discovery marks a pivotal step in the exploration of quantum matter, shedding new light on exotic particle behavior that may shape the future of quantum technologies.

Read more at: https://phys.org/news/2025-05-dimensional-anyons-exotic-quasiparticles-coldest.html

Original Paper: Nature (2025). DOI: 10.1038/s41586-025-09016-9

The generalization of statistical mechanics makes it possible to regularize the theory of critical phenomena

Statistical mechanics is one of the pillars of modern physics. Ludwig Boltzmann (1844–1906) and Josiah Willard Gibbs (1839–1903) were its primary formulators. However, Boltzmann-Gibbs statistical mechanics has limitations. For example, its predictions can fail when a system is in certain regimes, such as phase transitions or critical phenomena. For instance, statistical mechanics predicts the divergence of certain thermodynamic quantities at critical points, which is not observed experimentally. This has led to the development of the so-called "non-extensive statistical mechanics". This formulation introduces an entropic index (q), which makes it possible to adjust how probabilities are accounted for when calculating entropy. Under normal circumstances, the Boltzmann-Gibbs theory remains valid. However, in systems exhibiting critical phenomena, a specific value of q can restore the extensiveness of the entropy and eliminate the divergences predicted by the traditional theory.

Read more at: https://phys.org/news/2025-05-generalization-statistical-mechanics-regularize-theory.html

Provided By: Physical Review B (2025). DOI: 10.1103/PhysRevB.111.L060409

Is gravity quantum? Laser cooling brings torsional oscillators closer to answering this question

One of the most profound open questions in modern physics is: "Is gravity quantum?" The new paper presents the first time this technique has been extended to torsional oscillators, which are key to a worldwide effort to study gravity using these systems By using lasers to remove nearly all thermal motion from atoms, in recent decades scientists have created ultracold atomic gases at micro- and nanokelvin temperatures. These systems now power the world's most precise clocks, optical lattice clocks, with timekeeping precision so high that they would gain or lose less than a second over the age of the universe. The new paper demonstrates laser cooling of a centimeter-scale torsional oscillator from room temperature to a temperature of 10 millikelvins (1/1,000th of a kelvin) using a mirrored optical lever. Studying quantum aspects of gravity experimentally doesn't just require deep understanding of physics, relativity, quantum mechanics, but also demands hands-on expertise in system design, nanofabrication, optics, control, and electronics.

Read more at: https://phys.org/news/2025-04-scientists-liquid-lenses.html

Original paper: Results in Optics (2025). DOI: 10.1016/j.rio.2025.100824

Soumya Sarkar
IISER PUNE

June: The Month in the History of Physics

Bhupati Chakrabarti

1905 and more

In 1922 the Nobel Prize of physics for 1921, kept on hold for a year, was announced and it went to Albert Einstein. By that time Einstein was an iconic figure in the world of science for his extraordinary theoretical work that went on to predict some very unexpected things. The Nobel citation, the announcement that Nobel Committee mentions the scientific contribution of the recipient for the prize was an interesting one. It said that Albert Einstein has been awarded the prize “"for his services to Theoretical Physics, and especially for his discovery of the law of the photoelectric effect".

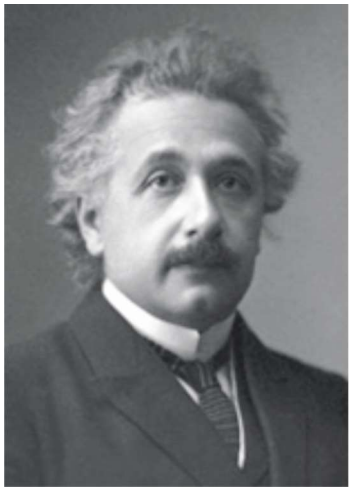
In 1905, the year known as 'Annus Mirabilis' or the 'Miracle Year' in the life of Einstein for the publication of some of his pathbreaking work during that single year. The first of these publications came out on June 09, 1905 in Annalen der Physik [17, (1905) 132-148]. The title of the paper (in English) was “On a Heuristic Point of View Concerning the Generation and Conversion of Light". In this paper Einstein picked up the quantum theory of light proposed by Max Planck barely five years back but was lying a bit unattended. He used this theory to explain the experimentally observed characteristics of the photoelectric effect where the wave theory of light completely failed. So, through this paper Einstein could offer the theory of an experiment already done and its characteristics reasonably widely studied but was waiting for a thorough and consistent scientific explanation.

This was a theoretical work by Einstein, with a difference. In most of his other works Einstein came up with some theoretical predictions and the experiments could be done only after that to establish the veracity of the theory. The bending of light beam around the strong gravitational field of the sun, during a solar eclipse as recorded by Arthur Eddington in 1919, gave credence to the predictions of General Theory of Relativity (GTR) and it happened within three years of the emergence of the GTR and a couple of years before the announcement of the Nobel Prize for Einstein. However, some other theoretical predictions of Einstein took time to get experimentally established. For example, the Bose-Einstein Condensate (BEC) could be experimentally observed after nearly 70 years of its theoretical prediction in 1925, and it happened on June 05, 1995 through the work of Eric Cornell, Carl Weiman. It was shortly followed by the experimental work of Wolfgang Ketterle. The gravitational waves could be experimentally detected even after that in 2015.

Interestingly, Einstein wrote only one paper on photoelectric effect. But his ideas described in this June 1905 paper not only got a mention in his Nobel citation but also established quantum theory of light on a very strong pedestal.

1980

In June 1980 three US scientists led by Vera Rubin published a paper in the Astronomical Journal [vol 238, p 471-483 (1980)] hinting at the existence of dark matter. After last forty-five years of research in the field, the experts accept the existence of dark matter that is actually considered as a form of matter albeit hypothetical. It does not interact with light or for that matter with electromagnetic radiation. And this gives rise to the darkness of 'dark matter.' Vera Rubin later said “In a spiral galaxy the ratio of dark-to-light matter is about a factor of 10. That is probably a good number for our ignorance-to-knowledge. We are out of kindergarten, but only about in third grade.” This June-published paper had opened wide range of possibilities in scientific research while at the same time it provided encouragement to the imagination of the scientists whose thoughts often reach out of the box. Moreover, this contribution of Vera Rubin contained a subtle message to the male dominated scientific community, that in 1950s, did not provide much encouragement to her to have a research carrier though she did her Ph.D. under the Nobel laureate Geroge Gamow.



Albert Einstein

Vera Rubin

1874

June 1874 saw the beginning of a new era in the research in experimental physics with the establishment of Cavendish laboratory in Cambridge, UK. It was one of the first initiatives to bring experimental activities in physics under a university system with the proper financial support and the appointment of academic leaders. This laboratory's special position was underlined by James Clarke Maxwell, the first Cavendish Professor who was in charge of the laboratory. He in his inaugural speech before a modest gathering said "The familiar apparatus of pen, ink and paper will no longer be sufficient for us, and we shall require more room than that afforded by a seat and a desk, and a wider area than that of a blackboard". What a wonderful way to underline the difference between theory and experiments in physics.

References

1. https://en.wikipedia.org Annus Mirabilis Papers
2. APS News (This month in Physics History, May 11, 2023) https://www.aps.org/apsnews/2023/05/vera-rubin-paper-dark-matter
3. The Cavendish Laboratory; Maxwell's Cavendish
4. https://www.phy.cam.ac.uk/history/old_maxwell

We have started a new series, 'The month in the history of Physics' from this issue. We invite contributions for this series from interested Academia. Please notify us in advance by email (iapt@pu.ac.in) so that we can earmark .

Donation received in account of IAPT@40 Corpus Fund

Sr. No.	Date	Name	Place	Amount Rs.
1.	05-05-2025	Vishwanath Barve	Sawantwadi	100.00
2.	08-05-2025	Dr. S. K. Nataraju	Bengaluru	10,000.00
3.	16-05-2025	B. Venkat	Hyderabad	200.00
			Previous Balance	**8,10,700.00**
			Total Rs.	**8,21,000.00**

Professor Jayant Vishnu Narlikar

19 July 1938 – 20 May 2025

by **Ajit Kembhavi,** IUCAA

Prof. J.V. Narlikar

Prof. Narlikar with students and colleagues

Flanked by his successors, Prof. Dadhich (left) Prof. Ajit Kembhavi

Prof. Narlikar with Prof. Yashpal, Prof. S. Chandrasekhar and Mr. Charles Correa

****

Professor Jayant Narlikar has for long been one of the best known scientists of the country. He passed away in his sleep in the early hours of May 20, following a brief illness. He would have been 87 years of age in July. He was active right to the end, reading, writing, discussing and occasionally interacting with the public. Since January 2024 he was writing a blog, covering different stages of his life, which surely will be sorely missed by the tens of thousands of people who read it. Narlikar was a great scientist, institution builder and mass communicator.

After graduation from Banaras Hindu University

where his father was a Professor of Mathematics, Narlikar left for Cambridge University, where he completed the mathematical tripos as Senior Wrangler (in the first position) in 1959. He then worked as a research student under the guidance of the great British astronomer, Professor Fred Hoyle. Over the next few years, he did an astonishing amount of work, got coveted awards including the Adams Prize, and held his own in fiery meetings of the Royal Astronomical Society. On a visit to India in the mid-sixties, he thoroughly impressed the scientific community, and captivated the public imagination through his ever smiling face, a gentle way of talking and a great ability to convey to non-expert people his researches on the Universe. He continued to interact with the public in many ways to the end of his life. He was awarded a Padma Bhushan at the young age of 26 years and a Padma Vibhushan in 2004.

1. Narlikar the Scientist:

Narlikar's first work was on the distribution of cosmic radio sources as a function of their measured brightness, which is known as the log N-Log S distribution. The shape of the distribution depends on the geometry of the Universe, the distribution of the sources in space, and whether or not the source population evolves as a function of cosmic time. The radio data was from the Cambridge radio telescopes built by astronomers from the Cavendish Laboratory in Cambridge, led by Professor Martin Ryle. Ryle favoured the big bang theory of the Universe in which the radio source population could be evolving, while Fred Hoyle, one of the creators of the steady state theory, believed that the distribution should be constant in time. A clear resolution of the problem was not possible, because of the very limited data then available. And yet the debates had far reaching consequences, not only for cosmology, but also for the career paths of the people involved in the work. Martin Ryle won the Nobel Prize in Physics for 1974, jointly with Professor Antony Hewish, who discovered radio pulsars with his student Jocelyn Bell.

Along with the astronomical data analysis, Narlikar also worked on difficult theoretical problems, including Newtonian cosmological models with rotation and shear, the age of galaxies and the avoidance of singularities in the steady sate cosmology, Mach's Principle and the Creation of Matter, and Time Symmetric Electrodynamics and Arrow of Time in Cosmology. In 1966 Hoyle and Narlikar published work on a new theory of gravitation, which is invariant under conformal transformations. This output was remarkable by any standards; it had amazing variety, depth and novelty, and went against many cherished conventional ideas.

Narlikar spent much effort, first with Fred Hoyle, and then with other distinguished astronomers including Professor Geoffrey Burbidge, on the steady state theory of Universe, working out its astrophysical implications. In this theory, the Universe forever remains the same, in spite of its expansion, because of the continuous creation of matter. In this model there is no creation of the Universe in a Big Bang, and so there is no early phase in which the Universe was very hot. The steady state theory lost much of its allure after the discovery in 1964 of the cosmic microwave background radiation. Over the years it was established that the radiation had the spectrum of black body radiation at 2.73 K with a near perfect fit to Planck's law. The background also had a remarkably isotropic distribution in the sky. It therefore could only have arisen in a hot phase of the Universe. That required a modification of the original steady state theory to a quasi-steady state theory, which was made by Narlikar and Burbidge in 1993. In this theory hot phases would be possible with mini-bangs, but there would be no singularity, making the Universe eternal as in the pure steady state theory. A possibility here is that galaxies from an earlier phase of the Universe could survive to appear as seemingly prematurely evolved galaxies in early epochs of our phase. Narlikar carried out observations with collaborators to find such galaxies, and it is intriguing that the JWST is finding just such objects in the very early epochs. With Burbidge and Halton Arp Narlikar also worked on possible anomalous redshift of quasars.

In later years Narlikar pursued the idea, originally due

to Fred Hoyle, that microorganism could have entered the Earth's atmosphere from outer space. The idea seemed very fanciful when Hoyle first proposed it. He was denied publication of his theory in scientific journals, and he had to publish it as a science fiction novel. Narlikar proposed experiments which could be carried out to detect organisms in the upper atmosphere, which could not have got there from the surface of the Earth, and which could possibly have nature distinct from their terrestrial counterparts. While much planning was done in collaboration with people from ISRO and other organisations, the experiment was never carried out. That was possibly a great lost opportunity, especially given the growing realisation that living organisms could exist in several locations in the Solar system, and the ubiquity of habitable extrasolar planets in our Galaxy, even though those planets are too distant to contribute organisms to our atmosphere.

In 1972 Narlikar moved from Cambridge to the Tata Institute of Fundamental Research (TIFR). There he continued his work on various of fronts in gravitation and cosmology. He mainly worked with a number of talented graduate students, with some working on problems of his interest, while others devoted their effort to areas of their own choice. He was very democratic in the matter, as he was in all his interactions at every level, and that attitude seems to have worked very well. Many of his students and other young researchers who worked under his guidance have done excellently in their professions, and others who have worked for him in various capacities have always contributed their best.

2. Narlikar the Institution Builder

In 1987, Professor Yash Pal, who was then the Chairman of the University Grants Commission, invited Narlikar to set up a new institution, which would be unique in addressing the difficulties of the universities in carrying out research in astronomy and astrophysics. It was decided that the new institution would be located in Pune, and was eventually named the Inter-University Centre for Astronomy and Astrophysics (IUCAA). Narlikar moved to Pune for the purpose on June 1, 1989, and with the help of Professor Naresh Dadhich and the author of this article, began the process of setting up IUCAA. Within a few years the unique buildings, designed by the architect Charles Correa were ready. But even before the facilities became available, the scientific work and all related activities had started and soon IUCAA became known as a place where good astronomy was done.

The unique feature of IUCAA of course were the tens of visitors from the universities and colleges who came all the way from distant parts of the country, even though there were hardly any facilities. They worked in collaboration, and brought their students and soon there was a thriving astronomical community in the universities. Narlikar helped by interacting personally with the visitors, who soon increased greatly in number. He often visited departments all over the country lecturing and introducing teachers and students to IUCAA, and providing basic email and other then emerging facilities at IUCAA's cost. The development of the university community is Jayant's greatest contribution to astronomy in India.

3. Narlikar the Teacher

Narlikar's role as a teacher should be of interest to IAPT members, some of who may have attended his talks and read his books, but perhaps very few would have had the privilege of attending a course by him. Narlikar lectured from undergraduate to more senior levels on a variety of topics, including general relativity, gravitation theory, cosmology, astrophysics, and various areas of physics. His courses appeared to be meticulously planned and structured, with much time spent in the preparation. But in reality, he devoted very little to prepare, since he was naturally a very well organised person. His grasp of the fundamentals and mastery over detail were astonishing, and he could reduce the most difficult ideas to straightforward calculations which were easily accessible to everyone. His delivery was very simple and smooth, and never did he make students feel that something was beyond their capabilities. The exercises and tests that Narlikar set were again doable by most students, and yet from the answers he could

judge very well the grasp and quality of each student.

General relativity is considered to be a subject difficult to learn, because of the deep ideas in its framework, and the complexity of the tensor analysis needed in its study. Narlikar was particularly adept at gradually introducing students to the mathematics, making them comfortable, and enabling them to develop mastery over a relatively short time. In the 1970s it was realised that the use of differential topology techniques could make general relativistic calculations much simpler, and were in fact essential for understanding some of the latest developments to do with singularities, black hole theory and so forth. I learnt these techniques and used them on the problems I was working on under Narlikar's supervision. He quickly studied the new techniques, but found that he could do all the calculations that he needed using traditional tensor analysis. But he encouraged me to go along the new paths, since those were so important for the future.

4. Narlikar and Public Outreach

Narlikar was a great communicator. He was able to convey ideas about astronomy and cosmology to the general public in a very simple and yet interesting and lucid manner.

He did that through his many talks, articles books and also science fiction stories. The public came in great numbers whenever and wherever he lectured, and were mystified that the great person they had heard so much about was after all one of their own. When they asked questions, he enthusiastically provided answers, but when they wanted his autograph, he politely refused. But as consolation he offered to send a signed reply if the concerned person sent him a question on a postcard.

Narlikar made public outreach an integral part of IUCAA. The activities began with hundreds of school children coming to the campus, still under construction, for Saturday lectures. Some of those young children, now in their middle age, still fondly recount the inspiration that they received from Narlikar to do well, and better, in whatever they were doing. That was a simple message, but it has produced many stars over the decades.

Truly, Jayant Narlikar was a great man in all ways.

About the author:

Professor Ajit Kembhavi is an Indian astrophysicist. He is presently a professor emeritus at the Inter-University Centre for Astronomy and Astrophysics, at Pune, India, of which he was also a founder member. He also serves as a vice president of the International Astronomical Union. Prof. J. Narlikar was his Doctoral advisor.

C. K. MAJUMDAR MEMORIAL SUMMER WORKSHOP IN PHYSICS 2025

A National Level Program Jointly Organized by **I**ndian **A**ssociation of **P**hysics **T**eachers **R**egional **C**ouncil-15 (IAPT RC-15) **&** **S**atyendra **N**ath **B**ose **N**ational **C**entre for **B**asic **S**cience (SNBNCBS) will be held at SNBNCBS, Kolkata

Date: 15th – 24th July, 2025

Eligibility: Students appearing in final year of **B.Sc.** with Physics Hons./Major and Students in First year of **M.Sc.** (Physics) or equivalent

Registration fee: Rs. 1000/- (for selected candidates only).

Link for application: https://forms.gle/dNd7ZyDQsvtpvfEC9

Details: https://www.bose.res.in/)

Last date of application: 10th June 2025

*Hostel facilities will be provided to the outstation participants on payment of **Rs. 2500/-**

A Tribute to Prof. S Lokanathan

Arunesh K Arora

I joined IIT, Delhi in 1966 as a research scholar with Prof. M S Sodha. At that time Prof. S Lokanathan was an Assoc. Prof. in the Physics Dept, IITD. He left IITD in 1968 to join as a Professor in the Jodhpur University. After a year, in 1969, he moved to the University of Rajasthan at Jaipur as a Professor of Physics. In 1970 I left IITD and joined the Physics Dept. as a lecturer in the Rajasthan University.

At IITD Prof. Lokanathan started a research group with K B Bhalla* and one more student on Study of High Energy particle collisions using Emulsions specifically focusing on Negative Binomial Distribution (NBD). His work has shown that NBD fits charged particle multiplicity distributions obtained in hadron-nucleus collisions. At Jaipur the group grew bigger and it started collaboration with many National and International Institutions like, VECC, Calcutta, University of Punjab, Chandigarh, University of Lund, Sweden, Geneva University, Kurchatov Institute, Moscow and a few others.

Prof Lokanathan also guided and helped establishing another research Lab. with B K Shrivastava* and Anjali Krishnamurthy* on Mossbauer effect to study the structure and behaviour of Ferromagnetic materials. This group also collaborated with the Uppsala University, Sweden among other institutions.

Prof. Lokanathan has 100 publications to his credit and has been cited 1160 times, indicating significant impact in his field. He had been himself a great researcher, a very active guide, always ready to help academically and otherwise. In IIT, though he was not my guide but he was always ready to help me and whosoever came to him with Physics or mathematical problem.

Prof. Lokanathan collaborated very actively with Prof. B. L. Saraf in developing experiments under C D P E. Prof Saraf was very enthusiastic in the development of experiments to explain various concepts of Physics. Prof Saraf would always seek Prof. Lokanathan's help and advice in developing the mathematical theory and explaining the observations. Some experiments were for demonstration purpose only while most of the experiments meant for the laboratory at the under-graduate level.

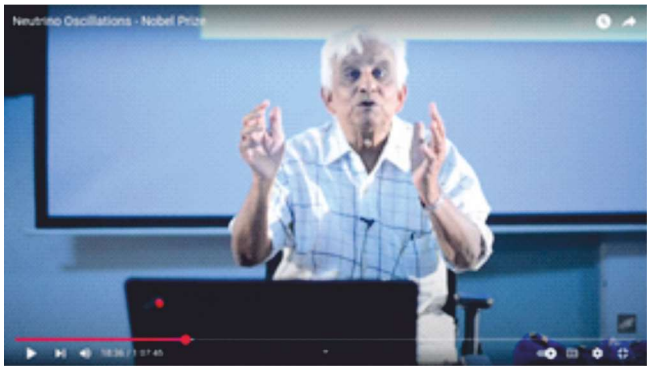
In IITD as well as in the University of Rajasthan he was considered an outstanding teacher. He would explain advance level and difficult concepts in a simple way. Students loved to attend his lectures. He was loved and respected by one and all, students as well as colleagues. He was very polite and down to earth person.

Last but not the least Prof. Lokanathan was a good violin player.

*All three of them retired from the University of Rajasthan as Professors in Physics.

Remembering Professor Subramanian Lokanathan: A Personal Tribute

Ajoy Ghatak
ajoykghatak@gmail.com



15 May, 1929 - 29 April, 2025

Lecture on *Neutrino Oscillations* delivered by Professor Lokanathan on November 8, 2015 at The Jawaharlal Nehru Planetarium, Bengaluru.

- B.Sc. (Hons) in Physics, Hindu College, Delhi University, 1949
- M.Sc. (Physics) Delhi University, 1951
- Ph.D. Columbia University, 1956
- Research Scientist at Brookhaven National Laboratory, Upton, L.I., NY during 1956-57.
- Research Scientist at Oxford University during 1957-64
- Assistant Professor of Physics, IIT Delhi during 1964-68
- Professor of Physics, Jodhpur University during 1968-69
- Professor of Physics, University of Rajasthan, Jaipur during 1969-89
- Emeritus Professor of Physics, University of Rajasthan, Jaipur during 1989-93
- Associated with Jawaharlal Nehru Planetarium, Bengaluru since 1997.

Areas of Interest: Quantum Mechanics, Particle Physics & Nuclear Physics

I had the privilege of collaborating with Professor Lokanathan in writing a textbook on *Quantum Mechanics: Theory & Applications.* It was a great experience for me; the first edition of the book came out in 1975 and this year the book has completed 50 years of its existence. In fact, in March (2025), Professor P K Ahluwalia, President IAPT very graciously invited me for a book talk; he wrote to me

This month under the IYQ series of lectures, I would like to talk to you in one session focusing on your Quantum Mechanics book which has been there for the last more than 50 Years. It has indeed been a landmark textbook and it is worth celebrating its popularity among both students and teachers.

Indeed, it has been so gratifying (for both Professor Lokanathan and myself) that our book (now in its 6th edition) has helped students and teachers.

My first meeting with Professor Lokanathan was in May 1966, when I had joined the Physics Department of IIT Delhi. Both Professor Lokanathan and I did our MSc (in Physics) from Delhi University; I did my MSc during 1957–59 and Professor Lokanathan was 8 years senior to me. Professor D S Kothari and Professor R C Majumdar taught both of us Quantum Mechanics. Both Professor Kothari and Professor Majumdar were outstanding teachers and we both developed great interest in learning Quantum Mechanics. Professor Lokanathan went for his PhD to Columbia University and did his PhD under the supervision of Nobel Laureate Jack Steinberger; however, he took a course on Quantum Mechanics

[1]The book talk can be heard at https://www.youtube.com/watch?v=SyrZWfee_-Q&t=2842s; it starts at 1:20.

[2]Jack Steinberger shared the 1988 Nobel Prize in Physics (with Leon Lederman and Melvin Schwartz) for their discovery of the muon neutrino in 1962. In a short autobiography by Jack Steinberger, he mentions about the work with Professor Lokanathan; see https://www.nobelprize.org/prizes/physics/1988/steinberger/biographical/. Incidentally, the brief autobiography tells us a very touching story of how Jack Steinberger came out of the jaws of death in Nazi Germany to becoming a Nobel Laureate.

taught by Professor Robert Serber.

I went for my PhD to Cornell University and had the privilege of taking 2 courses on Quantum Mechanics both taught by Professor Hans Bethe. He offered courses on *Basic Quantum Mechanics* and *Intermediate Quantum Mechanics*. Subsequently, Professor Beth wrote a book (along with Roman Jackiw) with the title *Intermediate Quantum Mechanics*. Professor Bethe was an outstanding teacher and I very fondly remember the meticulous way he prepared and delivered his lectures. Incidentally, Professor Serber and Professor Bethe were both part of the Manhattan Project for making the atom bomb – as you must have seen in the movie *Oppenheimer*.

When I had joined IIT Delhi, we used to teach two courses in each semester. I was asked to teach the course on *OPTICS* to the undergraduate engineering students and also the course on Mathematical Physics to MSc students. Professor Lokanathan was teaching Quantum Mechanics to MSc students. Because of my interest in Quantum Mechanics, Professor Lokanathan and I started to have detailed discussions in the teaching of Quantum Mechanics and I would often attend his classes. He was an outstanding teacher.

Each teacher has his own way of introducing Quantum Mechanics. For example, Professor D S Kothari taught us (almost verbatim) from the book by P A M Dirac; on the other hand, Professor Majumdar (and to a certain extent Professor Bethe) taught from books like the one by Leonard Schiff or by Enrico Fermi. And then we had the 3rd volume of the famous Feynman Lectures in which Feynman introduced Quantum Mechanics in his own unique style.

[3]On November 21, 1977, Professor Bethe delivered a lecture on *My Relation to the Early Quantum Mechanics*; you can hear this on You Tube: https://www.youtube.com/watch?v=E61UR4Lbifo&t=3199s

Both Professor Lokanathan and I felt that a good way to understand Quantum Mechanics is to solve a large number of problems corresponding to realistic situations and therefore we both collected problems and wrote their complete solutions.

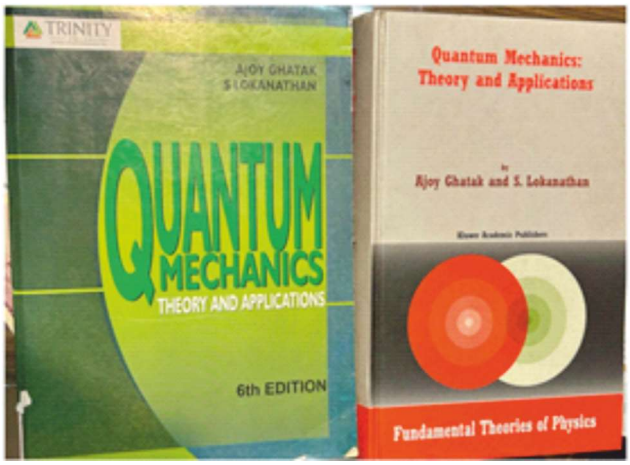
In 1968, Professor Lokanathan was offered the position of Professor and Head of the Physics Department at Jodhpur University, and he decided to go to Jodhpur. After Professor Lokanathan left for Jodhpur, Professor M S Sodha (then Head of Physics Department @ IIT Delhi) asked me to teach Quantum Mechanics to MSc students. And during my 40 years at IIT Delhi (implying 80 semesters), I must have taught, either the first or the second course on Quantum Mechanics, at least 35-40 times. My non-physicist friends (and relatives) often ask me "How could you enjoy teaching the same course so many times?" Well, I did greatly enjoy teaching Quantum Mechanics and every time, I learnt something new and maybe a slightly better way to teach some topics. As an example, in my later years, I really enjoyed teaching the implications of the beautiful Stern-Gerlach experiment and then follow it up with discussions on entanglement and Bell's inequality. In fact Professor Lokanathan had once told me;

I understand the spin angular momentum of the electron from the fact that the electron behaves like a tiny magnet and its magnetic moment is proportional to its spin angular momentum. If we measure the z-component of the magnetic moment of the electron, we will get one of the 2 discrete values.

There were many other topics like that. Also teaching bright young students was always a challenge and very rewarding.

Professor Babu Lal Saraf was the Head of Physics Department at University of Rajasthan in Jaipur and he persuaded Professor Lokanathan to join the Physics department there. Professor Lokanathan stayed at Jodhpur for about one year and then decided to join University of Rajasthan at Jaipur in July 1969 where he spent the next 24 years. Around 1970, Professor Saraf asked me to be a member of the Board of Studies in Physics; that made me very happy and I would go to Jaipur twice (sometimes three times) a year to attend the Board of Studies meeting. We used to have very enlightening discussions on the details of what should be taught to the BSc and MSc students and during one of the early visits, Professor Lokanathan and I decided that we would write a small book on Problems & Solutions in Quantum Mechanics.

I knew Mr. Samuel Israel (Editor in-Chief of Macmillan India) well, and when I mentioned about our writing a book on Quantum Mechanics, he immediately agreed to publish the book. The contract that we signed with Macmillan India was for a book with the title *Problems & Solutions in Quantum Mechanics*. We collected a large number of problems and worked out their solutions. When we were in the process of writing the book, Professor Sodha suggested that it will be better to have derivations of important formulae in the beginning, so that the book is complete, and we therefore changed the title to *Quantum Mechanics: Theory & Applications*.



It was indeed a great experience for me to collaborate with Professor Lokanathan. He was extremely knowledgeable, an outstanding teacher and an excellent researcher and above all a great human being. He was ever so kind, polite and affectionate to me and this was so with everyone who came in touch with him. During my visits to Jaipur, I would often stay with him and Mrs Amrutha Lokanathan (we knew her as Ammi) likewise was always very warm and affectionate. Although Professor Lokanathan was about 10 years older than me, I always felt very comfortable with him and his family. Mrs Lokanathan passed away in 2014. That was a huge blow for the entire Lokanathan family, in particular for Professor Lokanathan.

As a personal tribute, I am pasting below YouTube Links to Professor Lokanathan's two wonderful lectures:

Meghnad Saha's contributions to Physics: https://www.youtube.com/watch?v=wJMDX5dMKF4&t=900s

Neutrino Oscillations-Nobel Prize: https://www.youtube.com/watch?v=hYEeWqE0YuY&t=925s

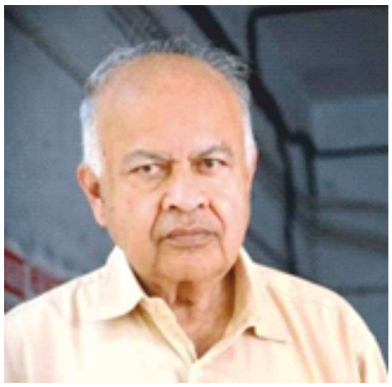
The lectures show how good a teacher he was and also the depth of his understanding of basic concepts in Physics.

In conclusion, I shall fondly cherish my association with Professor Lokanathan. He was a rare persona who was both brilliant and a very good human being – a rare combination! May his soul rest in peace.

I sincerely thank Professor P K Ahluwalia for asking me to write this article. I am particularly grateful to (in alphabetical order) Prof. Aalok Misra, Dr Adhip Agarwala, Prof. Ashok Singhvi, Dr Badri Lokanathan, Dr Bidisha Roy, Dr. Gargi Mitra, Prof. K R Patel, Prof. Kehar Singh, Dr Manish Khare, Prof. N Panchapakesan, Prof. Pruthul Desai, Prof. Pushpa Bindal, Professor Samit Ray and Dr Shobha Lokanathan for their comments and suggestions.

[4]In 2013, the entire Higher Education Program of Macmillan India was taken over by LAXMI Publications; as such, the book is now published by LAXMI Publications in New Delhi. In 2004, the 5th edition was also published by Kluwer Academic Publishers in Dordrecht which was subsequently taken over by Springer.

An excerpt from the autobiography of Padma Vibhushan awardee astrophysicist Jayant Narlikar



19 July 1938 – 20 May 2025

My father was a mathematician and my mother was a Sanskrit scholar. It was my mother who taught me and my brother Sanskrit and taught us a deep love for its literature. She took a keen interest in our studies and made us what we became.

My mother's teachings are the basis of our existence.

I spent my childhood in the beautiful surroundings of Banaras Hindu University, where my father taught. It was a beautiful place indeed. It is still beautiful to look at and live in, but in the fifties the academic environment here was not corrupt. My father was a mathematician and my mother was a Sanskrit scholar, but she did not teach in the university, though she was a postgraduate in Sanskrit from Bombay (Mumbai) University. It was she who taught me and my brother Sanskrit and taught us a deep love for its literature. She took a keen interest in our studies and made us what we became. After completing my B.Sc. from Banaras Hindu University, I went to Cambridge at the age of 19 to study higher mathematics. My first goal was mathematics. But there you are asked to choose from different branches of mathematics. I found particularly astronomy applications very interesting. The lecturers were very good. At that

time I also read a book by Fred Hoyle called Frontiers of Astronomy, which gave a very readable description of what was happening in astronomy. All these things inspired me to go into astronomy research. In Cambridge, astronomy is treated as a branch of mathematics. So I chose it. I have always stressed the need to develop a science culture in our society. Today, planetariums are found in major cities of India. I have seen the growth or spread of planetariums as I grew up. I remember the first planetarium was built in Kolkata and it was the only planetarium for some years, until a planetarium came up in Bombay (Mumbai). Now, there are a series of planetariums in many cities of the country. These planetariums have a great role to play in promoting the culture of science, if they work properly. By which, I mean that there are a lot of superstitions related to astrology in India - where people believe that the position of stars and planets controls a person's destiny. These baseless claims must be refuted. This is where planetariums can help. They should also be used to tell people what is happening around us, not only in the universe, but also highlight the many new scientific discoveries around us. There is a lot being discovered here on earth and some of these should be incorporated in planetarium programmes. I am very optimistic about the younger generation, at least the school going children. They seem to be much more curious than the generation before them. They also seem to be aware of the scientific discoveries and advancements happening around them, even if they do not fully understand the science of it. We should use their curiosity and let them know. This way they will be encouraged to ask the right kind of questions and eventually they will turn into a very knowledgeable group.

'स्मृति शेष'

–जयंत नार्लीकर;

मेरे पिता गणितज्ञ थे और मेरी मां संस्कृत की विदुषी थी। मां ने ही मुझे और मेरे भाई को संस्कृत सिखाई और इसके साहित्य के प्रति अगाध प्रेम सिखाया। उन्होने हमारी पढाई में बहुत रुचि ली और हमे वह बनाया, जो हम बने।

मां की सीख ही हमारे अस्तित्व का आधार है मैंने अपना बचपन बनारस हिन्दू विश्वविद्यालय के खूबसूरत वातावरण में बिताया, जहां मेरे पिता पढ़ाते थे। यह जगह वाकई खूबसूरत

थी। यह देखने और रहने में आज भी खूबसूरत है, लेकिन पचास के दशक में यहां का शैक्षणिक माहौल दूषित नहीं था। मेरे पिता गणितज्ञ थे और मेरी मां संस्त की बिदुषी थीं, लेकिन वह विश्वविद्यालय में पढ़ाती नहीं थीं, हालांकि वह बौम्बे (मुंबई) विश्वविद्यालय से संस्कृत में स्नातकोत्तर थीं। उन्होंने ही मुझे और मेरे भाई को संस्कृत सिखाई और हमे इसके साहित्य के प्रति अगाध प्रेम सिखाया। उन्होंने हमारी पढ़ाई में बहुत रुचि ली और हमें वह बनाया, जो हम बने। वनारस हिंदू विश्वविद्यालय से बी. एस. सी. करने के बाद 19 साल की उम्र में मैं उच्च गणित अध्ययन करने कैंब्रिज चला गया था। मेरा पहला लक्ष्य था गणित। लेकिन वहां आपको गणित की विभिन शाखाओं में से चुनाव करनेके लिए कहा जाता है। मैंने पाया कि विशेष रूप से खगोल विज्ञान अनुप्योग बहुत दिलचस्प थे। ब्याख्याता बहुत अच्छे थे। उस समय मैंने फ्रेड होयल की एक किताब भी पढ़ी, जिसका नाम था फ्रंटियर्स ऑफ एस्ट्रोनोमी, जिसमें खगोल विज्ञान में क्या हो रहा था, इसके बारे में बहुत ही पठनीय विवरण दिया गया था। इन सभी चीजों ने मुझे खगोल विज्ञान शोध क्षेत्र में जाने के लिए प्रेरित किया। कैंब्रिज में, खगोल विज्ञान को गणित की एक शाखा के रूप में माना जाता है। इसलिए मैंने उसे चुना। मैंने हमेशा अपने समाज में विज्ञान की संस्कति के विकास की जरूरत पर बल दिया है। आज भारत के बड़े-बड़े शहरों मे प्लेनेटेरियम (तारामंडल) पाए जाते हैं। मैंने बड़े होने के साथ-साथ प्लेनेटरियम के विकास या प्रसार को देखा है। मुझे याद है कि सबसे पहला प्लेनेटरियम कोलकाता में बनाया गया था और कुछ वर्षों तक यह एकमात्र प्लेनेटरियम था, जब तक कि बॉम्बे (मुंबई) में एक प्लेनेटेरियम नहीं बन गया। अब, देश के कई शहरों में प्लेनेटरियम कीं एक श्रृंखला है। विज्ञान की संस्कृति को बढ़ावा देंने में इन तारामंडलों की शानदार भूमिका रही है, अगर वे सही तरीके से काम करें। जिससे, मेरा मतलब है कि भारत में ज्योतिष संबंधित कई अंधविश्वास हैं-जहां लोग मानते हैं कि सितारों और ग्रहों की स्थिति किसी व्यक्ति के भाग्य को नियंत्रित करती है। इन निराधार दावों का खंडन किया जाना चाहिए। यहीं पर तारामंडल मदद कर सकते हैं। इनका उपयोग लोगों को यह बताने के लिए भी किया जाना चाहिए कि हमार आसपास क्या हो रहा है, न केवल ब्रह्मांड में, बल्कि हमारे आसपास कई नई वैज्ञानिक खोजों पर भी प्रकाश डालना चाहिए। यहां पृथ्वी पर बहुत कुछ खोजा जा रहा है और इनमें से कुछ को प्लनेटेरियम कार्यक्रमों में शामिल किया जाना चाहिए। मैं युवा पीढ़ी को लकर बहुत आशावादी हूं, कम से कम स्कूल जाने वाले बच्चों के बारे में। ऐसा लगता हैं वे अपने से पहले की पीढ़ी की तुलना में बहत ज्यादा जिज्ञासु हैं। वे अपने आसपास हो रही वैज्ञानिक खोजों और प्रगति के बारे में भी जागरुक दिखते हैं, भले ही वे इसके विज्ञान को पूरी तरह से न समझ पाएं। हमें उनकी जिज्ञासा का उपयोग करना चाहिए और उन्हें बताना चाहिए। इस प्रकार वे सही तरह के सवाल पूछने के लिए प्रोत्साहित होंगे अंततः ये बेहद जानकार समूह में तब्दील हो जाएंगे।

पद्म विभूषण से सम्मानित खगोल भौतिकविद जयंत नार्लीकर के आत्मकथ्य का एक अंश। उनका सोमवार 20.04.2025 को निधन हो गया।

Homage from the IAPT President:

Very Sad News. He was the brightest star of the Universe of Cosmology. He was a great nurtured of Institutions, IUCCA is a testimony to his unparallel contributions to the Indian Science. He was science communicator par excellence and always took pride in writing in his mother tongue Marathi. He was a true propagator of scientific temper as human value.

He will always inspire the aspirations of Indian scientific community in general and physics community in particular.

IAPT community conveys it's heartful condolences to his family members and his admirers spread across the world.

With folded hands we pay our homage to this great son of India.

May his soul rest in peace.

PK Ahluwalia

In Memoriam: Professor S. Lokanathan

A life devoted to Physics and Learning

(1929–2025)

The scientific community mourns the passing of Professor S. Lokanathan, an eminent physicist and esteemed educator whose career spanned both foundational research and decades of dedicated teaching. His contributions to particle physics and science education have left an enduring mark on the field and on countless students across generations.

Prof. Lokanathan was born on 15th May, 1929 in the then Madras State. After obtaining his Master's degree from University of Delhi, he began his research career in the 1950s at Nevis Laboratories, Columbia University, where he worked alongside several pioneers of modern physics. Notably, he collaborated with Nobel Laureate Jack Steinberger on early experimental studies of pion properties, an era that saw the emergence of techniques such as scintillation counters and bubble chambers. His work during this formative period played a vital role in shaping experimental methods in high-energy physics.

Following his time in the United States, Professor Lokanathan returned to India in 1960s and joined IIT Delhi as a faculty. Thereafter, he joined University of Rajasthan as Professor of Physics in 1969. where he became a respected figure in academia. At the University of Rajasthan in Jaipur, he was known for his rigorous scholarship, pedagogical clarity, and a rare ability to inspire deep scientific curiosity in his students. His lectures were not only informative but also intellectually enriching, often drawing connections between fundamental physics and broader scientific thought.

Beyond the classroom, Professor Lokanathan was a committed advocate for science communication. He regularly engaged in public outreach, most notably through lectures commemorating the legacy of Indian scientists such as Meghnad Saha. Through these efforts, he contributed to the popular understanding of physics and its role in shaping modern India. His books on Quantum Mechanics- Theory and Applications written with Professor Ajoy Ghatak, Thermodynamics and Statistical Physics with Prof. D.P. Khandelwal and Statistical Physics and Thermal Physics with Prof. R.S. Gambhir are widely used by Physics students.

Professor Lokanathan is remembered by colleagues and students alike for his intellectual integrity, quiet wisdom, and profound commitment to the pursuit of knowledge. His legacy continues in the research he influenced, the minds he shaped, and the values he upheld.

He is survived by his family, his former students, and a grateful academic community. His passing is a great loss to Indian science and education.

May his memory continue to inspire.

IAPT- RC06

Prof. Lokanathan: *May Your Love for Physics and Passion as a Teacher Keep Guiding Us*.

In passing away of Prof. S Lokanathan we have lost a great teacher, researcher and a founder member of Indian Association of Physics Teachers. He was passionate communicator of Physics who could keep young minds engaged and mesmerized. He is known for books which were a result of his collaboration with his colleagues like Prof A.K. Ghatak and Prof. Babu Lal Saraf and his younger colleagues. When IAPT requested him for permission to e-publish the book "*Physics Through Experiments: EMF, Constant and Varying"*, he readily agreed to grant permission and wrote a beautiful message for the e-edition.

Even after retirement he kept teaching and mentoring especially undergraduate students at Jawahar Lal Nehru Planetarium, Bangalore and This inspired many of his mentees choose science/physics as a career.

His going away is a great loss to the country and science community.

IAPT conveys its heartfelt condolences to his family and his extended family of students and physics lovers.

May his soul rest in peace and his work keep guiding us.

PK Ahluwalia
President, IAPT

S. Lokanathan : *A Rare Quanta ('packet') of Knowledge, Wisdom, and Inspiration*

H.R. Madhusudan*, J.N. Planetarium, Bengaluru

This is NOT an Obituary. Obituary is only for the dead. Here is a happy recollection of one who taught what science is, in general, and what physics is, in particular.

I must highlight, from my perspective, two important events in Prof Lokanathan's life – both of which have a strong bearing on me, personally, and on the institution where I work. Number one, Prof Lokanathan was born. A brief account of events leading the second one is here.

It was some day in July 1997. I do not remember the date but now I know that it turned out to be an auspicious day in my life. Prof C V Vishveshwara, the then Director of J N Planetarium (JNP), where I worked, called me over the phone, and told that I should be ready to go with him to meet someone in Indiranagar. I joined Prof CVV and along the way, he said that we were going to meet Prof S Lokanathan. Honestly, I had not heard about him until then. Prof CVV was amused at my ignorance! Being an ordinary student of physics during my BSc days, I had not heard of the great QM textbook that Prof SL had co-authored with Prof Ajoy Ghatak. I was destined to be introduced to the subject by the master himself! In any case, I did not study much beyond the prescribed, syllabus-based textbooks during my UG days. Prof CVV told several things about Prof SL and the one that I still remember is that “Mani, is a great teacher.” Prof SL was known as 'Mani' among his close circle of friends. Prof CVV was both excited and anxious all along the way – excited that he was meeting “Mani” after a long while and anxious because he had the onus of making 'Mani' accept his invitation to teach at JNP. We had just begun the year-long weekend programmes for High School and UG students. Prof Bala Iyer, renowned scientist known for his work in General Relativity, Blackhole Physics and Gravitational waves, was the solitary teacher teaching physics to just a handful of committed students (not more than four). Prof CVV was looking out for a teacher who could collaborate along with Prof Bala Iyer and inspire UG students to take to research. The programme itself was in a transient stage and earnestly in need of someone to transform it into a steady state along with Prof CVV and Bala Iyer. Then, SL happened to settle down in Bengaluru after his retirement from University of Rajasthan, Jaipur. Dr Vageeswari, the Chief Librarian, IIA mentioned about SL to CVV, who was working at IIA. That was why we were travelling to Prof SL's home in Indiranagar. We had a warm welcome from the Lokanathans, and it took just a couple of minutes for CVV to convince his “Mani' to teach at JNP in a programme that came to be called “Research Advancement Education Programme, REAP in short. Worldlines of great personalities met. Coincidentally, Vishveshwara and Lokanathan mean the same – Lord of the Universe! Prof SL had immense respect for CVV and his research work. Their admiration was mutual and stayed that way. Getting Profs Bala Iyer and SL to teach were the biggest seeds that CVV sowed which would see us reap a rich harvest of REAPers in the following years.

SL was an immediate 'hit' with students for his ability to weave wonderful anecdotes, most of them personal, into a mechanics class dealing with, say second order coupled differential equations or Maxwell's equations in a class on electromagnetism. Prof SL had a charming manner of telling stories and anecdotes of scientists that made students to happily embrace physics even if they did not fully understand what was being taught. But the students knew that SL sir was saying something profound. There was no dearth of profundity when SL was teaching. He would tell students that 'Science is all about making connections.' And, I have always marvelled at the effortless ease with which he made those 'connections' to various, seemingly unrelated ideas, in his discussions. He could easily go from a single oscillator to a coupled oscillator to n-coupled oscillators, then arrive at an expression for line transmission, and quickly go on to generalise the solution from Mechanics to electromagnetism and spectroscopy. At the end, he would excitedly tell the class in his inimitable style (at

two octaves higher than normal) "*Do you see that*?" (the connectivity of concepts across different branches of physics). Most students, untrained to think like this in their colleges and universities, would stare at the board, not knowing what to 'see'!!! Then, SL, having realised that students did not 'see' what he wanted them to 'see,' would slowly discuss, adding several 'missing steps' and 'logical ideas' that he had not explicitly discussed earlier. Then, there would be 'enlightenment' and some of the students who grasped the profundity of all this would cherish that "Aha!" moment. I have been a witness to students getting into a trance after such sweeping generalizations by SL. Over the years, for more than two decades, students would be treated to innumerable 'Aha!' moments during his classes. Making connections of ideas across physics and Prof SL's language was appropriate, whether he was teaching or having a casual conversation in the corridor, as it should be for every teacher. He said precisely what he ***meant*** to say. His vocabulary was vast. And he chose the right words to convey his thoughts efficiently – maximum piece of information in least possible words. So, one had to be vigilant in his class. And he expected students to speak in a similar vein. If a student answered his question using bookish words, SL was quick to tell him or her that he or she was merely repeating the books. " Don't tell me what the books say. Tell me what YOU have understood, in YOUR own words. I do not care for your grammar." If a student tried to confuse him with long winding 'reason,' SL would say, "Do not beat around the bush. Come to the point." There were several Lokanathanisms that students loved to repeat in their private gatherings and conversations. "What rubbish!" or '...those are details...tell me the essence.' "**That is** English. **SPEAK** Physics" was their most loved one. The words in 'bold font' indicate SL's way of emphasising.

Students had the freedom to ask questions about things that he was not teaching at the moment. A bit of digression was fine. He would draw the students after the class and begin to discuss...sometimes for hours after the class. If students told him that they had enough of Electromagnetism and that they wanted to learn some Relativity, then SL would accede to such requests. He was accommodative to students' needs. He has taught year-long courses in QM, Classical Mechanics, Mathematical Methods, Electrodynamics and so on. In fact, Prof SL and Bala Iyer are instrumental in setting up the 'syllabus' and reference texts that is ideal for a programme like REAP. SL also enjoyed teaching in a non-formal atmosphere without having to worry about 'completing the syllabus' or setting up question papers. In fact, he used to say that his most enjoyable phase of teaching was at the planetarium. Other branches of science came effortlessly to him.

All the students liked him so much that they even hosted a "Lokanathan Fan Community" on Orkut around 2003-04. It is exceedingly rare to find a popular and an excellent teacher in the same person. SL was one such person – immensely popular as an excellent teacher! SL not only saw through the 'transient phase' of REAP but also was instrumental in stabilizing it. He taught actively between 1997 and 2015. Later, he felt that younger faculty should come to teach at REAP, if it had to continue the legacy. His association with JNP was never broken even after 2025. He would come occasionally to give special talks, address students to inspire them AND US. It doesn't surprise us that a large number of students went on to do research and are actively involved in various premier research institutions in India such as ICTS, IISc, RRI, NCBS and abroad such as Purdue University, University of Illinois, University of Bonn, University of Heidelberg and so on.

Prof Lokanathan is also instrumental in setting up of a moderate physics lab at the planetarium that enables students to see physics unfold rather than 'Verify' results – a character that has been built into our laboratory education. He introduced the experiments developed at CDPE, University of Rajasthan to JNP. He was a great admirer of Prof Babulal Saraf who developed experiments in association with people like SL and D P Khandelwal. He not only helped in procuring these experiments but also taught how to use them. He would discuss a few fundamental

questions that could be answered by doing experiments and encourage students to come up with their own. He preferred to extract ideas from students rather than give them a few of his own. That is a hallmark of a great teacher. SL's classes have set up a benchmark in REAP. Very hard to live by but worthy of striving to achieve it. We can count ourselves as successful teachers, even if we fell short of that benchmark by 50%. That is my opinion.

I would like to end this informal, unedited, write-up on a personal note. I find it extremely hard to quantify SL's impact on me as a person and as a teacher. I learnt physics the 'right way' and very often I would tell my director, Prof CVV that I am getting my salary at JNP for learning physics! What else can one expect when one 'grows up' in the company of people like CVV , SL or Bala Iyer? The list of people who have influenced me at JNP is a long one, but I am stopping at these three in this context. SL has, fortunately, spent long hours with me while discussing (read, 'teaching'), science, philosophy, education, all of which have shaped me into what I am. His selfless attitude in sharing his thoughts is a rare trait these days. Prof SL was very agile, alert, and active to the end. He would forward interesting articles or messages either through email or on WhatsApp. And he was punctual in replying to all my messages or questions except for the last one that I sent two days before he passed away. I detailed him about a summer course that I had just concluded at JNP. There was no reply. Then, I had a call from his daughter, Dr Shobha, saying that he was not well. I had planned to meet him on the Wednesday, April 30th. But he passed away on the 29th of April. *He is now a bunch of free elementary particles that he once studied, perhaps being studied by one of the thousands who he inspired to do science!*

Dear Sir: You have toiled (but enjoyed all the time) for about seven decades shaping several hundreds of students including me. I may have been unfortunate in not being your student, formally. But what you have given me informally is no less.

About Prof Babulal Saraf, Prof Lokanathan once said “There was one 'constant' in Babulal Saraf. He was passionate in his beliefs. If the intensity of his passion was unusual, its authenticity was unquestionable.” I think, these lines apply equally well to Prof Lokanathan himself.

**[This is an informal, unplanned write up as it should be about one whose entry into my academic life was informal and unplanned but one whose impact will be for eternity.]*

A Great Indian Cosmologist Professor Jayant Vishnu Narlikar

Professor Jayant Vishnu Narlikar (19 July 1938 – 20 May 2025) was not only a world-renowned Astrophysicist but, like Einstein, was a great human being. He inspired many young students to do high-level research in astrophysics and popularization of science in the country. He prepared many talented students to do high-level research in the field of astronomy and astrophysics and gifted them to the service of the nation.

Popularization of science began in 1972 when Professor Narlikar returned home. Research in Astronomy and Astrophysics also started vigorously in Tata Institute of Fundamental Research (TIFR) and in India. This was a Herculean Task that he accepted for himself to do. He also established the Inter-

(19 July 1938 – 20 May 2025)

University Centre for Astronomy and Astrophysics (IUCAA) in the campus of Pune University for University researchers and teachers to carry out research in Astronomy and Astrophysics and allied subjects. This is to bring closer the research, institutes, Laboratories and Universities.

Narlikar's pompous remained the same right from the beginning to his end. This proved how great he was. There was no prestigious Award in our country which Professor Narlikar did not get. He was Padma Bhushan and Padma Vibhushan, Maharashtra Bhushan, Rashtra Bhushan and whatnot. While he was alive Government should have given him "Bharat Ratna" Award (Title).

His nature was very kind and simple. He never raised his voice with anybody working with him, say his associates.

In his life time he did a lot of things such as doing high level research in Astronomy and Astrophysics, popularization of science in the whole country, writing scientific articles in various newspapers and magazines in Marathi, Hindi and English, radio and TV talks, delivering lectures among astrophysicists and general public with equal ease. Writing books on the subject as well for lay persons, writing science Fiction Stories. Answering scientific queries and questions of children and students. To do all these activities simultaneously is very difficult but, Professor Narlikar could do it because he was expert in time management. This he learnt from the British. His hand writings were very nice.

Narlikar did not consider Astrology as science for various reasons. He was also against superstitions, myths and misbeliefs. He had special love for poor people and people living in rural areas.

He believed that medium of instruction in school level should be in mother tongue. This helps develop minds of children. The learning in mother tongue develops the imagination in the minds of children, and imagination is everything, the rest follows. Narlikar studied in Hindi medium while he was in school in Varanasi. Nothing came in his way to be a world-renowned scientist. Such an opinion was held by great scientists like Sir C.V. Raman, P.C. Vaidya, Satyendranath Bose, Meghnad Saha and others.

Narlikar did not have any kind of अहंकार for his great achievements. That shows his "Pragya". He never entangled himself in publicity of any kind.

The gesture shown by the government and the Chief Minister and the Deputy Chief Minister of Maharashtra at the death of Professor Narlikar is very much praiseworthy.

Narlikar Saheb now is not amongst us, but his legacy and ideals are with us which will go on to guide us forever.

Whatever, the development of Astronomy and Astrophysics we see in the country is mainly due to Professor Jayant V. Narlikar. Popularization of Science was his pat objective and the young generation of the country appreciated it very much. He made the surname Narlikar very famous in the country, and baroad Narlikar means Jayant Narlikar.

His father Vishnu Vasudev Narlikar was also a great relativist and one of the pioneers in introducing the subject of Relativity in India, way back about 80 years.

In the process of popularisation of science in the country. Narlikar developed the Planetarium culture in the country. He also worked on the subject: Does life exist elsewhere in the Universe? in collaboration with his colleague Chandra Vikramasinghe and scientists and technocrats of ISRO.

Kolhapur is the native place of Narlikar. He was born there on 19th July 1938. He has given the credit of his success to his parents Professor Vishnu Vasudev Narlikar and Smt. Sumati Vishnu Narlikar.

Kolhapur has produced two great people in the world: one is Didi Lata Mangeshkar and the second is Professor Jayant Vishnu Narlikar.

In his autobiography, Professor Narlikar has described his life in four cities Varanasi, London, Mumbai and Pune where he stayed during his life and climbed to a great height of achievements.

(Dr. J. J. Rawal did his research on **"Some Problems in the Solar System, Satellite Systems and the Local Group of Galaxies"** under the guidance of Professor Jayant V. Narlikar, Professor Sukumar Biswas and Professor S.M. Chitre of TIFR(Mumbai))

J. J. Rawal

Physicists We Come Across in Our UG Lab (Part two)

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This is a second part of the article by the similar name published in the Bulletin of IAPT in December 2020. Since the contributions of a significant number of scientists from our UG Physics lab could not be accommodated in that article, a second part, in a way, was due. (Editorial Note)

Abstract

UG physics students come across the contributions of number of scientists through some experiments that were designed and developed by them and have been used for a long time for an effective experimental training in the UG physics laboratories. Unfortunately, the references of these works are not significantly found in theoretical part of the physics syllabus and in a way most of these names remain confined to the UG laboratories. Some of these the experiments are not much in use now, yet the role of the concerned scientists cannot be forgotten. In this second part of the article contributions of more such physicists have been looked back. The other contributions of them are less talked about compared to a well-known experiment that often bear the physicist's name.

Introduction

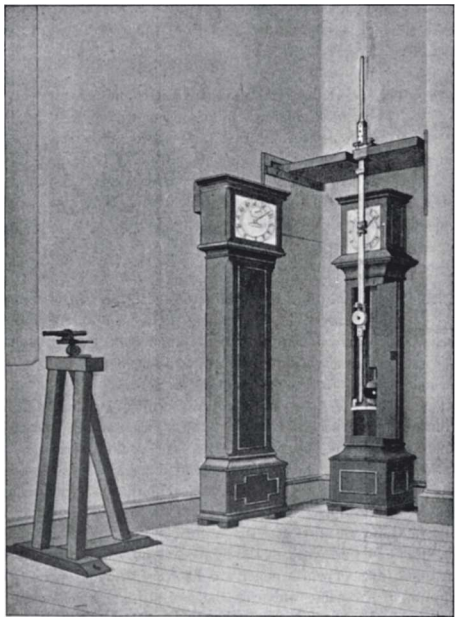
One of the main aspects of the nineteenth century experimental physics, that possibly continued till the first two decades of the twentieth century; was significantly oriented towards the very accurate measurements of different physical quantities. Physicists used to design and develop high quality precision instruments mainly based on mechanical electrical, electromagnetic and optical principles. Vacuum electronics began with the invention of diode valve at the beginning of the twentieth century but the solid-state electronics was a far cry. Physicists in 19th and in the early part of the 20th century designed these experiments keeping in mind the limitations of the resources in a UG lab. They also knew very well that until and unless an experiment, could provide a reasonably accurate result for a particular physical quantity that is being measured the young students would not attach importance to the experiments. All these activities enriched the laboratory practices and the UG students of physics in the last century, even in this country enjoyed the benefit of number of very well-designed experiments.

Physicists beyond physics

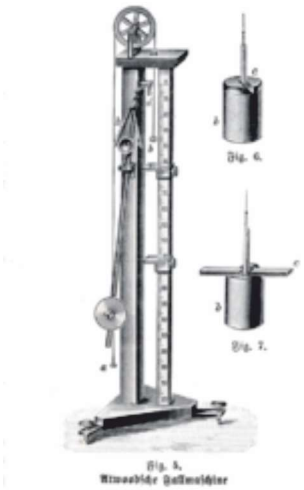
These experiments opened before the UG students the possibilities of measurements of more physical quantities and that too with improved accuracy. Some of the experiments proved to be great learning processes for students even when the determined quantities were not that accurate. These trainings became very important to the students of physics and partly to the students of many branches of Engineering. And all these activities possibly had a deeper role. Now we know that the First World War remained as a chemists' war as the knowledge of chemistry took the centre stage in various aspects of the war. But within 25 years when the Second World War began it proved to be a war of physics as physics took some very significant strides in a rather short span of time.

Not only the physicists but the engineers, geologists and some others took keen interest in gravimetry, an area that deals with the accurate determination of the 'g.' A very important contribution came from a physicist cum Surveyor **Henry Kater (1774 -1835).** Kater gave us a special pendulum named after him. He joined the Army at the age of nineteen and came to India as a commissioned Officer in the 12th Regiment on foot. Kater came in touch with Sir William Lambton and helped him in the work of the Great

Trigonometric Survey. However, owing to his recurring illness in Indian climate he went back to England. In England he made important contributions in Astronomy, metrology and in some related fields. He is known to our UG students for a pendulum known by his name and as like other pendula the main objective was the accurate determination of the acceleration due to gravity. It was developed in 1817 and because of its sturdy structure and the reasonably accurate value of 'g' that it could provide, this method was in use in different parts of the world for the calculation of the local 'g'. This has been used not only in UG labs but the other agencies used it till 1930, for accurate determination of 'g'. Kater's pendulum ruled the laboratory for more than 100 years.



At some point of time in the last century the Atwood machine used to be an integral part of a UG physics laboratory for the study of the behaviour of the connected systems. It was developed by **George Atwood (1745-1808)** who was a frontline mathematician of Great Britain during his time. He was also a very good chess player and he made it a point to record large number of moves in chess meticulously basically for the benefit of the future players. In his honour a lunar crater has been named as Atwood. The Atwood machine was a very important set up in a physics lab for the experimental study of and



the verification of the mechanical laws of with constant acceleration.

Scientists behind the UG Experiments for study the properties of materials

Thomas Young (1773 – 1829) was a British polymath and had contributed in several branches of knowledge. He did the famous double-slit experiment to provide a stronger footing to the wave theory of light. It may sound a bit surprising that Young was actually trained as a physician and had a good medical practice in London. He was an elected Fellow of the Royal Society and was often used to get referred to as the 'last man who knew everything.' His life and work are a must-read material for all. In the UG labs one can observe more than one method for the determination of the Young's modulus. For example, when the solid material is taken in the form of a beam normally the method of flexure is adopted. On the other hand, the well-known Searles' method is adopted when the material is in the form of a wire.

Thomas Young (1773-1829)

Among the classical experiments the determination of at least one elastic modulus has always been a very important exercise not only for the engineering students but also for the UG students of physics. This could have been Young's modulus, rigidity modulus,

Kater's original pendulum, from Kater's 1818 paper. The pendulum's period was measured by comparing its swing with the pendulum in the precision clock behind it. The sight (left) was used to avoid parallax error.
Form Wikipedia

Poisson's ratio, or Bulk modulus. Since these moduli [Bulk modulus 'k,' Rigidity modulus or Shear modulus 'n' and Young's modulus 'Y'] are connected by mathematical relationship $\frac{1}{k} = \frac{3}{n} - \frac{9}{Y}$ one can actually find out the third one if the other two have been measured. Incidentally another elastic constant not a modulus, Poisson's ratio [named after French mathematician, **Simeon Poisson** is also determined in some experiments included in UG courses. Young was the man who could establish the wave theory of light on a very strong foundation by designing and carrying out the famous experiment 'Young's double slit experiment,' named after him. It is the first experiment that Young did as a 28-year-old established the wave nature of light beyond doubt. Young was a great follower of Newton and his physics, but he through his double slit experiment knocked off the corpuscular theory of light offered by Newton.

Another simple method for the determination of Young's modulus Y was given by the

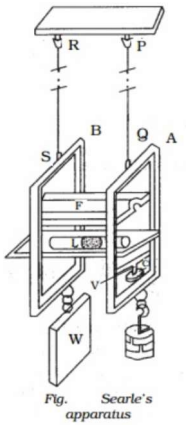
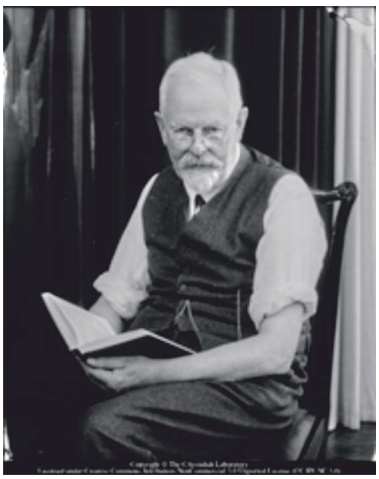


Fig. Searle's apparatus



G F H Searle

British physicist **George Frederick Charles Searle (1864-1954)** and it is used even at the high schools. At the age of 24 Searle went to Cavendish Laboratory at Cambridge University to work under Sir J.J. Thomson. He continued there as a teacher and instructor for next 55 years. During this period, he developed a method for the determination of Y for the materials taken in the form of wire. In the arrangement the elongation of a loaded wire after loading is measured in comparison to an unloaded identical wire. Searle is also quite well-known for the development of a method for the laboratory determination of the conductivity of a good conducting material now known as Searle's bar method. However, his most important contribution was his research involving the velocity dependence of electromagnetic mass.

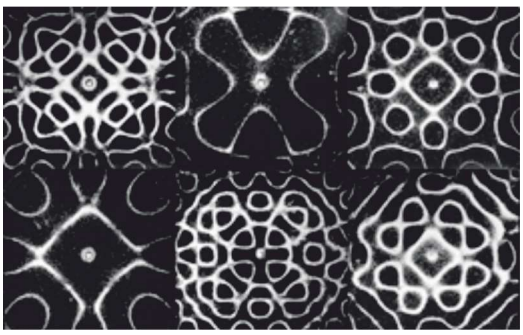
French mathematician **Simon Dennis Poisson (1781 – 1840)** has contributed in various branches of mathematics. He made extensive studies on elasticity in the early parts of the 19th century. He came up with the concept of Poisson's ratio that is essentially the ratio of the lateral strain and longitudinal strain when a solid material is subjected to the longitudinal stress within the elastic limit. We are normally more focused towards the longitudinal strain when a solid is put under stress along its length. But from the engineering point of view the lateral strain that also comes in with this exercise is very important. The ratio of two strains

or the two dimensionless quantities gives us Poisson's ratio. There are various methods for the determination of this ratio for a rubber-like materials where the lateral changes are more prominent.

Surface tension of liquids used to get studied in the UG laboratories with great care. There are at least two experiments that the students used to undertake for the determination of surface tension of water. The first one is relatively straight-forward and is often referred to as the capillary rise experiment. In the experiment capillary tubes of different radii are held vertically and are immersed in water. The water level rises in the tubes and stand at a certain height depending on the radius of the tube. And here we get the name of a British physician, to be precise an FRCP (Fellow of the Royal College of Physicians) who gave us a law connecting the radius of the tube with the surface tension and density of the liquid and the height of capillary rise. This is known as Jurin's law given by **James Jurin (1684 – 1750);** also an FRS.

Another very important experiment is often referred to as Poiseuille's method for the determination of viscosity of water. **Jean Léonard Marie Poiseuille** (French: [pwazœj]; **(1797 –1869)** was a French physicist and physiologist. He was actually interested in fluid mechanics and he studied the flow of fluids through narrow tubes an area that in today's parlance may be called as 'microfluidics.' His D.Sc. thesis in Ecole Polytechnique had the title (translated into English) as 'The force of the aortic heart.' That essentially shows that he was more interested in physiology and wanted to study the characteristics of blood flow through narrow arteries in human body. And that led to the development of the very well-known and simple experiment in the UG physics laboratories, known as Poiseuille's method for the determination of the coefficient of low viscous fluids like water. However, the formula that we get in the experiment is known as Hagen- Poiseuille's method. The first part comes from the name of the German engineer **Gotthilf Heinrich Ludwig Hagen (1797 –1884)** who had great interest in fluid mechanics. He independently did the well-known laboratory experiment and found that the power of the radius of the tube in the formula is 4.12. He however accepted that this could have been an experimental error and the present formula emerged known as Poiseuille's formula with radius raised to the power of 4. It is applicable for non-turbulent laminar flow through narrow pipes of uniform cross-section. The CGS unit of viscosity 'poise,' although not much in use now; has been named after Poiseuille.

Experiments involving vibrations and more German physicist **Ernst Florence Francois Chladni (1756– 1827)** was considered as the father of acoustics for the study of vibrating plates and he did most of his work in the late eighteenth century.



Chladni excited vibration in metal plates by using bows. That in turn shows various modes of vibration giving rise to what is known as Chladni patterns or Chladni figures where some nodal lines divide the vibrating and non-vibrating zones. This was an interesting experiment for visualization of the various modes of vibration and Robert Hooke first did it in 17th century by sprinkling flour over the surface of the vibrating plate. One can still see the application of Chladni plates for the construction of musical instruments where a plate when stuck upon produces musical sound. Chladni also studied meteorites and was considered a pioneer in the field.

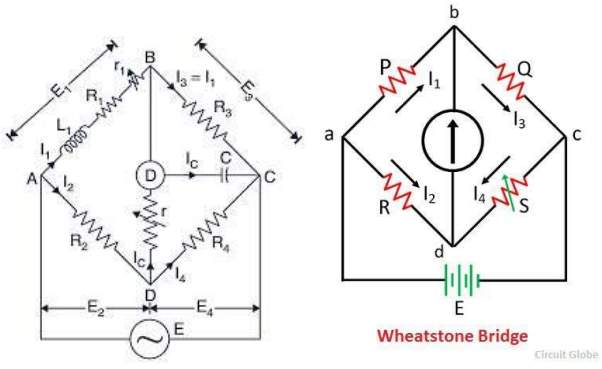
One more name come up during the discussion of polarization of light, but the experiments involving the contributions of this French scientists are not found in most of the UG courses. Yet Babinet's compensator given by French physicist **Jaques Babinet (1794–1872)** is worth mentioning. Among Babinet's contributions were the standardization of the unit for measuring wavelength of light at that time. We know it was Å and it was named after the Swedish physicist

Anders Jonas Ångström. Babinet's work involved the using of the red Cadmium line's wavelength, and a principle now known as Babinet's principle. In fact, through his work it emerged that using wavelengths of light measurements may be standardized. Between 1960 and 1983 a meter was defined based on the wavelength of light from krypton gas and the idea of Babinet was behind this.

AC bridges for the measurements beyond the electrical resistances and oscillator circuits

In the previous article on the same area, I mentioned about the number DC bridges used in the UG labs till some 20 years ago. In this part I am going to talk about number ac bridges developed not only by the physicists but also by some engineers and were named after the concerned personalities.

Alexander Anderson (1858-1927) was an Irish physicist from the "bridge" era. But he is also remembered as a physicist who first in a 1920 paper underlined the possibility of the real existence of a 'black hole'. We all know about the Wheatstone bridge and some of its modified forms are found in our UG lab mainly for the measurement of electrical resistances. These include Meter Bridge, Carey Foster's Bridge for the measurement of resistances of different orders and with different accuracies. Calendar and Griffith's Bridge was also made on the same principle but the purpose was the accurate measurement of the resistance of a piece of platinum that is used in a platinum resistance thermometer.



Anderson Bridge

If we look at the original circuit of the Wheatstone bridge (Figure above) it looks like two points 'a' and 'c' have been joined by two pathways and it has some resemblance with a bridge constructed by the civil engineers. Thus, the arrangement of the resistances got its name as a bridge and any other arrangement of similar nature came to be known as a 'bridge;' once again for its appearance.

Anderson designed a bridge now known by his name for the measurement of the self- inductance of a coil. This design had quite a few very significant differences. First, this bridge for the first time used not a dc but an ac source, second, there are not only the resistances in the bridge; but capacitances also formed the part of the bridge and since the supply is an ac source the detector could not be a dc galvanometer but a "head-phone" to detect the 'minima' of a sound to identify the null condition. Bridge designed by Anderson came as an effort for the modification of Maxwell's bridge given by none other than **James Clark Maxwell (1831-1879).** In 1873 when Maxwell bridge was introduced it had resistors, capacitance, and inductance all in it. The measurement of inductance of low Q value could be done if the values of resistors and capacitance were known. The supply of course was an ac one. No doubt we come across the name of Maxwell while studying some very significant areas of physics. Similarly for the determination of the resistance of a galvanometer there is a prescribed method by **Lord Kelvin (1824 – 1907).** This is based on the principle of Wheatstone Bridge and is known as Kelvin's method. Yet Lord Kelvin is possibly more widely known to the students of physics for his great contributions in various theoretical aspects of physics. In fact, if we look at the scientists from the British Isles Kelvin's name comes second only after Newton when one counts the number of laws, principles, equations etc. named after a scientist.

A bridge designed by a German physicist is now more familiar in electronics where the students design the Wein Bridge Oscillator because the balance of the bridge depends on the frequency of the ac source. Since the German Nobel laureate in Physics Wilhelm Wein is more widely known, one may tend to attribute this contribution to him. But Wien Bridge oscillator was developed by **Max Karl Werner Wein (1866 –**

1938), who did his Ph.D. under Hermen von Helmholtz. He also worked with Wilhelm Rontgen the first Nobel Laureate in Physics. Max Wein however was a cousin the Physics Nobel Laureate Wilhelm Wein. Max was an experimental physicist and he gave this design of the oscillator around 1891.

In electronics while dealing with the oscillators one of the basic principles that the students learn is known as Barkhausen criterion. When a part of the gain in an amplifier is fed back to the input through a suitable feedback loop circuit, we may get an oscillator and the oscillations may sustain if a special condition gets satisfied. As per this condition or criterion if A is the gain of the amplifying element in the circuit and β is the transfer function of the feedback path, so βA is the loop gain around the feedback loop of the circuit, the circuit will sustain steady-state oscillations only at frequencies for which:

1. The loop gain is equal to unity in absolute magnitude, that is, $|\beta A| = 1$ and
2. The phase shift around the loop is zero or an integral multiple of 2π:

This condition was put forward by a German physicist **Henrich Barkhausen (1881 – 1956)** nearly 100 years back in 1921.

Another electronic oscillator, Colpitts oscillator is included in UG courses of some universities. It is not that popular, but historically this is one of the first oscillators developed by using vacuum tubes by a Canadian-American engineer **Edwin Henry Colpitts (1872-1949)** way back in 1918. In the design of electronic oscillators the combination of inductors (L) and capacitors (C) are used to produce an oscillation at a certain frequency. The Colpitts oscillator is that way different from the others as the feedback for the active device is taken from a voltage divider made of two capacitors in series across the inductor and it does not use any inductance.

Concluding remarks

It appears now the UG labs are having more experiments where the students need not spend much time for what used to be called as the setting up of the experiments. In several occasions, the students get the experiments in an assembly that often is referred to as 'black box' type arrangement. This name comes from the fact that the set-ups are so designed they function as some sort of an input-output system with not much of an opportunity for the students to 'see' and understand what are going on inside. The experiments are sturdy and well-designed and do not involve many components like ballistic galvanometers, resistance boxes, long U-tubes etc. As a result, these experiments are not often associated with any name of a physicist or an engineer. This looks like a natural journey of the experiments and possibly we should not complain against this trend. Only regret is that names of the some of the stalwarts who developed the experiments during the nineteenth and during the first half of the twentieth century keeping in mind the experimental training of the physics students will possibly fade away from the memory of the physics community.

One may term that a 'natural process.' Yet many teachers of UG physics and their students are likely to go on appreciating the roles of these experiments in the teaching-learning process of the UG physics. Some organizations or institutions or may be science museums should try to keep a collection of these experiments as a part of history of physics teaching-learning process.

References:

1. Advanced Practical Physics for Students B.L. Worsnop and H. T. Flint (first published in 1923 from London)
2. Physicists We Come Across in our UG Lab (Part one), Bulletin of The IAPT, December 2020, p 270
3. Different entries on various scientists from Wikipedia

Lecture series to commemorate

The year 2025 as the International year of Quantum Science & Technology

A 3-days lecture series is being organized each month since January, 2025 by IAPT to commemorate the year 2025 as the **International year of Quantum Science & Technology**, as declared by UNESCO. The 4th such series was organized by IAPT- Rajasthan Chapter-06 in collaboration with IIS (Deemed to be University) Jaipur from 17th to 19th April, 2025. The 1stSpeaker of series was Prof. Jainendra Jain, The Evan Pugh University Professor & Erwin W. Mueller Professor of Physics at the Pennsylvania State University, U.S.A. Professor Jain presented on 17.04.2025 his theory of composite fermions, which provides unified understanding of fractional and integral quantum Hall Effects-the two Noble prize winning phenomena, and led Professor Jain for the award of the prestigious Wolf Award 2025, awarded by the Wolf Foundation Israel. Professor Jain is the first Indian to get this award. The session was chaired by Prof. Arun Kumar Grover, Former Vice Chancellor of Punjab University, Chandigarh. Professor Jain was honored for his ground breaking research by Citations given by Prof. P.K. Ahluwalia on behalf of IAPT and by Prof. K.S. Sharma on behalf of RC06 and IIS (Deemed to be University).

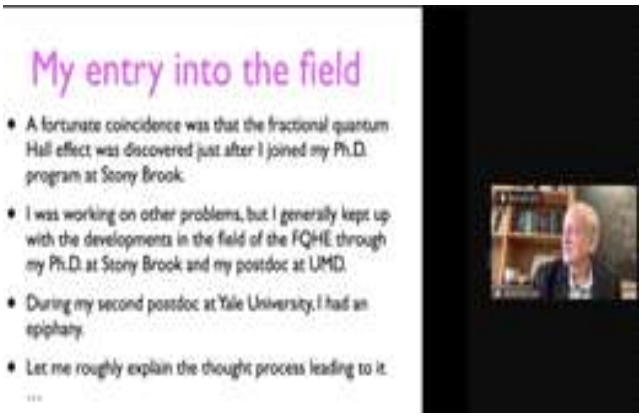


Fig. Prof. Jainendra Jain.

On 2nd day (18.04.2025) Prof. B.L. Ahuja, Vice Chancellor of Bodoland University Kokrajhar (Assam) gave his presentation on Density Functional Theory and its applications,which was followed by demonstration of physical concepts through models given by Prof. Y.K. Vijay, Director CIST, IIS (Deemed to be University) Jaipur.

Both the sessions were chaired by Prof. B.K. Sharma, former Professor of University of Rajasthan.

The third day (19.04.2025) Prof. P.K. Ahluwalia, President, IAPT gave his interesting talk on 'Predictive Simulations: from in situ to in silico', which was followed by the presentation given by IUAC Senior Scientist Dr. Sugam Kumar on "Quantum computing with trapped electrons in a planar penning trap at IUAC". The session was chaired by Prof. Yogesh Bhatnagar, Vice President - RC06.

The lecture series has been very effective in illustrating the solid state physics as the testing ground of quantum mechanics over the years and also in bringing together the Physicists of the country and reconnecting the USA based Indian Scientist Prof. Jainendra Jain.

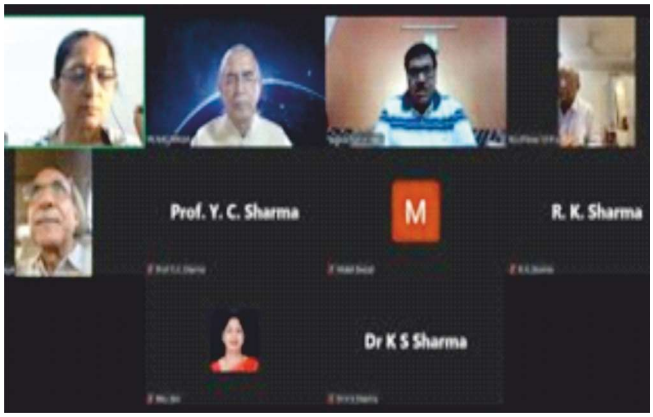


Fig. Participants

Experimental Workshop for Higher Secondary Students

In May 2025, two transformative three-day physics workshops were organized under the banner of Regional Council- 15, under the leadership and coordination of Dr. Subhas Chandra Samanta, the key driving force behind the program. The first workshop took place at Anandapur High School, Paschim Medinipur on 9th, 10th, and 12th May, and the second at Vidyasagar Vidyapith Girls' High School, Midnapore on 14th, 15th, and 16th May, engaging 59 rural and 75 urban students, respectively. Using the Indigenous Metre Bridge (IMB)—an ultra-low-cost experimental platform built from materials such as nichrome wire, a mobile charger, a galvanometer, and a digital multimeter—participants were guided through a rich array of hands-on electricity experiments. These included the determination of the EMF and internal resistance of a mobile charger, calibration and resistance measurement of a galvanometer, resistivity of a nichrome wire, Ohm's law verification, diode characteristics, potentiometric measurement of EMF (including with a potato cell), measurement of unknown resistance using the Wheatstone bridge principle, and analysis of series and parallel combinations of resistors. Each experiment helped bridge theoretical physics with practical skills, significantly enhancing students' conceptual clarity and confidence in handling real-world circuits.

In addition to electrical experiments, the workshops also featured fundamental optics activities that broadened the scientific experience of participants. These included the determination of the focal length of concave and convex lenses using the distant object method and illuminated screen technique, as well as focal length measurements of concave mirrors using the pin and candle method. Through these optics' experiments, students explored image formation, magnification, and lens formula applications, using minimal but effective class room apparatus. The workshops not only fostered scientific inquiry but also addressed barriers to laboratory access and fear of instruments by providing a simple, engaging, and inclusive learning environment. A strong team of dedicated resource persons enriched the program. Institutional support came from the Midnapore College Centre for Scientific Culture, with strong cooperation from Headmasters Mr. Bisweswar Mondal and Mrs. Swati Bandhopadhyaya, and valuable guidance from Prof. Satyaranjan Ghosh. Behind-the-scenes contributions from Mr. Samir Dhal and Miss Sabit Guin ensured smooth operations.

Together, these efforts showcased how locally-driven innovation and collaboration can democratize science education and inspire a new generation of learners in both rural and urban India.

Sanjoy Kumar Pal

EC Member RC15

Report (SRC-08E)

Maplesoft Outreach Webinar

Title: ***Applied Mathematics Meets Modern Physics: A Maplesoft Showcase***

Date: 24th April 2024 **Platform**: Online (Zoom) **Organized by**: Maplesoft

In collaboration with: SRC-08E and Shri Shivaji Science College, Nagpur

This outreach webinar was conducted under the leadership of Dr. S. W. Anwane, Ambassador for Maplesoft in the SAARC region, to promote the use of computational tools in STEM education.

Key Speakers:

- Dr. Shyamkant Anwane, Head, Dept. of Physics, Shri Shivaji Science College, Nagpur
- Ms. Nithyashree K. S., Data Analyst, Binary Semantics Ltd.
- Prof. P. K. Ahluwalia, President, IAPT and Former Professor at HPU

Highlights of the Webinar:

- Introduction to Maple 2025 and its new AI-enabled features
- Demonstration of advanced physics packages
- Hands-on session solving differential equations and real-world models
- Visualizing mathematical and physical concepts in 2D/3D
- Use of Maple in both teaching and research
- Live Q&A session with participants from across India

Session Focus:

- Prof. Ahluwalia emphasized the growing importance of computational physics and encouraged the use of Maple in research and education.
- Ms. Nithyashree introduced the updated user interface and AI-driven tools in Maple 2025.
- Dr. Anwane conducted a live demo covering topics like Bohr Model, SHM, LCR circuits, DE solving, gravitational potential, and quantum tunnelling using Maple worksheets.

Participants included faculty and students from reputed institutions like IITs, NITs, Central Universities, and BITS Pilani. The event successfully demonstrated how Maple can enhance conceptual understanding and research efficiency in applied mathematics and modern physics.

S.W. Anwane

Announcement

Call for Articles – Special Issue(s) of IAPT Bulletin

Celebrating the International Year of Quantum (IYQ 2025)

The **IAPT Bulletin** is delighted to announce **special issue(s)** dedicated to the **International Year of Quantum (IYQ 2025)**—a global celebration of the transformative legacy and future promise of quantum physics.

We invite **educators, researchers, students, and enthusiasts** to contribute articles that explore any dimension of quantum science—from foundational breakthroughs to imaginative frontiers.

Themes for Submission May Include:

- Historical narratives of quantum discoveries.
- Unforgettable or lesser-known moments in the evolution of quantum theory.
- Experiments—classic, modern, or classroom-friendly.
- Reflections on how quantum ideas have shaped science, technology, and society.
- Biographical sketches of quantum pioneers, especially Indian scientists.
- Conceptual essays, thought experiments, and simplified expositions.

- Creative expressions—poems, fictional dialogues, letters, or artistic interpretations.

We welcome both **academic and creatively written pieces**, provided they remain scientifically sound and accessible to a broad readership.

Submission Guidelines:

- Deadline**:** September 30, 2025
- Word Limit**:** 1000–1500 words
- Format**:** DOC or DOCX file
- Font: Times New Roman; Title – 14 pt bold; Section headings – 12 pt bold
- Page Style: Two-column, column spacing 1cm.
- Reference Format**:** As shown below; Example: [6] P. W. Higgs, *Phys. Lett.* **12** (1964) 132

All submissions will undergo a review and plagiarism check prior to acceptance.

Submit Your Articles To:
udayanandan@gmail.com

Let this special issue serve as a collective tribute to the beauty, mystery, and transformative power of quantum physics—through the voices of those who teach it, study it, and are inspired by it.

Core Committee – IYQ 2025 Special Issues

- Prof. P. K. Ahluwalia – President, IAPT
- Dr. C. H. Madhusudan
- Dr. Sanjay Kumar Sharma
- Dr. K. M. Udayanandan

Join us in celebrating **Quantum Physics**—its past, present, and future!

Announcement

NATIONAL COMPETITION FOR INNOVATIVE EXPERIMENTS IN PHYSICS (NCIEP)

4th-7th October 2025, Goa University, Goa

National competition for innovative experiments in Physics (NCIEP) is being held since 2003, to encourage Physics Teachers, students and Physics educators to conceive and set up original innovative experiments in Physics. The Competition is held every year at the venue of the Annual Convention of IAPT. Innovation rather than sophistication is the main theme and therefore the use of computers for data acquisition and display is not allowed.

Please read the following guidelines: There are three categories.

1. (A) The participant can be a teacher at any level or M. Phil. / Ph. D. awarded /Ph.D. pursuing student or a Scientist from national laboratories or a science communicator working in science centres, etc. He/she need not be an IAPT member.

   (B) The participant can be a student pursuing UG/PG course

   (C) The participant can be a High School student Studying in 9-12 standard.

   For all categories participants themselves must demonstrate the experiment.

2. The experiment should be an original one, designed by the participant himself/ herself. It can be even a demonstration type experiment. As 2025 had been declared as the year of Quantum Science and technology participants are most welcome to design experiments in that topic.

   For category 'C' students can work under the guidance of a teacher.

3. Top 3 experiments from each category A, B and C are awarded cash prizes.

Category	Participants	First Prize	Second prize	Third prize
A	Teachers/scientists/science communicators/ Students pursuing M.Phil./Ph.D.	Rs 7000/-	Rs 5000/-	Rs 4000/-
B	Students pursuing UG/PG course	Rs 7000/-	Rs 5000/-	Rs 4000/-
C	Students studying from 9-12 standard	Rs 7000/-	Rs 5000/-	Rs 4000/-

4. The covering letter in the form of an email must contain: Title of the experiment, name of the participant (s) with age, category A / B /C, institutional affiliation of each participant, address for correspondence, email address and mobile number along with the following declaration:

   "The proposed experiment is original, designed and developed by the participant(s) and not published / submitted elsewhere".

   Format given at the end. Fill up the declaration, sign and mail the scanned copy.

5. Please submit the write-up of experiment as an email attachment (both word & PDF file is a must) to the coordinator at the email id: nciepiapt03@gmail.com in the following format: Times New Roman, font size 12, line spacing1.5, justified, sufficient margins on all sides. It should contain title of the experiment, abstract of the experiment (not exceeding 300 words), detailed theory with necessary diagrams, procedure, observations, calculations, graphs, results and references. There is no limit for the number of pages. The participant should not write his / her name, name of college / school, etc. anywhere. This may reveal his/her identity.

6. Selected entries from each category will be invited for demonstration at the 39th IAPT convention to be held at Goa University, Goa from 4th-7th October 2025. The invited participants will be paid railway fare from workplace to convention place as per IAPT rules. In case of joint authors only one of the participants is eligible to receive TA (as per IAPT rules). Top ten student participant entries (for category B and C only) may be given an amount of Rs 1000/- each towards expenditure incurred towards setting up the experiment. The selected participants must come with their own setup for final demonstration.

7. Please feel free for any query at e mail nciepiapt03@gmail.com

8. Decision of the judges will be final.

9. The abstracts of all the selected experiments will be published in IAPT bulletin after the competition. IAPT bulletin has ISSN number 2277-8950.

10. Closing date to receive the entries is 31st August , 2025.

Note: All participants are required to perform/Demonstrate the experiment.

Geetha R S
National Coordinator, NCIEP,
E mail: nciepiapt03@gmail.com
Mob. 8088812890 You can also WhatsApp

Declaration letter

Title of the experiment:

Name(s)of participants	1.
	2.
	3.
Institution address	
Category of participation (A,B or C)	
Class in which studying	
Date of birth	
Mentor name (in case it is applicable) and address	
Mobile number	
E mail for communication	
Address for communication	

"The proposed experiment is original, designed and developed by the participant(s) and not published / submitted elsewhere".

Signature of participants Signature of mentor (if applicable)

Another Cognition Thread - Facilitating `Product' to `Practice' Transition

One of the most emphasized ideas in PER is to not consider students as recipients of the final products of scientific inquiry. Instead, they should be provided with opportunities to engage in authentic scientific practices similar to those employed by professional physicists. How to facilitate this `product to practice' transition is an ongoing discussion in science education research (see paper below for more details)

Passmore, C., Gouvea, J. S., & Giere, R. (2014). Models in science and in learning science: Focusing scientific practice on sense-making. In International handbook of research in history, philosophy and science teaching, Springer, Dordrecht. **https://link.springer.com/chapter/10.1007/978-94-007-7654-8_36**

Let us discuss some issues pertaining to the `product' vs `practice' transition in the context of the teaching and learning of derivations - a major component of physics instruction in the Indian classrooms. Most of our classrooms are textbook driven and follow the lecture based pedagogy. Both these factors - structure of typical textbooks and the lecture method - are not very conducive to the `practice' approach if enacted in the traditional way. The textbooks are organized in terms of topics or contents and not necessarily in terms of the `practices' engaged in by physicists. The focus of the lecture is typically on mimicking the textbooks, working out the mathematical steps sequentially, analogous to offering a ready-to-eat *thali* meal plate of knowledge to students. Many physics teachers have an intuitive feeling about the inefficacy of this approach. An often-heard complaint from them is that students memorize and regurgitate derivations in examinations and are not able to `solve problems'. The learning happening in such cases can be interpreted as students perceiving the derivations as `products', in terms of different components constituting it, without a know-how of the underlying manufacturing process. To address this issue we have to enable a process-oriented approach by recasting the pedagogy of derivations. We illustrate this next with the help of the derivations of wave equation and heat equation.

Typically derivations of wave equation and heat equation are taught and learned separately. Students consider them as distinct, disconnected entities (or `products') from two different topics or books. Here we explore them from a `process' perspective, as mathematical model building of physical systems or loading of reality into equations. Let us consider the physical system to be, say a metallic string or rod. Wave equation is basically concerned with the variation of position of different points on the string with time, while heat equation is concerned with the variation of temperature of different points on the rod, among other things. This transition from the physical world (string/rod) to the world of physics involving mathematical entities like points is a key process in building mathematical models. However they are often glossed over in instruction even though they can be found across derivations from diverse topics. Another recurring strategy in model building is to focus on the the simplest version of the system to begin with - in the present case a one dimensional rod or string. It may be noted that with this step we have already moved into a world of mathematical representations as there are no strings or rods in the real world which don't have any thickness. Next, as we have to talk in terms of points and how the position or temperature of it varies, we discretize the continuous 1 D string (or rod) and focus our analysis on an arbitrary mass point. In both the wave equation and the heat equation, we assume that the variation of the position or temperature is influenced only by the immediate neighboring points. For wave equation, we take into account the forces exerted on the arbitrary point under focus while for heat equation we bother about the temperature differences between the points on the left and right. Remaining processes involved and further details of these derivations can be found in the `Interactive Derivation' systems of these equations which we developed. They can be accessed at: **https://mcc.hbcse.tifr.res.in/interactive-derivations/** (see Wave Equation and Heat Equation).

The take home point of the above discussion is that we can recast the pedagogy of derivations by bringing to forefront the `processes' involved in it, as loading of real world into mathematics. In this way we can give students the experience of engaging in a modeling activity, in contrast to being recipients of the content of different chapters of the textbooks.

Paraphrasing an old saying, if we give a person a fish to eat, he will eat for a day; however if we teach him how to fish and he will eat for life !

K K Mashood
HBCSE - TIFR, Mumbai

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