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Editor : Dipanjan Mukherjee (dipanjan@iucaa.in)
Editorial Assistant : Hemant Kumar Sahu (hksahu@iucaa.in)

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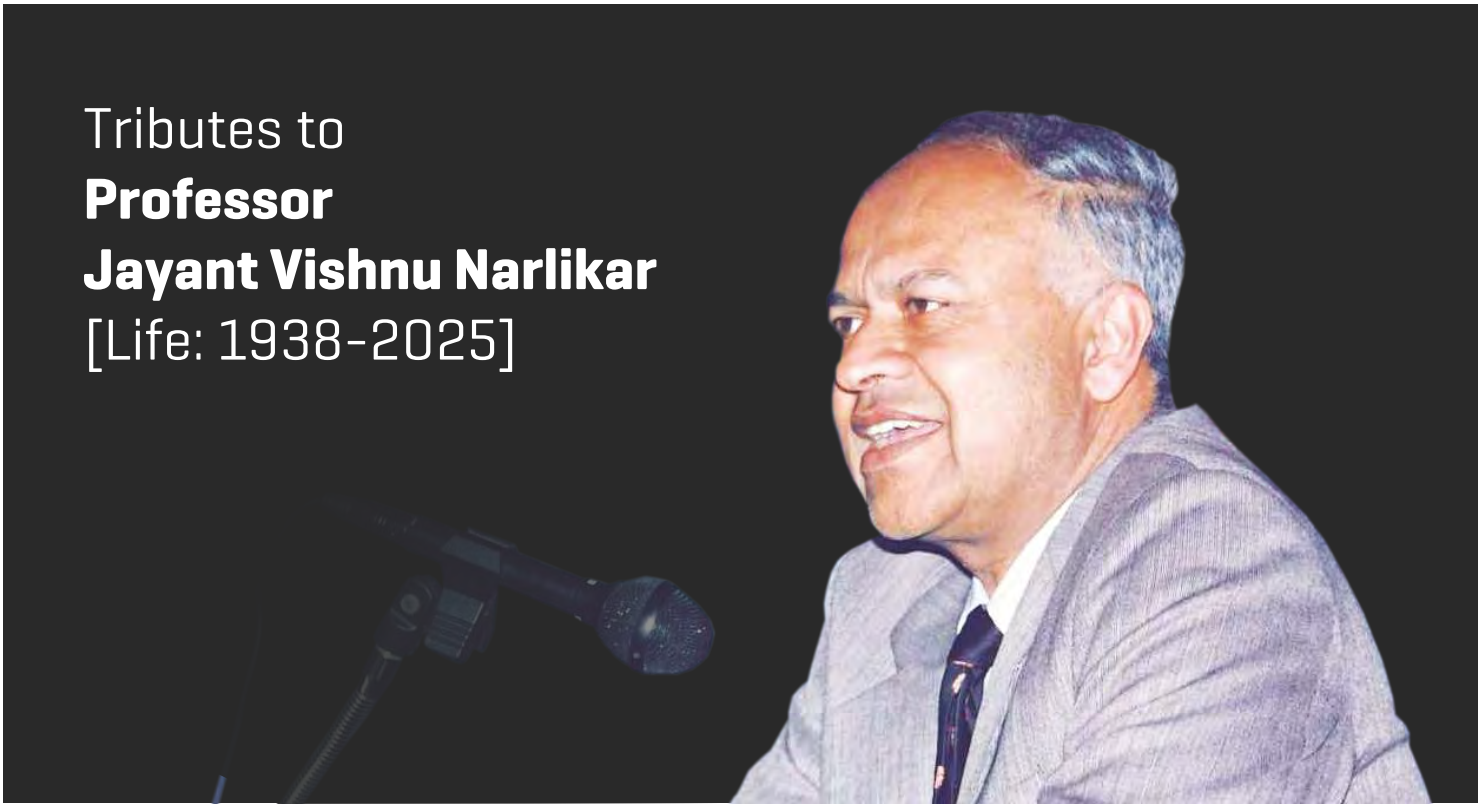
Tributes to **Professor Jayant Vishnu Narlikar** [Life: 1938-2025]



R. Srianand
Director, IUCAA

Professor Jayant Vishnu Narlikar (JVN as we fondly refer to) left us peacefully in his sleep at his residence in Pune on May 20, 2025. This marks the end of an extraordinary chapter in Indian science. During his long decorated career, he inspired an uncountable number of young minds to take up science, shaped the careers of a large number of young scientists who went on to become world leaders in various aspects of Astrophysics and Cosmology.

As a researcher, he made unique and ground-breaking contributions to cosmology, challenged prevailing scientific orthodoxy, and took it as a mission to spread science and scientific temper to the broader public. He is best known for co-developing the Hoyle–Narlikar theory of gravity and for championing the steady-state theory in the initial days and quasi-steady-state theory of the universe in the later years. These theories challenged the widely accepted Big Bang model. While being a strong proponent of alternative models, he did not impose his views on his students and colleagues. No surprise, best research articles providing support to the Big Bang model and those that improved the foundations of Big Bang model emerged from IUCAA when it was under his leadership. Allowing young researchers to grow in their own way is a rare but admirable trait among researchers - one quality worth emulating from JVN.

JVN built IUCAA as a "role model" institute to promote the nucleation and growth of active groups in astronomy and astrophysics at Indian universities. He embedded the best practices of the world's most successful institutions into IUCAA's foundation. IUCAA is the first institute to have both Scientific Advisory Committee (SAC) and Users' Committee (UC) as statutory committees in its Memorandum of Association (MOA). He firmly believed that a regular scientific scrutiny is essential for an institute to constantly grow without stagnation.

He had unparalleled commitment to spreading A&A in Indian universities. All steps were taken at IUCAA to encourage and support high quality research among university teachers. The whole setup is such that any university visitor will feel at home at IUCAA. Personally, I benefited a lot from IUCAA while starting my career from Utkal University, Bhubaneswar.

While JVN is a celebrity to the outside world, he was an easily accessible person to IUCAA members. I am sure each one of us have our own personal moments with JVN. He recognised even the smallest of contributions made by the members while building and growing IUCAA. His commitment to IUCAA is reflected in the fact that till his last breath, he was always there, even in the "farewell functions" of different IUCAA employees. In his speeches he used to highlight contributions, various interactions and personal moments with the retiring individual. This used to be the life-time moment for the employees of IUCAA. While he was emotionally attached to IUCAA, he showed remarkable restraint and stayed away from involving himself directly or indirectly in the day-to-day activities of IUCAA. This again is a unique virtue of JVN. Needless to say, he was extremely forthcoming and supportive when we went to him for advice or suggestions on any issues.

A common line we often hear from the science administrators is, 'I am busy and have no time to do science'. In cricketing terms (a sport he loved dearly) JVN seemed to have far more time on his hands than the rest. I think he was born with a natural instinct of "time-management". When he was the Director he was guiding students, writing papers and books, regularly teaching in IUCAA Graduate School, Pune University and giving enormous numbers

of public talks etc. I was always amazed by this. When you fix a meeting with him it used to start exactly on time and end within the scheduled time. He never seemed hurried at any point during the meeting. Despite that, all the key points were discussed, and the meeting ended smoothly — unlike what we often experience these days: 'Sorry, we need to end this meeting, I have another one starting in a minute.'

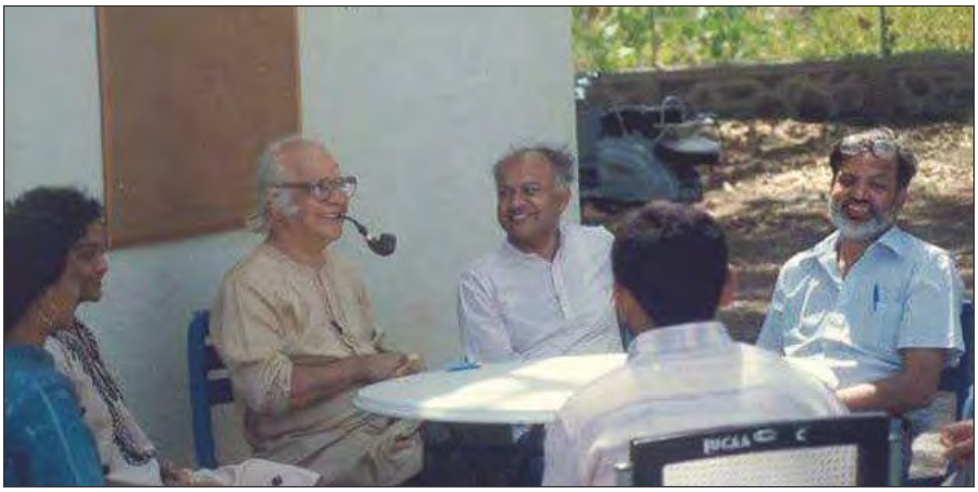
Dr. Narlikar authored numerous books and articles in English, Hindi, Marathi and occasionally in Sanskrit as well, making science accessible to the general public. He firmly believed in bringing science to the general public as one of the duties of any researcher. This is why he made science popularisation a core activity of IUCAA from the very beginning. Various regular activities like 'Second Saturday Public Lectures' and 'Summer Programme for school children' were started by him in early 1990s. His interaction with the public through "Ask a scientist?" during National Science Day celebrations was the most popular event every year. He was always there for this event. This year, when it became apparent that interacting with the public was difficult, he held a 30-minute session titled 'Mathematics Without Number Crunching.' It was an outstanding event.

When we talk about JVN, we can go on and on... Surely, we will miss him. But the best tribute we can offer is to follow at least some of his finest principles.

Naresh Dadhich
Former-Director, IUCAA (2003-2009)

Narlikar is no more, yet he is all around!

Some people do not come in through the door but rather jump through the roof. Jayant Narlikar was one amongst them. In 1964, when Fred Hoyle and he announced in Cambridge their New Theory of Gravity, suddenly modern India of Nehru's vision



found a science hero. It is therefore no surprise that Narlikar became overnight a household name in the country seeking its bearing in the world of science and technology.

He passed away peacefully in sleep in the early hours of the morning, just two months short of his 87th birthday on 19th July 2025. It marks the end of an era. He doesn't leave behind a vacuum but a thriving world class institute in IUCAA, a brilliant school of cosmology and astrophysics in the country, a galaxy of young women and men inspired through his works and books, and millions of admirers all over the globe. He has curved a special and unique hole for himself in "time". That would be the right and proper way to remember him – a fitting tribute. Nothing more could he have asked for.

Today we should rather celebrate the life of a great human being, committed to science and its propagation, and personified excellence in whatever he happened to indulge in. It was a matter of great privilege and fortune for some of us who had the opportunity to work with him at various levels. He had the uncanny knack of getting the best out of everyone by sharing and involving.

He was an exceptionally talented and outstanding student in the most prestigious Cambridge University and had won great laurels including the coveted Adams Prize which he shared with Roger Penrose who is now a Nobel Laureate. He was thus among the front-ranking researchers of the time.

The Hoyle-Narlikar theory accorded to the steady state theory (the Universe looks the same from anywhere in space and time, and it has no beginning and no end) of cosmology which unfortunately did not find favour with the astronomical observations which conclusively showed that the Universe began in a big explosion, called Big-Bang – it was so christened by Fred Hoyle who was one of the proponents of the steady state theory. Jayant was the last of the steady state adherents. Notwithstanding that, he was a brilliant researcher par excellence, and had conviction and courage to ride against the tide and yet being held in the highest esteem even by his academic opponents. The distinguished visitors to IUCAA, including Nobel Laureates, bear testimony to this fact.

IUCAA was his greatest gift to science and nation, and more importantly to University students and faculty. The main objective of

IUCAA was to facilitate good research in the universities by creating a world class shared facility with a scintillating academic environment and state of the art facilities in library, computing and instrumentation. This was the university' s own institute for doing world class work. It is gratifying to come across university students and faculty observing at the world's largest telescope at Atacama Desert, Chile, and publishing their work in the front-ranking journals. This is what indicated that Jayant's dream has not only been realized but has also come of age

The thing that stands him out is his missionary zeal to communicate science and its method to young students and ordinary people through his innumerable public lectures and science fiction books. It would be no exaggeration to say that it is this aspect that strongly relates him to people. There are other very good scientists in the country, but none has attained this kind of popularity and respect. To make the point, let me recall an incident. In 1997, we organized Roger Penrose's lecture in the Balgandharva theatre, and there were a riot-like situation. About 200 people who could not get in, were shouting and banging the gates, and from the other side, Dr Shreeram Lagoo was pacifying them saying – it is our Narlikar's institute. That was the measure of love and affection people had for him.

The ultimate value of one's work and contribution is how far and how well it is remembered. Besides his scientific work and books, the two things that will take him long and far, the institute, IUCAA, he created and millions he inspired and influenced through his popular writings and science fiction. I am sure even after 50 years or more, one would certainly come across some people who would swear by the inspiration and motivation they derived from him. This would be a good measure of the influence he had on several generations of young women and men as well as on people at large.

Let me end on a personal note. In 1965, three of us travelled from Vallabh Vidyanagar to Ahmedabad to listen to his lecture in the Atira hall. Little did I then know that I would end up spending over half a century intimately interacting and working with him. This is what I will always treasure.

Ajit Kembhavi

Former-Director, IUCAA (2009 - 2015)

Professor Jayant Narlikar passed away in his sleep in the early hours of May 20, following a brief illness precipitated by a simple fall at home, the ensuing surgery and the effects of a heart condition. He had not been in the best of health for some time, and yet was able to carry out his routine in a highly productive way. Since January 2024, he has been writing a blog, covering different stages of his life, which I am sure will be sorely missed by the tens of thousands of people who read it.

By any measure, for long Jayant has been the face of astronomy, and even wider science, in India. He rose to fame as a research student of the great Fred Hoyle at the University of Cambridge. 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 about the most profound matters, and a singular ability to convey to non-expert people his thoughts about the universe including his own researches. He continued to interact with the public in many ways right to the end. He was awarded the Padma Bhushan at the tender age of 26 years, and the Padma Vibhushan in 2004.

Jayant's first work was on the distribution of cosmic radio sources as a function of their flux, the log N-Log S distribution. The shape of the distribution depends on the metric 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 Cavendish Laboratory led by 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. The young Narlikar was sandwiched between these quite different points of view. A clear resolution of the problem would have then been impossible, because of the very limited data available and absence of measured redshift of the sources. Nevertheless, the debates had far reaching consequences, not only for cosmology, but also for the career paths of the protagonists. Martin Ryle and Anthony Hewish jointly won the Nobel Prize in Physics for 1974, being the first astronomers to be so honoured.

Along with the data analysis, Narlikar also worked on difficult theoretical problems, including Newtonian cosmological models with rotation and shear, to study the nature of the singularity present in them. Such models in general relativity had already been studied by A. K. Raychaudhuri, but models in the Newtonian framework could not be obtained as simple special cases of the Raychaudhuri equation, and needed a sophisticated approach. In the same years, Jayant worked with Hoyle on the age of galaxies and the avoidance of singularities in steady state cosmology, Mach's Principle and the Creation of Matter, Time Symmetric Electrodynamics and the Arrow of Time in Cosmology. This output was remarkable by any standards; it had great variety, depth and novelty, and went against many cherished conventional ideas. In 1966, Hoyle and Narlikar published work on a new theory of gravitation, which is invariant under conformal transformations. The theory incorporated Mach's Principle, action-at-a-distance concepts and so forth, and is sweeping in its scope. It reduces to Einstein's theory in the weak field regime of the classical tests, but is different in its global implications. The attractive nature of the gravitational force arose as a consequence of the theory.

Jayant spent much effort, first with Fred Hoyle, and then with other distinguished astronomers including Geoffrey Burbidge, on the steady state theory, working out its astrophysical implications. The model lost much of its allure after the first discovery of the cosmic microwave background, but in the early years of the discovery attempts were made by Jayant, Hoyle and Chandra Wickramasinghe to attribute the origin of the radiation to Galactic sources. Over the years' accurate measurements of the Planckian form of the radiation, and its isotropy made an early hot phase of the Universe inescapable. That required a modification of the steady state model to a quasi-steady state theory in which 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. Jayant 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 of the present Universe. With Burbidge and Halton Arp, Jayant also worked on possible anomalous redshift of quasars.

In later years, Jayant pursued the idea, originally due to Fred Hoyle, that microorganisms 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. Jayant proposed balloon borne 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 various organisations and support from ISRO, and a balloon flight was

carried out, another flight which could have been crucial never took place. That was possibly a great lost opportunity, especially given the growing realization 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.

Jayant was at Cambridge until 1972, when he joined Tata Institute of Fundamental Research (TFR), Mumbai in 1972. There Jayant continued his work on various 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 choosing. 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 have done excellently in their professions, and others who have worked for him in various capacities have always contributed their best.

Jayant's phase as an institution builder started when Professor Yash Pal, who was then the Chairman of the University Grants Commission, invited him in 1987 to set up a new institute, which would be unique in addressing the difficulties of the universities in carrying out research in astronomy and astrophysics. When Jayant moved to Pune for the purpose on June 1, 1989, the piece of land where IUCAA now stands was a verdant plot with tens of banyan trees, and where buffalos grazed peacefully on the abundant grass. Soon the buffalos moved on, the trees were relocated to other places on the plot where they have thrived, and in their place rose the unique buildings of IUCAA, designed by Charles Correa. But even before the facilities became available, 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 was the tens of visitors from the universities and colleges who came all the way, during the first years of the institute, from distant parts of the country, even though there were hardly any facilities. They worked in collaboration with IUCAA faculty and with each other, and brought their students who were trained and soon there was a thriving astronomical community in the universities. Jayant helped by interacting personally with the visitors, who over the years increased greatly in number. He often visited departments all over the country, lecturing and introducing teachers and students to astronomy and 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.

The process was far from simple. There was widespread scepticism in the existing astronomical community about Jayant's setting up a new centre outside the traditional umbrellas, and that too with the help only of a small group of untested young persons. There was great support from the highest levels of the government, but there was the regulatory space to be traversed, which was made so much more difficult because of the uniqueness of the new venture. Jayant mostly got over the difficulties in his usual gently persuasive way, but on occasion he had to tell people at the highest level that either the project goes in his way, or he goes.

Jayant 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. In many countries that would have been an insurance nightmare. But the children were not worried, and now in their middle age, still fondly recount the inspiration that they received from Jayant to do well, and better, in whatever they were doing. That was a simple message, but it has produced many stars in astronomy and other fields over the decades. Jayant took the message beyond students and teachers to the general public, who always 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. Jayant's books, articles and science fiction stories have been received very well. The public affection and adulation he got has been truly unique.

Jayant contributed much to the development of the Astronomical Society of India in its early years. He was its President during 1983-1985, and Chair of its Scientific Organising Committee during 1995-1997. In 2023 he became the first recipient of the Govind Swarup Lifetime Achievement Award. Jayant was keen that the Journal of Astrophysics and Astronomy (JAA) and the Bulletin of the Astronomical Society of India be merged into a single impactful journal.

Jayant's father was a general relativist, with his first student P. C. Vaidya being the discoverer of the famous Vaidya metric, and his mother was a Sanskrit pandit. Jayant lost his wife Mangala almost two years ago, just two days before his 85th birthday. She was a mathematician, teacher and author, but spent much of her time facilitating, and in later years enabling his many activities. She was a great strength and inspiration for him, and to countless others who met her. Jayant is survived by his three daughters Geeta, Girija and Leelavati, and their families. The three work at the top of their chosen professions in science and technology.

Somak Raychaudhury
Former-Director, IUCAA (2015-2022)
Vice-Chancellor and Professor of Physics, Ashoka University, Sonepat

JVN, a tribute

For the world, JVN was the founder of modern cosmology in India, and a fearless

challenger of orthodoxies. But to those of us who had the good fortune to know him personally, his loss is intimate and painful. He was not just a scientist of rare brilliance — he was a powerful presence, a unique mind, a teacher, a friend.

My own journey into science began with one of his books "The Structure of the Universe", which I got as a school prize. That slim book was the first glimpse into the universe I had, and it made everything else — every other ambition — seem pale. Years later, as a college student, I was fortunate to meet him- an unforgettable experience. Over the years, I realized that his was a quiet revolution — turning young people toward science, not through slogans or grand gestures, but through example, generosity, and clarity and excitement about Science.

While I was a student in Cambridge, and during subsequent visits, I met JVN, who visited almost every year. So did his mentor Fred Hoyle. Once, as the Institute of Astronomy (IoA) celebrated the 80th birthday of its Founder, Fred Hoyle was asked to speak about his life in Science. He started his speech by saying "If I have seen further than others, it is by standing on the shoulders of a Jayant."

In the mid-nineties, JVN visited the Harvard-Smithsonian Center for Astrophysics in Cambridge MA, where I worked, to give a talk on steady state cosmologies. After the talk, he came to my office and suggested I apply to IUCAA.

Soon after I shipped all my belongings and arrived at IUCAA in 1995. One of the earliest responsibilities JVN gave me was to build the popularisation of science programmes, which had been so lovingly started by him along with N C Rana. I worked hard with him on putting together the Science Park, which was a novelty when it opened in 1998, and has been an inspiration to school students in Pune and nearby for decades.

JVN was in my mind the embodiment of the ideal Scientist. The pursuit of knowledge and truth to him was not about allegiance to dogma but about the relentless pursuit of questions. He would be open to all-out debate about anything he did or did not believe in. He would argue with impeccable rigour, ever smiling. Contradicting him in academic debates was never held personally against anybody else.

Working alongside him on bringing science to the public, and particularly to young people, I saw the true Jayant Narlikar. The maverick who was not afraid to question the core dogmas of Science, but also to question the all-pervasive pseudo-Science in society, embodied in the belief in astrology, fear of comets and eclipses, and general superstition.

A core feature of JVN was his inimitable sense of humour. During the time when I was a Visiting Associate of IUCAA, I represented the Universities of India at a meeting of the Astronomical Society of India to thank him for his contributions to setting up Astrophysics education and research in so many of them. As I handed to him on stage the traditional gifts of a shawl, a coconut and flowers, JVN cheekily reminded me that the meaning of his name was "he who holds the coconut".

I was so thrilled and honoured that a couple of years ago, as the Marathi Vidnyan Parishad granted me their first J V Narlikar Lifetime award, JVN appeared on a video link to speak on the occasion.

During my tenure as Director of IUCAA, it was such a pleasure to see JVN every day at the institute, ever smiling, and inspiring us with the quiet and persuasive pursuit of his principles. He built IUCAA brick by brick, and we hope we are worthy of his legacy.

Tarun Souradeep
Director & Professor, Raman Research Institute, Bengaluru

Professor Narlikar was a doyen of Indian science. Renowned cosmologist, a distinguished science statesman and

communicator, and perhaps most importantly, a gifted institution builder. Our institution, IUCAA, stands as a lasting legacy of his commitment to creating and promoting scientific excellence across the nation.

Indeed, the large community of IUCAA Associates in the Universities knit together over the decades would miss him the most dearly. He was instrumental in the setting up of the Indian Association of General Relativity and Gravitation to organise the Indian community in Gravitation and Cosmology. The first International conference on Gravitation and Cosmology (ICGC) meeting in Goa in 1987 brought together the best researchers in the world in touch with the Indian community. This meeting series, much like many of his other initiatives, has sustained and grown over the decades.

In my humble opinion, a couple of points that make him stand apart among the Indian greats are his strong sense of justice and equality and his unwavering commitment to the causes he believed in — science popularisation and outreach, empowering the university sector and openly confronting pseudo-science-based superstitions and astrology.

This is a great loss to the nation and, in particular, Indian science. Personally, it is a deep loss for Sucheta and me since we took our first steps in research in the unique ambience that he fostered at, the then nascent, IUCAA. He mentored my first years of PhD when I enjoyed his unstinted support for complete freedom of thought.

I was also fortunate to have him as the Director when I returned to a faculty position at IUCAA. He remained a true well-wisher for all my endeavours till date. I especially treasure the fact that he himself proposed to journey to visit the then newly selected LIGO-India site – by far, not a comfortable endeavour. His demise is an immeasurable loss to the nation and, in particular, Indian science.

IUCAA to all of us is synonymous with JVN. While it is difficult to imagine. IUCAA, without him, the greatest tribute to him would be to work together to fulfil his dream of an eminent scientific centre that spreads excellence across the nation and the world.

Shyam Narayan Tandon

Former faculty member, IUCAA

Prof. Jayant Narlikar made very major contributions to science, propagation of science, teaching and institution building. For all his contributions he received abundant love and praise from Indians as well as many national and international recognitions. In addition to the quality of his contributions, the sheer volume of his contributions makes one wonder how a single person could accomplish so much. In my long association with him I had the opportunity to observe his unique personal traits. I shall try to share some of these in my narration below.

His insistence on keeping a time-schedule was known to anyone who had any direct interaction with him. On one occasion he could not find a car for a short trip because the driver had left quite early to pick up a guest at Shivaji Nagar Railway station. On his return the driver was told by Jayant that reaching too early for an event was as bad as reaching too late and therefore he should plan to reach the station only about 5 minutes before the arrival of the train.

While he expected high standards from his surroundings, he had a lot of patience and hardly ever showed any anger if he found something not meeting his expectation. I remember two rare instances on which he expressed his disappointment. The first was when he experienced the terrible state of telephone connections at TIFR, Mumbai (then Bombay). He got so disappointed that he unplugged the telephone apparatus in his office-room and gifted it to the registrar. The other instance was related to poor quality of English used in some of the notices at IUCAA. One day he got so upset that he circulated an e-mail asking the notices to be sent to him for correcting the language before being displayed.

In his vision, observational astronomy and hence instrumentation were essential components of IUCAA's academic profile. As he was a theoretical astronomer, many were surprised by this emphasis. However, despite the slow maturation of instrumentation activity at IUCAA he supported it whole heartedly through the years and the other directors continued to provide similar support. It is the result of this sustained support, resulting from his long term vision, that IUCAA has been a major participant in the first two space missions of ISRO which are fully devoted to astronomy.

We shall always remember him for his contributions to science and Indian society.

Sanjeev Dhurandhar
Former faculty member, IUCAA

Prof. Jayant Narlikar: a tribute

Prof. Jayant Narlikar was a renowned cosmologist and was among the greats in science. He is identified by the quasi-steady state theory and its precursor the Bondi-Gold-Hoyle's steady state theory. Although these theories were not favoured by the mainstream cosmologists, they illustrate a serious and sustained campaign to incorporate Mach's principle into gravitation. Mach's principle propounds that the inertia of a body is due to the net effect of the rest of the bodies in the universe. In the course of developments of these cosmologies, Hoyle and Narlikar (HN) proposed a new theory of gravitation which incorporates Mach's principle, and while doing so, successfully extends the Wheeler-Feynman absorber theory of classical electrodynamics to a theory of gravitation. This was in 1964.

The British newspapers followed by Indian newspapers announced the Hoyle-Narlikar theory. Jayant became a hero overnight in India, and especially in Maharashtra. He became a household name. I was twelve years old at the time and in school. My parents, my father's uncle, Bhalchandra Dhurandhar (who fought along with Mahatma Gandhi and was the editor of Loksatta), took an interest in me, urged me to regard Jayant as my ideal, and so did my science/maths teacher in school. Jayant instantly became my hero. I used to dream of talking to him one on one, discussing science with him and even playing cricket with him! He was a legend.

Little did I imagine that I would ever meet him in person in my life, let alone work under his guidance as a research student. I was remarkably fortunate; my dream had come true. It was 1975. I was sitting in Jayant's office on the fourth floor of the Tata Institute of Fundamental Research in Colaba, Mumbai. This was my first meeting with him as a Ph. D. student. It was memorable. He described to me a problem in general relativity and asked me to work out the first steps. But try as I would, I could not make any inroads into the problem. A week went by.

I then went back to him and explained my inability to make any progress. He went to the black board and in 15 minutes or so had set up the necessary equations and also partially solved the problem. It was magic! Or so it seemed to me at the time. It was then that I realised my mistake. My basic approach was faulty. My undergraduate training involved using recipes like integration by parts, substitutions etc. and applying them blindly, without any real effort at comprehending the problem. Although I could do integrals, solve differential equations a la Mathematica, I did not understand either. Standard techniques work only in standard situations and have limited scope.

I understood integrals (especially contour integrals around branch points), differential equations for the first time from Jayant. He was an excellent teacher. Understanding the crux of the problem is most important – understanding is the key - when faced with a non-standard situation and when standard techniques fail.

In 1986, in a workshop held in Corsica, France, I listened to a lecture by Prof. Kip Thorne (Nobel Laureate in physics 2017) on the detection of gravitational waves. This field brought together a lot of disciplines - physics, engineering, statistics and mathematics. I was interested in them all. I found this very challenging and worth pursuing seriously. But it seemed an impossible task in 1989. It involved among other things, effectively measuring distances something like 1 part in 1022 which is ridiculously small. Nobody in their right minds would have anything to do with

it. The technology did not exist at the time even internationally. It was a crazy idea in 1989 (but so were jet planes in 1889!). But I was out of my mind! I discussed my interests with Jayant, and he offered me a job at IUCAA. He encouraged revolutionary ideas – he himself was swimming against the tide!

There was one vital aspect of the experiment which I was certainly capable of, namely, the analysis of detector data. Accordingly, I focused on the data analysis aspect. I worked with post-doctoral fellows and students, notably, Dr. B. S. Sathyaprakash. We laid out for the first time a procedure for detecting inspirals of compact binary stars, for instance, black hole binaries. This procedure lies at the heart of today's algorithms and the paper has been repeatedly cited in the recent detections by LIGO and Virgo and in the discovery paper of 2016. IUCAA has been part of the LIGO Science Collaboration since 2000 and has been part of the team which made the discovery of gravitational waves a decade ago. It duly got the stamp of a Nobel prize in 2017. It led to the launching of the LIGO-India project of building a 4 km laser interferometric detector on Indian soil in collaboration with the US.

The endeavour of detecting gravitational waves involved a big risk and seemed to be an impossible task in 1989 and early '90's. Moreover, IUCAA was a new institute at the time. In spite of this, I received unstinted support from Jayant. Jayant believed in academic freedom and encouraged radical ideas.

Jayant was a multifaceted person. I think his greatest contribution is the founding of IUCAA – the Inter-University Centre for Astronomy & Astrophysics in Pune. He was the founder director of IUCAA from 1988-2003. The mandate of the centre is to do research at an international level in astronomy & astrophysics and foster the field in Indian universities. The endeavour has succeeded splendidly.
Jayant Narlikar was a prolific writer and science communicator. He wrote books and articles in English, Hindi, and Marathi. His writings ranged from advanced scientific treatises, science fiction to popular books.

In his brilliant career beginning from school – he always stood first in his class - Jayant was a recipient of numerous awards. I mention here the notable ones. He became a Senior Wrangler (1959) and received the Tyson medal in Mathematical Tripos (1960), the Smith prize (1962) and the Adam prize (1967) when in Cambridge. From the Indian government he received Padma Bhushan (1965) and the Padma Vibhushan (2004). He received the UNESCO Kalinga Prize (1996) for the popularization of science.
His legacy as a scientist, educator, and science communicator is immortal. It will continue to inspire students, scientists and the public for many more years.

P. Sreekumar

Member,
Scientific Advisory Committee, IUCAA
Professor & Director,
Manipal Centre for Natural Sciences (MCNS)

It is with deep sadness that we at the Manipal Centre for Natural Sciences, MAHE, received the news of the passing away of Prof. Jayant Narlikar.

Prof. Narlikar is the leading figure in Indian Astronomy in this era and has made numerous contributions to Astronomy & Astrophysics research, teaching, and community outreach. His vision of IUCAA truly transformed the size and extent of the Indian astronomy community, in particular, the University sector. His own fundamental contributions to Cosmology research and pedagogy are well recognised globally, and we will truly miss his presence, guidance, and support in future activities.

The faculty, IUCAA Associates, and students of MCNS, MAHE express their heartfelt condolences to the family of Prof. Narlikar and IUCAA in this time of grief.

Shyamal Kumar Banerjee

IUCAA Visiting Associate

Professor and Dean, School of Basic Science and Research, Sharda University, Greater Noida

We have lost one of the best teachers we have ever met. Professor Jayant Vishnu Narlikar was a remarkable and brilliant teacher who touched the lives of countless students, as well as teachers. He wasn't just an educator but also a mentor and a friend to all. He left behind a legacy in the field of education with his inspirational and thought-provoking teaching style and a multitude of scholarly publications. On the collaboration of research projects, many of us will always treasure the moments of delightful discussions and the hearty laugh that shattered the weekend silence in IUCAA. I personally have lost my guru, my mentor, and a great human being. I fall short of words to express my profound grief at the sad demise of our beloved Narlikar Sir. We pray to God for his soul to rest in peace. We plead Almighty to give his

family members and the entire scientific community strength and fortitude to bear this irreparable loss.

Murli Manohar Verma
IUCAA Visiting Associate
Professor, Department of Physics, Dean Research, University of Lucknow, Lucknow

A tale of unknown destinations!

Jayant Vishnu Narlikar or JVN is no longer with us in this world, but, as someone aptly said, "to live in the hearts of those you leave behind is not to die"...

In him lay a huge inspiration that came my way. I recall meeting him for the first time in July of 1987 at Centro Brasileiro de Pesquisas Fisicas, Rio de Janeiro, though I had interacted with him several times through postal mail before that as a master's student at Allahabad University. Postal communication through those pale postcards or blue inland envelopes continued for years. He wrote one such letter to me on the day when his mother (Tai) passed away. He had scribbled a few lines about black hole entropy and the arrow of time. JVN was fond of writing... yes, even letters. He carefully and sparingly chose his words. Later, as my research work progressed and time flew by, we met at Allahabad, and more frequently, at IUCAA along with my family, and at his own house at Pashan for lunch or evening snacks.

At the door of his house, he had put up a self-made cardboard clock for the milkman, telling him not the time, but the amount of milk to be given on a particular day. Often, when in Pune, he took my family to a restaurant for lunch. He would pick us up at the guest house foyer at the scheduled time. At lunch, Mangala Ji and he described the recipe for food items or condiments in detail. Thus, he explained to us why in the IUCAA canteen, he had put up a quote by Brillat-Savarin: "The discovery of a new dish brings more joy to mankind than the discovery of a star". His culinary traits were matchless.

We also invited him to Lucknow in December of 2012 for a lecture on the topic, "How well do we know our Universe?" It attracted a huge audience in our large Malaviya Hall as never before. Despite not being at the peak of health in his seventies then, he expressed his desire to visit the Bhoolbhulaiya at the Imaambaara, which has many sharply inclined stair steps to walk up with unyielding excitement. He, Mangala ji, and my wife Leena happily moved around with insatiable curiosity. He also inquired if the state government had a map of the labyrinth, which no one knew about. Even though he followed the protocol of being the state guest and stayed in the Raj Bhavan as the Hon'ble Governor had insisted, both of them visited my University flat on the third floor (which too had stairs, but he was undeterred) for

lunch. He smilingly asked me to ensure the list of items at the table before lunch so that no item would be missed out when serving!

Once, I took a handicraft (chikankaari) kurta for him from Lucknow and presented it to him in his office at IUCAA the following morning. He burst into cheers like a child, and softly said, "Aaj to main ise hi pahnunga." And post lunch, like a magic wizard, he appeared in the new robe.
Such was this man!

A train of seemingly endless memories flashes through my mind.

I had already seen him walking a long distance in the corridor from his office at a far end slowly up to the tea room and back with a stick without accepting any human help, holding tea cup with trembling hands, sipping tea while sitting on stones at the IUCAA lawns, keeping a tab to write even when he got stuck in flight delays at airports (interestingly, he dedicated one of his books to airlines authorities for the delays which allowed him enough time to write).

Last my family joined Mangala ji and him together in Pune, was in January 2023, 9th of that month to be precise, when we again had lunch in the same restaurant, and incidentally, when he came to know that it was my birthday too, he happily asked me to eat more as a mark of celebration cracking a few jokes about facts and fictions in life.

The same year, on July 17, Mangala ji passed away.

He did not let his health conditions sway him from his academic pursuits. He continued writing enlightening blogs on life, science, the world, and how it all began. As usual, clarity, precision, and time management were the hallmarks of his expression, as much as it was for the other parts of his life.

As he ardently wished science to be brought to the common man in simple language, he also entrusted me to translate his book, "Seven Wonders of the Cosmos", into Hindi. Sadly, it is still incomplete; the two chapters impeccably edited by him, carrying his calligraphic remarks with pencil, are looking upon me.

His autobiography "My Tale of Four Cities" relaxes me to the extent that it has become a routine for me to read a few lines from it in my free time. The tale of four cities has now taken him to an uncharted city where he may have found his new abode. Knowing him from his ilk, he would keep sending us his writings on the pale yellow postcards about the new wonders, with a strong message "don't blindly follow the bandwagon" or "use your rational mind, quite often missing even in so-called scientific pursuits". He would still say, "I'd reply with my autographs only if you ask me questions about life and the world".

He may have crossed the event horizon towards a singularity that we don't know about. He would have many more tales to tell. How would we learn about those tales?

Gyan Prakash Singh
IUCAA Visiting Associate
Professor, Department of Mathematics, Visvesvaraya Institute of Technology, Nagpur

Prof. J. V. Narlikar provided invaluable support to researchers, especially those working in colleges and universities, through IUCAA.

I participated in the Graduate School on Gravitation and Cosmology at IUCAA, Pune, from September 4-23, 1989. Since then, I have had the opportunity to visit IUCAA and utilize its facilities for research. Like me, a large number of researchers and students received motivation, encouragement, and support from Prof. Narlikar, which enabled them to enhance their knowledge and careers in the fields of Relativity, Cosmology, Astronomy, and Astrophysics. Prof. Narlikar was always interested in teaching and motivating the younger generation, especially students. At our request, he visited VNIT, Nagpur, twice and delivered talks for the benefit of students, researchers, and teachers. It is difficult to express in words his help to the scientific community; rather, it can only be felt.

D. Shanti Priya
IUCAA Visiting Associate
Head, Department of Astronomy, Osmania University

It is with deep respect and admiration that the Department of Astronomy at Osmania University pays tribute to Professor Jayant Vishnu Narlikar, a towering figure in the field of theoretical astrophysics and cosmology, and an enduring inspiration to generations of scientists, educators, and students in India and around the world. Beyond his research, Prof. Narlikar was an extraordinary science communicator. His popular science writings and lectures ignited the imaginations of countless young minds, bringing the wonders of the cosmos within reach of every curious student. His establishment of the Inter-University Centre for Astronomy and Astrophysics (IUCAA) laid a strong foundation for collaborative astronomical research in India, empowering institutions like ours to flourish. At Osmania University, we have long drawn inspiration from Prof. Narlikar's integrative vision of science and education. His legacy continues to guide our teaching, research, and outreach activities. On behalf of the faculty, researchers, and students of the Department of Astronomy, we express our heartfelt gratitude to Prof. Narlikar for a lifetime of scholarly brilliance and selfless service to the advancement of science in India. "To look up at the stars and dream is human. To show others the way to the stars—that is greatness." Thank you, Professor J. V. Narlikar. Your legacy will remain a guiding force in the pursuit of knowledge and the spirit of scientific inquiry.

Srijit Bhattacharjee
IUCAA Visiting Associate
Indian Institute of Information Technology, Prayagraj, Uttar Pradesh

JVN: A humble giant

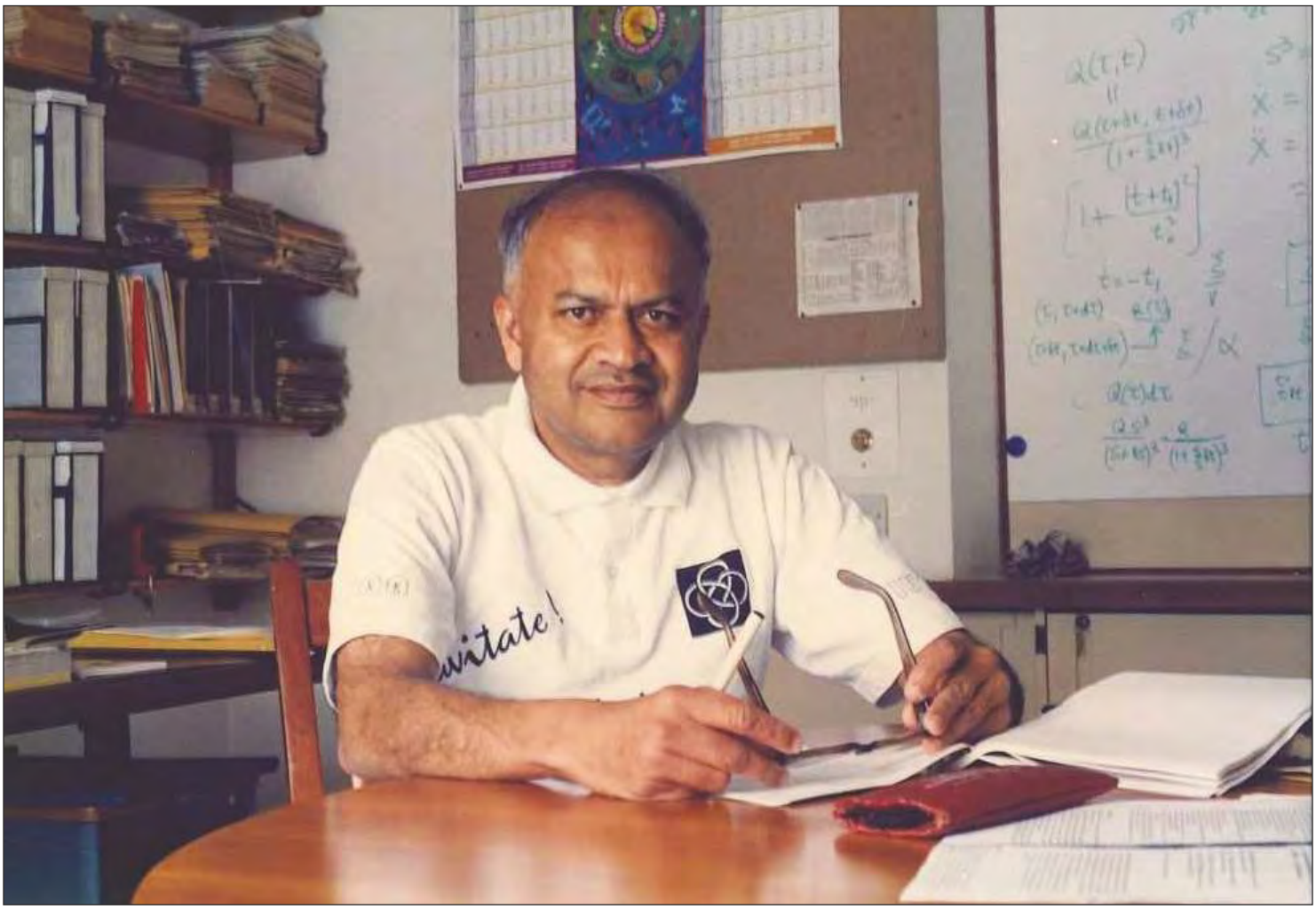
When I entered high school, I first heard about Prof. Jayant Vishnu Narlikar from one of my science teachers. Later, I encountered his name many times in quizzes, television programs, and newspapers, but I did not know at the time that one day I would have the opportunity to preside over a meeting between JVN and

research scholars. This remarkable incident happened at the Saha Institute of Nuclear Physics some fifteen years ago when I was doing my PhD. I consider it one of the most memorable events of my life. I spent almost an hour sitting beside this towering figure of Indian science and noticed how astonishingly humble he was, listening to all the questions with immense patience and answering each of them with his characteristic smile. Apart from his scientific achievements, he will be remembered as one of the greatest science communicators and administrators of the country. Above all, the most important lesson one should learn from him is to remain calm and humble even after achieving almost everything a scientist can dream of.

Ksh. Newton Singh
IUCAA Visiting Associate
Department of Physics, National Defence Academy, Khadakwasla, Pune

Loss of Another Great Theoretical Physicist

Prof. Jayant Vishnu Narlikar was a visionary astrophysicist, a pioneering thinker, and an inspiring educator whose contributions reshaped our understanding of the universe. His work challenged conventional cosmological theories, offering alternative perspectives to the widely accepted Big Bang model. Born on July 19, 1938, in Kolhapur, Maharashtra, Prof. Narlikar's intellectual brilliance was evident from an early age. He pursued his education at Banaras Hindu University and later at Cambridge University, where he collaborated with the legendary Sir Fred Hoyle to develop the Hoyle–Narlikar theory of conformal gravity—a revolutionary alternative to the Big Bang theory. Beyond his scientific achievements, Prof. Narlikar was a passionate science communicator. He believed in making complex scientific ideas accessible to the masses, writing extensively to popularize astronomy and astrophysics. His leadership as the founding director of the Inter-University Centre for Astronomy and Astrophysics (IUCAA) in Pune helped establish India as a global hub for astronomical research. His passing on May 20, 2025, at the age of 86, marked the end of an era in Indian astrophysics. Yet, his legacy lives on in the countless students, researchers, and admirers he inspired. His contributions will continue to illuminate the path for future generations of scientists, ensuring that his vision of a universe filled with curiosity and discovery remains alive and vibrant. Rest in peace, Prof. Narlikar. The cosmos you studied so passionately will forever carry your imprint.



Most precise expansion rate of the Universe determined with "Cool" Stars

Astronomers have known for almost a century that the Universe is expanding. Ever since determining the present expansion rate of the Universe, also known as the Hubble constant, has been remarkably challenging. An accurate and precise value of the Hubble constant is crucial because it is a fundamental parameter in cosmology that is related to the spatial and temporal scales of the Universe. The latest results have established a 5 sigma discrepancy between the Hubble constant values determined using the two most precise methods – standard cosmological model based inference from the early Universe observations and the cosmic distance ladder based late Universe measurement. This discord, termed as the "Hubble Tension", suggests that the Universe is expanding at a significantly faster rate than predicted by the cosmological model, a result that warrants exploring new physics in understanding the Universe.

The cosmic distance ladder based Hubble constant determinations are anchored with standard candles in astronomy, in particular, the classical Cepheids and type Ia supernovae. Cepheids are young stars that exhibit a strong correlation between their luminosity and pulsation period. This period-luminosity relation makes them excellent primary distance indicators. Type Ia supernovae are the result of the thermonuclear explosion of a carbon-oxygen white dwarf in a binary system. Cepheid based distances are used to calibrate peak luminosity of type Ia supernovae, which serve as secondary distance indicators leading to the determination of the expansion rate of the universe. The Cepheid-Supernovae distance ladder based Hubble constant values have approached percent-level precision increasing the tension with its value measured from the early universe probes. Cepheid-independent calibrations of the first rung of the distance ladder are now critical to explore possible systematic uncertainties in the distance ladder that may be contributing to the Hubble tension.

Mira variables are very cool asymptotic giant branch stars with typical temperatures around 3000K. These intermediate to old-age variable stars pulsate periodically and follow a period-luminosity relation similar to Cepheids. However, Mira pulsation periods are much longer ranging between 100 and 1000 days. Their identification and accurate luminosity determination from well-sampled light curves require long-term monitoring observations. Miras are typically M spectral-type stars, and are very bright at infrared wavelengths. Recently, a near-infrared time-domain observational program on star clusters provided a unique Mira sample that can be used for a Cepheid-independent calibration of the distance ladder. So far Mira variables in our Galaxy have not been used to anchor the distance ladder, which utilizes their luminosity calibrations in nearby galaxies like the Large Magellanic Cloud and NGC 4258.

The top panel of Figure 1 displays the absolute calibration of Mira period-luminosity relation in the Galactic globular clusters covering a wide range of metallicities. The Gaia space mission has provided accurate distances to these clusters which are used to obtain absolute luminosity of their Mira stars. The globular cluster Mira period-luminosity relation provides comparable precision to the Cepheids in open clusters, offering an independent calibration of the distance ladder. The bottom panel of Figure 1 shows the variation in the absolute luminosity of a Mira with a 200 days' period in different galaxies. The cluster Miras, together with the Large Magellanic Cloud and NGC 4258, provide a three-anchor baseline calibration for the first-time. This approach is similar to the one adopted for Cepheid variables and allows stringent constraint on metallicity effects on the absolute luminosity of stellar standard candles used in the distance ladder. The uncertainties on the Gaia distances to individual Mira stars in the Milky Way field are significantly larger than on the distances to globular clusters. Therefore, field variables are excluded from the absolute luminosity and metallicity calibrations. The metallicity dependence of Miras is three times smaller than those for Cepheids, thus making them a promising alternative for the Hubble constant determination.

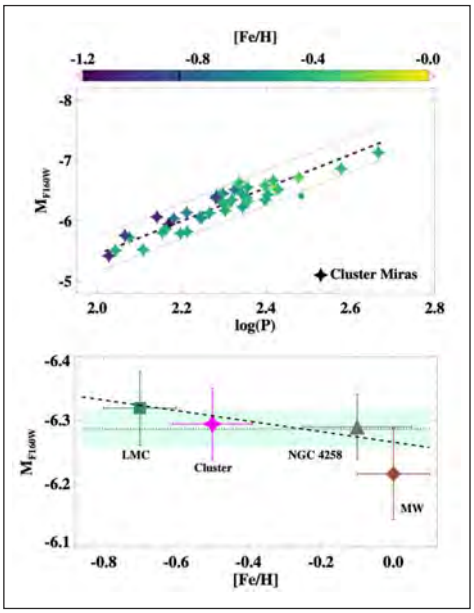


Fig. 1: The top panel shows the absolute calibration of the Period-Luminosity relation for Mira variables in the Hubble Space Telescope photometric system. The bottom panel displays the variation of the absolute zero-point in different anchor galaxies – Large Magellanic Cloud (LMC), Clusters, Milky Way (MW), and NGC 4258. The dotted and dashed lines represent weighted average and best-fit linear regression, respectively, to three anchor galaxies excluding the MW.

Mira variables in star clusters provided a new anchor for the Mira-Supernovae distance ladder. The three-anchor baseline solution leads to the most precise 3.7 percent value of the Hubble constant based on these cool stars. The absolute calibration of Miras at the first step of the distance ladder has reached a precision comparable to Cepheids. But the total error on the Mira based Hubble constant is currently three times larger than that of the Cepheid-Supernovae distance ladder. This

error budget is dominated by the availability of only two supernovae host galaxies with known Miras. Miras are expected to be discovered in supernovae host galaxies with Rubin observatory allowing their use for the precision cosmology. Nevertheless, the most accurate Mira-Supernovae distance ladder based Hubble constant to date is in excellent agreement with Cepheid based local determination, further supporting the ongoing Hubble tension.

Reference:

Absolute Calibration of Cluster Mira Variables to Provide a New Anchor for the Hubble Constant Determination; Bhardwaj, Matsunaga, Huang, Riess, Rejkuba (2025). Absolute Calibration of Cluster Mira Variables to Provide a New Anchor for the Hubble Constant Determination. The Astrophysical Journal, 990, 63. DOI: **https://doi.org/10.3847/1538-4357/adf20b**

High-resolution Spectroscopic Metallicities of Milky Way Cepheid Standards and Their Impact on the Leavitt Law and the Hubble Constant, Bhardwaj, Riess, Catanzaro, et al., 2023, The Astrophysical Journal Letters, 955, L13, DOI: **10.3847/2041-8213/acf710**

Dr. Anupam Bhardwaj has been an Assistant Professor at IUCAA since March 2024. He obtained his Ph.D. from the Department of Physics and Astrophysics, University of Delhi, India, in 2018, during which he also spent one year at the European Southern Observatory, Germany, for a Ph.D. studentship. Prior to joining IUCAA, he was a Marie Curie Fellow of the European Commission at the INAF–Capodimonte Observatory in Naples, Italy. Dr. Bhardwaj was awarded the Gruber Foundation Fellowship by the International Astronomical Union in 2020, and he recently received the Prof. M. K. Vainu Bappu Gold Medal 2024 from the Astronomical Society of India. His research expertise includes precision cosmology through time-domain astronomy, stellar astrophysics and pulsations, and Galactic archaeology using multi-wavelength observational datasets and theoretical models.

My Journey into Astronomy and Astrophysics

My journey into the world of astronomy and astrophysics began with a sense of wonder during my high school days. I remember being taught by my teachers that we live on a planet called Earth, constantly receiving solar radiation from the Sun. Though it was just a small piece of information, it left me deeply curious. I would often look up at the sky and wonder, what lies beyond, what are stars, how do they twinkle, and what secrets does the vast expanse hold?

As I moved on to senior secondary school and later college, I found it disappointing that none of the physics curricula included discussions on these cosmic questions. My curiosity persisted, but I lacked the academic environment to nurture it. During my M.Sc. in Physics, I opted for Astrophysics as an optional subject. I still recall the first day of class with Prof. Farooq Ahmad. Despite my interest, I couldn't immediately focus on the subject, there was pressure from many other demanding papers like Quantum Physics, Statistical Physics, Classical Mechanics, Solid State Physics, and more. Like most M.Sc. students, I was chasing good grades and thinking ahead to further studies. After completing my master's, I spent a few years teaching before enrolling in the M.Phil./Ph.D. program. Drafting a Ph.D. proposal seemed overwhelming at first, but I'm grateful to my supervisor who helped me prepare my research synopsis. I also had a strong desire to go beyond the geographical boundaries of Kashmir and visit reputed institutions like Delhi University, AMU, and JMI in New Delhi. My parents were understandably hesitant, as I had never travelled outside the valley before, but I was determined. Visiting those universities, exploring their physics departments and libraries, and speaking with faculty and students was an eye-opening experience.

Upon returning, I expressed to my supervisor a desire to gain research exposure at other institutions. Though there was no immediate response, a few months later, he encouraged me to visit IUCAA (Inter-University Centre for Astronomy and Astrophysics) in Pune, where he himself was an Associate. I had never heard of IUCAA before, nor did I know how I would be received there. But with encouragement, I prepared for the journey, a long three-day trip from Srinagar to Pune. The moment I arrived at IUCAA, I felt I had entered a place unlike any other, a place where academic passion, humility, support, and kindness embraced me instantly. At check-in, I was given accommodation that felt luxurious to a student like me. The next morning, I visited the IUCAA Library and began interacting with people at the library and nearby computer center. These interactions, even in the first few days, brought new energy to my research. The collaborative atmosphere was electric.

During my stay, I was fortunate to attend a gathering hosted by the renowned astrophysicist Prof. J. V. Narlikar, where I met international guests like Prof. Geoffrey Burbidge from the UK. These personal interactions added immeasurable depth to my academic life. I also made lifelong friendships, including one with Prof. Ravi

Kumar of Calicut University. That first visit to IUCAA, which lasted over two months, transformed my perspective entirely. When I returned to Kashmir, I didn't share all the details of my experience, sensing that my supervisor might not appreciate the extent of my interactions and independent initiatives. Still, I quietly kept requesting permission to revisit IUCAA. With God's grace, I began actively attending national seminars and conferences at institutions like BARC, TIFR, IIA, and various universities across India. As my Ph.D. progressed, I requested permission to complete the writing portion at IUCAA to take advantage of their exceptional library and computing facilities. During February, March, and April 2001, I completed my thesis writing at IUCAA. In May 2002, the University of Kashmir awarded me my Ph.D.

Though I considered applying for postdoctoral positions, in June 2003 I was appointed as an Assistant Professor at the University of Kashmir. For a while, I couldn't return to IUCAA. But in May 2005, I applied to become an Associate, and was selected. That affiliation has continued to this day. As a Senior Associate, I've had the privilege to collaborate with eminent scientists like Prof. Ranjeev Misra and Prof. Kanak Saha of IUCAA Pune. We received research projects funded by ISRO, under which four to five students completed their Ph.D.'s. Our collaborations extended to scientists like Prof. M. N. Vahia of TIFR and Prof. Sunder Sahayanathan of BARC. From 2005 till now, over ten students have completed their Ph.D.'s under my guidance and in collaboration with these esteemed colleagues. With the support of IUCAA faculty we got several funded projects from ISRO, Government of India. These projects helped our students to work for their research projects and also for their Ph. D's. I mention here the title of these projects as:

1. Study of correlated Ultra-violet and X-ray emission from X-ray Binaries. Indian Space Research Organization (ISRO) funding agency, Government of India.

2. Effect of Very High Energy Emission (VHE) in Universe.
   Indian Space Research Organization (ISRO) funding agency Govt. of India

3. Multi-wavelength studies of Rich and Poor galaxy clusters.
   Indian Space Research Organization (ISRO) funding agency India.

4. Unveiling High Energy Emission Properties of Blazers using AstroSat observations.
   Indian Space Research Organization (ISRO) funding agency Government of India.

In addition to these projects as an Associate of IUCAA I extended collaborations with some other institutions like TIFR Mumbai and BARC Mumbai. With the support of some scientists like Dr. Sunder Sahayanathan of BARC Mumbai and Prof. M N Vahia of TIFR Mumbai we also worked on few other projects from other funding bodies. These projects were as:

1. Estimation of Diffuse Extra Galactic Background Light through VHE Gamma Ray Observation of Blazars. Board of Research in Nuclear Science (BRNS), Department of Atomic Energy, Government of India.

2. Archaeoastronomy in Indian context. Jamshetji Tata Trust Mumbai.

Many students of the University of Kashmir worked with me and with my colleagues from IUCAA Pune and BARC Mumbai on different research projects for their Ph. D's. I feel it privilege to mention the titles of these Ph. D programs:

1. A preface to the study of clustering of galaxies in an expanding universe (Tabasum Masood - M. Phil. awarded in 2007).

2. Probing of Large scale structure of universe on the basis of statistical mechanics (Fayaz Ahmad - M. Phil. awarded in 2007).

3. Astronomical significance of terrestrial impacts and their post effects (Ajaz Ahmad - M. Phil. awarded in December 2011).

4. Accretion Disk process in LM X-Ray binary stars (Bari Maqbool - M. Phil. awarded in December 2012).

5. Spectral properties of Accretion Disk X-ray irradiated Binaries (Mubashir Hamid - M. Phil. awarded in December 2012).

6. Correlation functions in clustering of galaxies (Naveel Ahmad - M. Phil. awarded in January 2013).

7. Gravitational waves and their recent status (Showkat Ahmad Moonga - M. Phil. awarded in December 2015).

8. The Role of peculiar velocity in Cosmological many body problems in an expanding universe (Tabasum Masood - Ph. D. awarded in November 2016).

9. Understanding High Energy Gamma rays from AGN's (Zahir Ahmad - M. Phil. awarded in November 2014. Ph. D. awarded on December 22, 2018).

10. Study of correlated X-Ray and UV Emission from X Ray Binaries (Bari Maqbool - Ph. D. awarded in April 2017).

11. Geometry of Accretion flow around compact object systems (Naveel Ahmad - Ph. D. awarded in July 2018).

12. Spectral time evolution and disk variability of Black Hole X Ray Binaries (Mubashir Hamid - Ph. D. awarded in October 2017).

13. Study on Extragalactic background light using Multiwavelength observations of Blazars (Zahoor Ahmad Malik - Ph. D. awarded in July 2023).

14. Properties of Rich and Poor Galaxy Clusters in an Expanding Universe (Sheeraz Ahmad Khanday - Ph. D. awarded in November 2024).

15. Understanding on Blazar energetics through Multiwavelength studies (Aqib Manzoor - Ph. D. awarded in December 2024).

16. Broadband spectral study of very high energy Blazars (Athar Ahmad Dar - Ph. D. thesis submitted).

17. Multiwavelength study of Jet dominated Active Galactic Nuclei AGN (Sikandar Akbar - Ph. D. thesis submitted).

18. Spectral and temporal studies of Black Hole X ray binaries (Sajad Ah Boked - Ph. D. thesis under submission).

19. To study the high energy emission properties of Blazars (Javid Ahmad Tantray - Ph. D. thesis under submission).

With the support of IUCAA, I also organised several conferences and seminars at the University of Kashmir. One of the most memorable event was the ASI (Astronomical Society of India) meeting in 2016, which brought together a record 375 participants, including students, postdoctoral researchers, and faculty. Every two years, we host IUCAA-sponsored events in Srinagar, further enriching the scientific environment here. Many of my students have now become faculty members in different institutions across Kashmir.

I speak at length about IUCAA because it has been central to the fulfilment of my childhood dream—to understand the sky, the stars, and the universe beyond. That innocent curiosity about the twinkling stars eventually led me into the realm of extragalactic space, where I now work on blazars, galaxy cluster dynamics, and archaeoastronomy fields that connect modern data with ancient human wonder. Each project, each lecture, and every collaboration brings me back full circle to those childhood questions. The unwavering support from IUCAA has been instrumental in my journey. In 2021, with the recommendation of IUCAA's Director, I was honoured with the INSA Teacher Award, a deeply meaningful recognition of my contribution to teaching and mentoring. Recently, I was nominated as a member of IUCAA's Users Committee. IUCAA has become my second home, truly a place of intellectual freedom, warmth, humility, and vision. It is a place where every interaction leads to growth, where science flourishes in an ecosystem of trust and openness.

To me, IUCAA is not just an institution, it is a sanctuary of scientific worship. Those who have the privilege to visit and work here are truly fortunate. Its faculty and environment are a rare treasure in our scientific world. IUCAA Pune remains the axis of my academic orbit. My journey continues to evolve, but at its core, it is still powered by the same awe and love for the cosmos that began under the starlit sky of my childhood. With all my heart, I say, my deepest love and gratitude for IUCAA, always.

Professor Naseer Iqbal is a physicist and academic administrator at the University of Kashmir, where he has been a faculty member for over two decades and has served as Professor of Physics since 2016. His research interests include cosmology, the large-scale structure of the universe, archaeoastronomy, X-ray and high-energy astrophysics, and physics education. He has published more than 50 research papers, authored two books, and completed several national and international research projects funded by ISRO, DST, DAE, BRNS, and Kuwait University. He has supervised eight Ph.D. and eight M.Phil. scholars, guided numerous postgraduate projects, and mentored hundreds of students in pursuing careers in science. For his contributions to teaching and mentorship, he received the INSA Teacher Award (2021) and the Best Science Communicator Award (2022). Professor Iqbal has delivered over 50 invited lectures worldwide and represented India at scientific meetings in China, Egypt, UAE, Singapore, Europe, Iran, and Kuwait. He has also organized major academic events, including the 2016 Astronomical Society of India conference that brought together 375 astrophysicists. He is a Visiting Associate at IUCAA Pune, President of the Indian Physics Association (Jammu–Kashmir–Ladakh Chapter), and serves on academic and governing bodies of several institutions including NIT Srinagar, SKUAST Kashmir, and IUCAA Pune. Through his research, teaching, and leadership, Professor Iqbal has established himself as a leading figure in astrophysics and higher education in India.

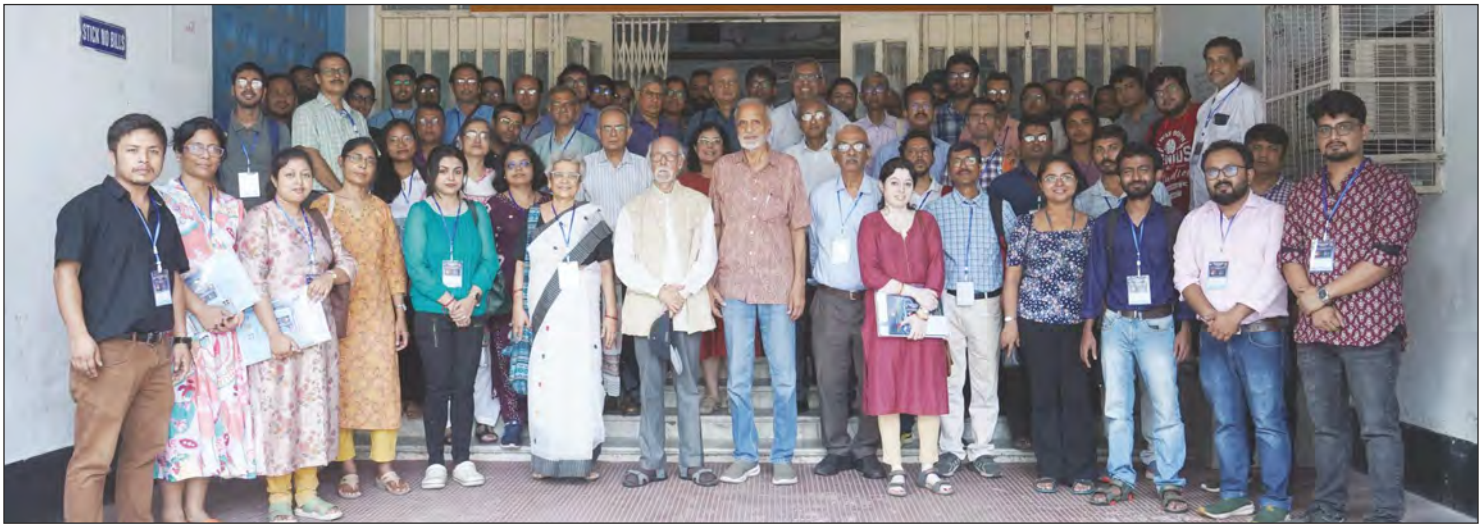
Events at IUCAA

Annual GW Open Data Workshop (ODW) by the LIGO-Virgo-KAGRA Collaboration

The IUCAA study-hub of the '*GW Open Data Workshop 2025*' was held during *May 13-15, 2025* at the TLC building. The initiative was part of an ongoing effort by members of IUCAA's gravitational-wave (GW) group to provide hands-on training in GW data analysis techniques to students from local colleges and universities. The event marked the fourth consecutive year that IUCAA hosted such a workshop in coordination with the main Gravitational-Wave Open Data Workshop conducted by the LIGO-Virgo-KAGRA collaboration. The participants attended online lectures covering a broad range of topics in gravitational-wave science and received guided assistance in completing data analysis tutorials. The workshop attracted around 25 undergraduate and postgraduate students from both physics and engineering backgrounds. Over the course of three days, the participants engaged in intensive, hands-on sessions led by research scholar, Anirban Kopty and Apratim Ganguly. These sessions equipped them with practical skills to access publicly available GW data and perform real gravitational-wave signal searches and parameter estimation. Efforts such as these continue to build local capacity in GW science, and similar initiatives are anticipated in the future. The workshop was coordinated by *Apratim Ganguly*.

Events outside IUCAA

International Meeting on Relativistic Astrophysics and Cosmology: Emerging Areas



The international meeting on *Relativistic Astrophysics and Cosmology: Emerging Areas* was organised by the *ICARD, North Bengal University (NBU)* from *June 09-11, 2025*. The conference was held jointly in collaboration with the three ICARD centers, namely, *Gauhati University, Cooch Behar Panchanan Barma University (CBPBU), and Malda College,* generously funded by IUCAA. The event was a significant milestone, being the first international meeting co-organized by four ICARDs from the North-Eastern region of India. Eighty-five participants attended the meeting, including delegates from South Africa, researchers from premier Indian institutions, faculty and research scholars from IISER Kolkata, IIT Guwahati, several universities and colleges across north-eastern India.

The conference featured thirteen invited talks by eminent scientists covering a broad range of topics in astrophysics and cosmology, including black holes, gravitational waves, dark energy, dark matter, and the evolution of the universe. Special emphasis was placed on emerging areas of research, particularly gravitational wave studies and the growing role of artificial intelligence in astronomy. Alongside the invited lectures, the event included thirty-nine contributory talks and seventeen flash presentations, all designed to engage young researchers and foster academic interest.

The conference began by observing a moment of silence in the honour of Professor Jayant Vishnu Narlikar, a legendary figure in astronomy and astrophysics, who passed away on May 20, 2025. The formal inauguration on June 09, 2025 was chaired by M. N. Roy, (Dean, Faculty of Science, North-Bengal University). The inaugural session commenced with a welcome address and the ceremonial lighting of the lamp. B. C. Paul, coordinator of the conference, welcomed the delegates and dedicated the first day of the event to the memory of Professor J. V. Narlikar.

The distinguished invited speakers included Sunil D. Maharaj (University of KwaZulu-Natal, South Africa), Suvodip Mukherjee (TIFR, Mumbai), Naresh Dadhich, Ajit Kembhavi, Sanjeev Dhurandhar, Kanak Saha, Shasvath Kapadia, Apratim Ganguly (all from IUCAA, Pune), Ashish Chattopadhyay (Kolkata University, Kolkata), Rajesh Nayak and Narayan Banerjee (IISER Kolkata), Manjari Bagchi (IMSc, Chennai), and Sumanta Chakraborty (IACS, Kolkata). Their presentations sparked rich discussions and stimulated collaboration among attendees throughout the three-day event. A special highlight was the felicitation of Sailojananda Mukherjee on the first day of the conference, in recognition of his lifelong contributions to teaching and research in North-Eastern India. The session, filled with warmth and appreciation, began with a welcome by his former Ph.D. students, followed by a brief biography presented by B. C. Paul, highlighting Professor Mukherjee's remarkable academic journey and his collaborations with IUCAA and other prestigious institutions.

Kanak Saha (IUCAA), S. Kalita (Gauhati University), Ranjan Sharma (CBPBU), and S. Das (Malda College), co-coordinators of the event, jointly expressed their satisfaction at the successful organisation of the conference. Members of the Scientific and Local Organizing Committees, including young scholars and faculty from the Departments of Physics and Mathematics, contributed enthusiastically and played a vital role in ensuring the smooth execution of the program.

The event concluded on *June 11, 2025* with an open feedback session, where participants shared their appreciation for the academic richness of the conference and its success in fostering scientific dialogue and potential future collaborations.

Invited Lectures and Seminar on General Relativity, Astrophysics, and Cosmology

A lecture series and seminar on *General Relativity, Astrophysics, and Cosmology* was held at the *ICARD, Department of Physics, Cooch Behar Panchanan Barma University (CBPBU),* during *June 03-04, 2025*.

Sunil D. Maharaj (University of KwaZulu-Natal, South Africa) and Kanak Saha (IUCAA, Pune) delivered a series of lectures during the programme. Sunil Maharaj spoke on various techniques used to model static and radiative stars, while Kanak Saha presented lectures on techniques for measuring the size of galaxies. In addition, Kanak Saha conducted classroom sessions on Cosmology. While most participants attended the lectures in person, an online link was also provided for those wishing to join remotely. The event saw the active participation of more than sixty attendees comprising undergraduate and postgraduate students, research scholars, faculty members from institutions in India and abroad both in-person and online. The lecture series offered participants valuable insights into

stellar modelling and cosmological probes from leading scientists, as well as opportunities for direct interaction. It also provided a platform for young researchers to present their recent work and refine it based on feedback from the invited speakers. The meeting was coordinated by *Ranjan Sharma (ICARD, CBPBU)*.

Multi-wavelength study of the AGN Central Engine and its Environment

A three-day focused national conference *Multi-Wavelength Study of the AGN Central Engine and its Environment*, was organised by *IUCAA, Pune* and the *ICARD Center of the Department of Physics & Astronomical Science (DPAS), Central University of Himachal Pradesh (CUHP)* from *June, 06-08 June, 2025* at the Seminar Hall, Dhauladhar Campus, CUHP, Dharamshala. The national-level event was designed to bring together experts, early-career researchers, and Ph.D. students working in the field of Active Galactic Nuclei (AGN) to explore their physical properties, observational characteristics, and their role in cosmic evolution. The conference aimed to facilitate discussions on recent advancements in AGN research through multi-wavelength observations, promote collaborations among researchers from diverse institutions across India, provide early-career scientists a platform to present their work and receive expert feedback, and align current research interests with upcoming space-based missions and large-scale survey projects.

The core of the meeting comprised thematic sessions, invited talks, contributed talks, and expert lectures. Discussions focused on AGN classification, accretion processes, jet physics, and time-domain variability. Particular emphasis was placed on the utilization of high-energy data from space missions such as AstroSat, XMM-Newton, Chandra, and Fermi-LAT, along with ground-based multi-band monitoring from facilities like the Zwicky Transient Facility (ZTF). These discussions highlighted the importance of integrated observational approaches in advancing AGN studies. The conference successfully provided a platform to advance the study of AGNs using multi-wavelength data and fostered several new collaborations among AGN researchers. The event concluded with strategic discussions on the future of AGN research, underscoring the significance of combining diverse observational facilities and expertise, particularly for timing and

broadband Spectral Energy Distribution (SED) modelling.

Thirty-eight participants attended the meeting, including twenty-eight outstation researchers, ten local student participants, and seven faculty members who delivered invited talks. The attendees included Ph.D. students, postdoctoral fellows, and early-career faculty from various research institutions across India. The conference was coordinated by *Hum Chand (CUHP)* and *Gulab C. Dewangan (IUCAA)*.

Following the workshop, CUHP Ph.D. students, along with several other participants, engaged in outreach activities in the region. Notably, Gulab C. Dewangan delivered a popular science lecture titled India's Multi-Colour Eye in

Space: Exploring Accreting Black Holes with the AstroSat Mission, at the Rainbow International School auditorium, Nagrota Dharamshala. The talk attracted an enthusiastic audience of approximately seven hundred students from schools across the Nagrota Bagwan area.

Workshop on Gravitational Waves and LIGO India

The Workshop on *Gravitational Waves and LIGO India* was organised by the *Department of Physics, HNB Garhwal University* from *April 28-May 02, 2025*. The workshop sponsored by IUCAA, aimed to enhance knowledge, engagement, and collaboration in the field of gravitational wave research. The workshop was inaugurated by the esteemed chief guest, Rajendra Dobhal, (Vice-Chancellor, Swami Rama Himalayan University). The event brought together a diverse group of forty participants, including thirty students and faculty members from the HNB Garhwal University and ten attendees from reputed institutions such as Lucknow University, Central University of Haryana, Sri Dev Suman University, GKV University, IIT Roorkee, and UPES Dehradun. Over the course of five days, participants were immersed in a series of lectures and interactive sessions covering foundational and advanced topics. These included general relativity, principles of interferometry, detection methods, and the astrophysical sources of gravitational waves. The workshop integrated theoretical instruction with practical training, featuring hands-on sessions focused on detector calibration, instrumentation, and feedback control systems. A highlight of the program was the public lecture Challenges and Opportunities in LIGO India, which offered attendees a forward-looking perspective on the national landscape of gravitational wave research.

The sessions were conducted by distinguished resource persons from IUCAA, Pune. Sanjit Mitra introduced the fundamentals of general relativity and the theoretical underpinnings of gravitational wave science. Apratim Ganguly discussed the astrophysical aspects of gravitational

waves and methods for parameter estimation. Shivaraj Kandhasamy and T. R. Saravanan led detailed sessions on interferometer simulations, vibration isolation techniques, and practical challenges in gravitational wave detection. A special hands-on module led by T. R. Saravanan provided participants with a unique opportunity to gain experience in working with interferometric setups. The workshop encouraged active participation, with dedicated opportunities for discussion, questions, and collaborative learning. It not only deepened the participants' understanding of gravitational wave astronomy but also fostered a strong spirit of academic exchange and community-building within this rapidly evolving research field.

At the conclusion of the event, local coordinators *Hemwati Nandan* and *Vivek Sharma* expressed their sincere gratitude to all volunteers, resource persons, and supporting institutions for their essential contributions to the success of the workshop. Overall, the workshop served as a valuable platform for students and early-career researchers to engage with leading experts from IUCAA and gain meaningful insights into the science and technology behind LIGO and gravitational wave detection, as well as explore future research opportunities in this exciting frontier of physics.

Workshop on Introduction to Astronomy and Astrophysics and the Applications of Quantum Mechanical Calculations in Observational Astronomy

A three-day workshop titled *Introduction to Astronomy and Astrophysics* was organised jointly by the *Bahona College* and the *Jagannath Barooah College* (recently upgraded to Jagannath Barooah University under Assam Act No. LXVI of 2023) in Jorhat, Assam, from *April 24-26, 2025*. The workshop witnessed enthusiastic participation from students, researchers, and faculty members across various institutions. It was organized as part of the activities of the ICARD, Tezpur University, Assam.

The first day of the event, titled *Workshop on Introductory Astronomy and Astrophysics* was hosted by the *Bahona College* and focused on introducing participants to the fundamental concepts of astronomy, key astrophysical phenomena, and basic observational techniques. The highlight of the day was the inaugural talk by Durgesh Tripathi (IUCAA) and the Principal Investigator of the Solar Ultraviolet Imaging Telescope (SUIT) on board India's Aditya-L1 mission. He delivered an insightful session on solar astrophysics, discussing sunspots, solar cycles, space weather, and observational methods, while also elaborating on the

mission objectives and instrumentation of Aditya-L1. He encouraged participants to explore the publicly available data from the mission for their academic and research pursuits.

The two-day workshop hosted by the *Jagannath Barooah University*, focused on Applications of Quantum Mechanical Calculations in Observational Astronomy. These sessions provided participants with an in-depth understanding of quantum mechanics, particularly the use of Density Functional Theory (DFT) in analysing astronomical data. The program included a rich blend of practical exercises, scientific lectures, and skills development modules aimed at empowering postgraduate students, research scholars, and early-career faculty members with modern tools used in molecular astronomy. Several distinguished experts served as resource persons, including Amit Pathak (Banaras Hindu University), Gazi A. Ahmed and Rupjyoti Gogoi (Tezpur University), Mridusmita Buragohain (University of Hyderabad), Nishant Shukla (The Assam Kaziranga University), Satyam Srivastav, Anshika Pandey and Shivani Mishra (Banaras Hindu University). The workshop was coordinated by Ranjeev Misra (IUCAA), Durgesh Tripathi (IUCAA) and Aishawnnya Sharma (Bahona College) and Ankur Gogoi (Jagannath Barooah University). More than forty-five participants attended the workshop, representing reputed institutions such as IISER Bhopal, Dibrugarh University, Tezpur University, Sibsagar University, DKD College, Bahona College, and Jagannath Barooah University.

As a concluding activity on *April 26, 2025*, a satellite programme titled "*Invitation to Astronomy*" was conducted for school and college-level students. The outreach event featured interactive sessions and motivational talks designed to ignite interest in astronomy and astrophysics among young minds and inspire future scientific exploration. The workshop concluded on a successful note, having made a significant academic impact on its participants and further strengthening collaborative networks and interest in astronomy-related research in the region.

Conference on Advances in Astrophysics and Cosmology

The two-day Conference on *Advances in Astrophysics and Cosmology* was organised by the *ICARD, Aliah University*, in collaboration with *Calcutta University* during *April 29-30, 2025*, at *Aliah University, Kolkata*. The conference was a dynamic and intellectually stimulating event that brought together over eighty participants, including Ph.D. research scholars, postdoctoral fellows, and faculty members from various colleges, universities, and research institutions across India. The central theme of the conference focused on recent advances in cosmology and astrophysics, particularly

in areas such as early universe physics, cosmic structure formation, dark matter and dark energy, gravitational waves, and alternative theories of gravity. The conference provided a vibrant forum for researchers to engage in meaningful academic dialogue, share their latest findings, and explore emerging ideas at the intersection of theory and observation. A series of plenary sessions featured distinguished speakers Kanak Saha (IUCAA, Pune), Anjan Ananda Sen (CTP, JMI, Delhi), Asis Chattopadhyay (Calcutta University, Kolkata), Parthasarathi Majumdar (IACS, Kolkata), Kanan Kumar Dutta (Jadavpur University, Kolkata), Banibrata Mukhopadhyay (IISc, Bangalore), Farook Rahaman (Jadavpur University, Kolkata), Sourav Sur (University of Delhi), B.C. Paul (North Bengal University, Siliguri), and Soumen Mondal (Jadavpur University, Kolkata). The sessions covered a wide spectrum of theoretical developments and observational techniques, encouraging collaborative inquiry and the exchange of ideas among participants.

In addition to the plenary talks, four parallel sessions were held two each day where thirty-two participants, primarily young faculty members and Ph.D. research scholars, presented their work. Two talks from the field of astrophysics and two from cosmology were selected by the distinguished speakers and awarded prizes for the best presentations. The conference left a lasting impact on the academic community by fostering an environment of active learning, rigorous scientific discussion, and interdisciplinary collaboration. The presence of early-career researchers alongside seasoned experts created a dynamic exchange of ideas, with young scholars benefiting from mentorship and critical feedback. The event not only highlighted the current frontiers of astrophysics and cosmology but also helped shape the discourse on future research directions in areas such as high-energy phenomena, cosmological observations, and quantum gravity. By bringing together theoretical insights and observational strategies, the conference bridged crucial gaps between conceptual frameworks and experimental validation. Several participants expressed that the experience deepened their understanding of ongoing challenges in the field and motivated them to pursue advanced research collaborations. Consequently, the conference played a pivotal role in building a stronger, more connected research community committed to pushing the boundaries of our understanding of the universe.

The conference was guided by a highly experienced Steering Committee, with Rafikul Islam, (Vice-Chancellor, Aliah University), serving as Chief Patron; Nurul Huda Gazi, Registrar, Aliah University, serving as Patron; and Sk. Faruque Ahmed, Head, Department of Physics, Aliah University, Chairman. The co-convenors included Debades Bandhopadhyay, Md. Abdul Khan (both, Aliah University) and Asis Kumar Chattopadhyay (ICARD, Calcutta University). The Scientific Organising Committee comprised Kanak Saha (IUCAA, Pune), Asis Chattopadhyay (Calcutta University, Kolkata), Banibrata Mukhopadhyay (IISc, Bengaluru), Farook Rahaman (Jadavpur University, Kolkata), and Mehedi Kalam (Aliah University, Kolkata).

The conference was coordinated by *Kanak Saha (IUCAA)* and *Mehedi Kalam (Aliah University)*.

Workshop on Cosmology and Astrophysics of Teleparallel and Symmetric Teleparallel Gravity

The workshop on *Cosmology and Astrophysics of Teleparallel and Symmetric Teleparallel Gravity* was organised by the *ICARD, Department of Physics, Indira Gandhi Institute of Technology, Sarang* during *April 21-22, 2025*. The workshop attracted sixty participants from various parts of the country who engaged in learning the fundamentals of teleparallel and symmetric teleparallel gravity theories. Lectures were delivered by B. Mishra (BITS Pilani, Hyderabad) and G. C. Samant (Fakir Mohan University, Balasore). These sessions were highly interactive and included practical exercises that helped reinforce the theoretical concepts.

In addition, A. Parhi and S. Pradhan conducted sessions on the basics of Python programming, equipping participants with essential computational skills relevant to the subject matter. The workshop was a significant success, both in terms of active participation and the valuable learning outcomes achieved by the attendees.

The workshop was coordinated by *S. K. Tripathy (IGIT, Sarang)*.

Exoplanet Detection and Characterization: From Observation to Understanding the Science of Exoplanets

A three-day introductory workshop on *Exoplanet Detection and Characterization: From Observation to Understanding the Science of Exoplanets* was organised by the *Department of Physics and SPASE (Space, Planetary & Astronomical Sciences & Engineering)* at the *Indian Institute of Technology Kanpur*, in collaboration with *IUCAA, Pune*, from *April 04-06, 2025*. The workshop aimed to introduce students and early-career researchers to the latest developments in the study of exoplanets, focusing on their detection, atmospheric properties, and implications for planetary science and habitability. This immersive event provided participants with a comprehensive introduction to various detection techniques, including transit, radial velocity, direct imaging, data analysis methods, and observational tools employed in exoplanet research. Participants engaged with real astronomical data to analyse transits, radial velocity signals, and direct imaging data, enabling them to characterize planetary atmospheres.

The workshop commenced with a foundational talk titled Overview of Exoplanets and their Atmospheres & Interiors: Current Frontiers and Future Prospects by Liton Majumdar (NISER), which laid the groundwork by highlighting key challenges and advancements in planetary detection, internal structure modeling, and atmospheric characterization. Detection methods were explored in detail through focused sessions such as Direct Imaging of Exoplanets by Prashant Pathak (IIT Kanpur), Detection of Exoplanets using Transit Method, and Detection of Exoplanets using Radial Velocity Method by Priyanka Chaturvedi (TIFR). Each method was discussed in terms of principles, instrumentation, current limitations, and the types of planetary systems best suited for each technique. To complement the theoretical components, hands-on sessions on transit, radial velocity (RV), and direct imaging data provided practical experience in applying detection algorithms and interpreting signals. On the second day, the session Exospheres of Exoplanets, and the Role of Ground-based Spectroscopy by Joe Ninan (TIFR) introduced participants to the outermost atmospheric layers of exoplanets and emphasized the importance of high-resolution ground-based observations for studying atmospheric escape and composition. A deeper exploration of atmospheric science was presented in Fundamental Physics and Chemistry of Exoplanetary Atmospheres and their Link to Planet Formation: From Building Forward Models to Applications by Liton Majumdar. This talk examined how atmospheric characteristics are shaped by formation history, chemical processes, and the host star environment, and how forward modeling aids the interpretation of observed spectra.

Further, the session Atmospheric Mass Loss and Habitability by Gopal Hazra (IIT Kanpur) addressed key questions regarding the evolution of planetary atmospheres under stellar radiation and their implications for long-term habitability, especially of terrestrial-type exoplanets. Emerging observational techniques were discussed in the talk Spectro-Polarimetric Signatures of Exoplanets by Bhavesh Jaiswal (ISRO), which showcased how polarization measurements can provide additional constraints on cloud properties, surface compositions, and atmospheric asymmetries. To aid the understanding and interpretation of observational data, the session Statistical and Retrieval Analysis of Exoplanet Atmospheres by Jayesh Goyal (NISER) highlighted the importance of statistical inference methods and retrieval frameworks for extracting physical parameters from spectroscopic observations.

The workshop concluded with a hands-on session on basic forward modeling and retrieval using POSEIDON, a state-of-the-art retrieval code widely used in the exoplanetary science community. This practical session allowed participants to engage with model construction, parameter estimation, and the challenges involved in interpreting noisy and incomplete observational data. In summary, the workshop successfully combined theoretical lectures with practical training, offering participants a comprehensive exposure to the dynamic field of exoplanetary science—from detection techniques to the complexities of planetary atmospheres and prospects for habitability.

The workshop was coordinated by *Prashant Pathak (IIT Kanpur), Gopal Hazra (IIT Kanpur)* and *Durgesh Tripathi (IUCAA)*.

Welcome to...

Harsh Mathur, who has joined IUCAA as a Post-Doctoral Fellow.

Farewell to...

Stanley Johnson, Post-Doctoral Fellow, who left IUCAA to take up a new assignment.
Suvas Chandra Choudhary, Senior Research Fellow, who resigned from the Doctoral Program.

Colloquium

07.04.2025	Prof. Vitor Cardoso on ***Testing GR with GWs***
15.04.2025	Prof. Piyali Chatterjee on ***A laboratory analogy for the solar spicule forest related to the nonlinear focusing of waves***
22.04.2025	Prof. Sanjit Mitra on ***Assessing and enhancing the science potential of Gravitational Wave detectors***
30.05.2025	Prof. Bharat Ratra on ***Dark Energy Dynamics, Spatial Curvature, Neither, or Both?***
12.06.2025	Prof. Jihad Touma on ***Debris Disks as Tracers of Exotic Planetary-System Architecture***

Seminars

17.04.2025	Dr. Deep Chatterjee on ***Online Analyses and Real-time Discovery Alerts from LIGO-Virgo-KAGRA in O4 and Beyond***
08.05.2025	Kabir Chakravarti on ***Investigating the connection between Dark Matter and GW merger events***
20.05.2025	Prof. Giles Hammond on ***Fused Silica Suspensions and Opportunities for LIGO India***
27.05.2025	Dr. Sourath Tarun Ghosh on ***Prospects of Enhancing LISA Instrumentation and Science Goals***
29.05.2025	Dr. Payaswini Saikia on ***Disc-Jet Coupling and Mass-Scaling of Black Holes***
03.06.2025	Dr. Navin Sridhar on ***New theoretical insights into black hole coronae***
05.06.2025	Dr. Dripta Bhattacharjee on ***Implementation of the global calibration scheme for the network of gravitational wave observatories***
17.06.2025	Prof. T. P. Singh on ***Flat galaxy rotation curves: dark matter or Modified Newtonian Dynamics (MOND)?***
19.06.2025	Dr. Siddharth Maharana on ***Advancing Astronomy with Innovative Instruments: From FiberPol and WALOP to ELT-PCS***
24.06.2025	Dr. Jyotirmay Paul on ***Pushing the Frontiers of High Angular Resolution Astronomy: Insights from iRobo-AO, SALTO, SCExAO VAMPIRE, and the BIFROST/Asgard Suite***

Public Outreach Activities

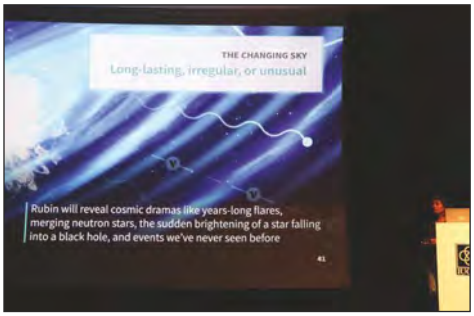
Public Lectures

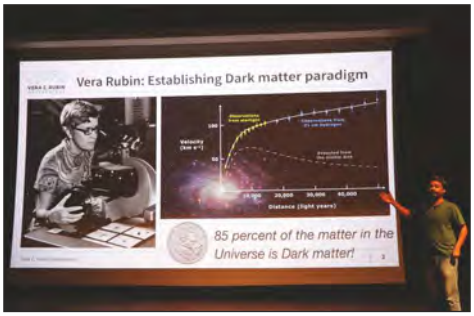
The ***Chandra Public Lectures* series**, along with other outreach collaborations, brought the following talks to the people of Pune and a wider online audience:

Dipankar Banerjee (Director, Indian Institute of Space Science and Technology) delivered a lecture titled '*Understanding the Sun with Aditya L-1*' on *April 01, 2025*.

Bharat Ratra (Kansas State University, USA) delivered a lecture titled '*The Accelerating Expanding Universe: Dark Matter, Dark Energy and Einstein's Cosmological Constant*' on *May 30, 2025*.

Nobel Laureate Brian Schmidt (Australian National University) delivered a lecture titled '*The Universe from Beginning to End*' on *June 04, 2025*.





Surhud More (IUCAA), Anupreeta More (IUCAA) and Yogesh Wadadekar (NCRA) delivered a lecture titled '*From Asteroids to Cosmos: Rubin Observatory gears up for the largest survey of Space & Time*' on *June 30, 2025*.

Regular Workshops, Visits, and Outreach Events

Various outreach activities were conducted during this quarter by members of the IUCAA SciPop team, either as organizers or resource persons.

Telescope Making Workshop

Rajiv Gandhi Academy of e-Learning School, Pune, *April 01, 2025*.
10 students and 02 teachers attended the workshop.

MIT, Loni Kalbhor, Pune, *April 24, 2025*.
100 students accompanied by teachers attended the workshop.

Training Session on Amateur Telescope Handling and Public Events

- Horizon, the Physics and Astronomy Society of IIT Madras, *April 04, 2025*.
  15 students participated in the session.

- Basic Astronomy & Moon Awareness Programme by the Institute of Mathematical Sciences, Chennai, hosted at the Anna Centenary Library Amphitheatre on *April 05, 2025*.
  350 students and members of the public attended the programme.

Science Toys Demonstration and Sun Observation Session

New English School, Ghodegaon, *April 08-09, 2025*.
150 students participated in the session.

Sky Observation Event

- Chendawan, Konkan on *April 26, 2025*.
  500 students accompanied by 30 teachers and 400 members of the public participated in the event.

- Muktangan Exploratory, Pune on *May 14, 2025*.
  70 students and 05 teachers participated in the event.

Hands-on Workshop on Astronomy and Science

Shiv Nadar School, New Delhi during *May 21-23, 2025*.
750 students and 90 teachers participated in the workshop.

Astronomy, Science Toys and Telescope Making Workshop

Ashoka University, Sonepat during *June 02-08, 2025*.
100 students participated in the workshop.

Astronomy Workshop

AFS Global STEM Innovators Programme on *June 19, 2025*.
40 teachers participated in the programme.

Science Toys Session

Vidnyan Bharati, Paschim Maharashtra on *June 25, 2025*.
13 students and 04 teachers participated in the session.

IUCAA Astronomy Summer Camp and School Students' Summer Programme

IUCAA conducted its annual summer programmes for school students over three weeks, aimed at encouraging both urban and rural participation. A total of 110 students attended across the following batches:

Batch I: *April 28 - May 02, 2025*

Batch II: *May 05 - May 09, 2025*

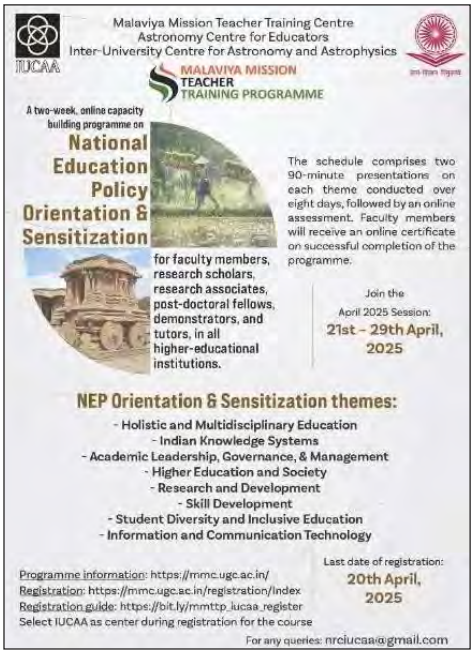
IUCAA Rural Astronomy Camp

Rural Astronomy Camp held during *May 13-16, 2025*.

Astronomy Centre for Educators

Malaviya Mission Teacher Training Centre

National Education Policy – 2020: Orientation and Sensitization



The Malaviya Mission Teacher Training Centre (MMTTC) of the Astronomy Centre for Educators (ACE) conducted a two-week online capacity-building programme titled "*National Education Policy – 2020: Orientation and Sensitization*", from *April 21-30, 2025*. The programme was open to faculty members, research scholars, research associates, postdoctoral fellows, demonstrators, and tutors from all higher education institutions across India.

To be eligible for a certificate, participants were required to submit two essays on topics covered during the programme. On average, 35–40 participants attended each day's sessions, and 33 participants successfully completed the course requirements and received certificates. The programme featured two sessions each on eight key themes of the NEP–2020, delivered by distinguished speakers with extensive experience in their respective domains.

The themes and speakers were as follows:

- **Academic Leadership, Governance, and Management**
  Ved Prakash (Former Chairman, UGC) and Dhruba Saikia (Former ACE Head, IUCAA)
- **Skill Development**
  Vineeta Sirohi (NIEPA) and Narayan Sharma (Cotton University)
- **Indian Knowledge Systems**
  Mayank Vahia (formerly TIFR) and Sushruti Santhanam (Musician and Music Historian)
- **Research and Development**
  Sourav Pal (Ashoka University, Sonepat) and Pramod Kale (Former Director, Vikram Sarabhai Space Centre)
- **Holistic and Multidisciplinary Education**
  G. Nagarjuna (IISER Pune) and Saikat Majumdar (Ashoka University)
- **Higher Education and Society**
  K. J. George (IIT Jodhpur) and Dhruba J. Saikia (Former ACE Head, IUCAA)
- **Student Diversity and Inclusive Education**
  Sumit Saurabh Srivastava (University of Allahabad) and Deepa Chari (HBCSE, TIFR Mumbai)

- **Information and Communication Technology**
  Sherin Sabu (IIT Jodhpur) and Pradeep Kumar Misra (NIEPA)

Teaching a First Course in Astronomy and Astrophysics

A short-term online programme titled "*Teaching a First Course in Astronomy and Astrophysics*" was conducted from *May 12-28, 2025,* by the Astronomy Centre for Educators (ACE). The course was designed for college and university instructors who are either currently teaching or planning to teach an introductory course in astronomy and astrophysics.

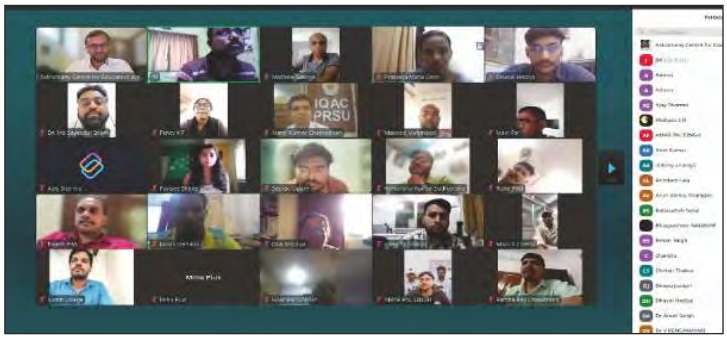
The programme featured expert instructors from institutions across the country who have been instrumental in inspiring students in the field.

It was structured into six modules, taught by seven instructors:

- **Module 1: Introduction and Tools of Astronomy**
  Suprit Singh (IIT Delhi) and Bharti Arora (JIIT Noida)
- **Module 2: Hands-on Activities**
  Arun Varma Thampan (St. Joseph's University, Bengaluru)
- **Module 3: Stars and Stellar Structure**
  Joydip Mitra (Scottish Church College, Kolkata)
- **Module 4: Stellar Evolution and End States of Stars**
  Rabbi Akkiba Angiras (St. Joseph's University, Bengaluru)
- **Module 5: Milky Way and Galaxies**
  K. Indulekha (formerly Mahatma Gandhi University, Kottayam)
- **Module 6: Cosmology**
  Geetanjali Sethi (St. Stephen's College, Delhi)

The programme consisted of approximately 40 hours of live lectures, and assignments were given for each module. IUCAA's new Moodle platform **(https://moodle.iucaa.in)** was used to manage course content and learner engagement. This platform served as a hub for announcements, lecture recordings, presentation slides, notes, assignment submissions, and discussion forums. Over the two-week period, daily attendance ranged between 80 and 100 participants. A total of 60 participants fulfilled the certificate criteria, which included regular attendance and timely submission of assignments.

Feedback from participants was overwhelmingly positive. They appreciated the engaging and high-quality presentations, the comprehensive and well-organized content, and the supportive learning resources. Some participants, however, reported scheduling conflicts and technical difficulties that affected their attendance. A few also found certain sections of the content challenging, particularly those with limited backgrounds in astronomy or related technical fields.



Caption: (Left) Mayank Vahia delivering a talk on the origin and growth of astronomy in India; (Right) Screenshot of the Zoom gallery view of participants.

LIGO-India Education & Public Outreach (LIEPO) Activities Report

1. Series of Virtual Tour Videos of LIGO Livingston in Marathi

Dates: *April 12 and May 31, 2025*

To address myths and misconceptions surrounding gravitational wave detectors in rural areas near the LIGO-India site (Hingoli), LIEPO released a series of virtual guided tour videos in Marathi. These videos were recorded by Indian students interning at the LIGO Livingston Observatory (LLO), USA.

The series was conceptualised by Dr. Debarati Chatterjee and features Dr. Shreejit Jadhav (postdoctoral researcher at Swinburne University of Technology, Australia) and Gaurav Waratkar (PhD student at IIT Bombay). The first video, released on 31 May 2025, presents a Marathi-language tour of the LLO Science Education Center. Gaurav explains the four-stage suspension system used in gravitational wave detection.

The series is hosted on LIGO-India EPO's YouTube channel, which currently has around 6,500 subscribers. Four additional videos are scheduled for future release. Video editing was handled by LIEPO intern Anurag Bhaisare, with facilitation support from Saurabh Salunkhe.

2. Participation in Pint of Science Festival

Dates: *May 09–11, 2025*

LIGO-India EPO took part in the *Pint of Science* festival, an annual international event that brings science into public spaces. For the first time, the 2025 edition was held in India, with events in Pune, Bengaluru, and New Delhi.

In Pune, at the Doolally Taproom (KOPA Mall), Prof. Giles Hammond (University of Glasgow) and IUCAA Ph.D. student, Swarnim Shirke gave engaging public talks. Prof. Hammond's talk on May 21, titled *"Can You Hear Black Holes Collide?"*, discussed techniques developed for Advanced LIGO and next-generation detectors such as LIGO-India.

On May 20, Swarnim Shirke presented *"Meet the Most Extreme Stars in Our Universe!"*, focusing on gravitational waves from compact stars.

Each session saw full attendance (40+ participants) and included interactive games and discussions. Senior IUCAA faculty members Varun Sahni and Sanjit Mitra were present and shared inspiring remarks.

The event was coordinated by Debarati Chatterjee (Director, Pint of Science India) and Saurabh Salunkhe (Pune Coordinator).

3. Cosmic Canvas Comic SciArt Contest – Social Media Showcase

Date: *March 24, 2025*

LIGO-India organised the *Cosmic Canvas* Comic SciArt contest on February 15, 2025, ahead of National Science Day celebrations. Entries were judged by Priya Gohad, curator of the Museum of Cartoon Art, Pune University.

Winning entries were displayed during IUCAA's National Science Day 2025 events. On March 25, selected artworks under the theme *"Newton vs Einstein"* were showcased on LIGO-India's social media platforms. These entries will also be featured in LIGO-India's upcoming virtual SciArt gallery.

The initiative was led by Debarati Chatterjee and Saurabh Salunkhe.

Outreach Programme at Gauhati University

Dates: *April 07–08, 2025*

An outreach programme on gravitational wave (GW) astronomy was conducted at the Department of Physics, Gauhati University, in collaboration with LIGO-India EPO. The event featured popular science talks by Saurabh Salunkhe, Shasvath Kapadia (IUCAA), and PhD student Nilaksha Barman (IUCAA), aimed at university and college students from diverse academic backgrounds.

Activities included:

- Talks on gravitation and GW detection
- Career discussions in GW science
- Live demonstrations
- An evening interaction session at the Gauhati University Observatory

The programme was coordinated by Sanjeev Kalita (Gauhati University) and Saurabh Salunkhe.

In addition, on *April 6, 2025*, Saurabh Salunkhe and Nilaksha Barman delivered public talks on gravitational waves, neutron stars, and LIGO-India at IIT Guwahati.

Visitors

[April - June 2025]

Deepali Agarwal, Amarkumar S. Agrawal, Shane Alam, Musavvir Ali, Rithesh Amalraj, G. Ambika, Kewal Anand, Anuraag Arya, Birger Felix Aufschlaeger, Arit Bala, Arunima Banerjee, Dipankar Banerjee, Devansh Bangar, Prasad Basu, Aru Beri, Manthan Bhagat, Rahul Bhagat, Rajeev Bhagwat, Sujoy Bhanja, Yash Bhargava, Dripta Bhattacharjee, Dipankar Bhattacharya, Mahasweta Bhattacharya, Soumya Bhattacharya, Sree Bhattacherjee, Soumadip Rabindranath Bhowmick, Arnab Biswas, Promila Biswas, Ritabrata Biswas, Sanchari Biswas, Sujay Kr. Biswas, Mary Bosco, Mridusmita Buragohain, Fairoos C., Vitor Manuel Dos Santos Cardoso, Madhukrishna Chakraborty, Kabir Chakravarti, Yugandhara Satish Chamare, Suresh Chandra, Laishram Tarubi Chanu, Salam Sada Chanu, Deep Chatterjee, Piyali Chatterjee, Sabyasachi Chattopadhyay Suchismito Chattopadhyay, Shivani Chaudhary, Navin Chaurasiya, Ahmed Rizwan Cl, Pravat Dangal, Ashmita Das, Patrick Dasgupta, P.K. Datta, Baiju Dayanandan, Ashwin Devaraj, Laishram Saroda Devi, Ningombam Chandrachani Devi, Yengkhom Kalpana Devi, Ruchika Dhaka, Harleen Dhingra, Payaswinee Dhoke, Aman Dubey, Kaustav Dutta, Sourav Dutta, Sukanya Dutta, Samridhi Dwivedi, Sreeraj E., Romanshu Garg, Gunjita Gaur, Sandip V. George, Prabir Gharami, Rohit Ghosh, Sourath Ghosh, Sushant G. Ghosh, Rupjyoti Gogoi, G.K. Goswami, Abhishek Guha, Sarbari Guha, Anshika Gupta, Vaibhav Gupta, Purbasha Haldar, Giles Hammond, K.P. Harikrishnan, Anisha Hazra, Kazi Rajibul Islam, Md Monirul Islam, Rinku Jacob, Shreejit Jadhav, Bhavya Jain, Deepak Jain, Dhruv Jain, Madhumita Jana, Arpan Aryam John, Raj Kishor Joshi, Akhila K., Malavika K., Sneha Kachhara, Sonali Kadam, Anil Kakodkar, Sammi Kamal, Reshma Maharudra Kapse, Debalina Kar, Shaili Kar, Rahul Kashyap, Meet Narayan Khatri, Harshit Krishna, Debasish Krishnatreya, Aaditya Himanshu Kshatriya, Dnyanada Nitin Kulkarni, Rajesh Kumar, Rajesh Kumar, Venkatesha M.R., Devabrat Mahanta, Ritanjali Maharana, Shikha Maharana, Siddharth Maharana, Sanidhya Srinivas Mallya, Ashish Mandal, Bhaswati Mandal, Priyanka Mandal, Soma Mandal, Poonam Mehta, Anuj Mishra, Bivudutta Mishra, Shivani Mishra, Debasmita Mohanty, Aditya Sow Mondal, Subhra Mondal, Tushar Mondal, Mithun N.P.S., Ganga R. Nair, Vishnu Namboothiri, Manasi Ravindra Nikate, Gayatri P., Prasia P., Sreebala P.S., Vishnu A Pai, Amlan J. Pal, Satyajit Pal, Rakesh Kumar Panda, Sanjay Pandey, Mahadev Pandge, Arvind Paranjpye, Mansi Parekh, Amit Pathak, B.C. Paul, Jyotirmay Paul, Devraj Pawar, Ninan Sajeeth Philip, Abhishek Sharad Potdar, Ananta Charan Pradhan, Anirudh Pradhan, Sasmita Kumari Pradhan, Kaustubh R.S. Priolkar, Aman Priyadarshi, Durakkshan Ashraf Qadri, Harikrishnan R., Kamal Raj, Gayathri Raman, A.R. Rao, Bharat Ratra, Somak Raychaudhury, Adhithya Rengamani, Ketan Rikame, Rupayan Roy, Aswathy S., Sruthi S.L., Sonali Sachdeva, Amrita Sadarangani, Aritra Saha, Tathagata Saha, Akarsh Sahay, Najah A Saleem, Saumyadip Samui, Subrata Sarangi, Divita Saraogi, Alphesunny Sarkar, Banibrata Sarkar, Chitrak Sarkar, Vasant Sathe, Aryansh Saxena, Manish Saxena, Brian Schmidt, Banashree Sen, Somasri Sen, Anand Sengupta, Kannabiran Seshasayanan, Vishant Shah, Mohd Shahalam, Mohammad Sohail Shaik, Md. Arif Shaikh, Dimpal Sharma, Shubham Sharma, Vaibhav Sharma, Parisee Sunil Shirke, Ashutosh Singh, Bhawani Singh, H.P. Singh, Manjeet Singh, Manpreet Singh, Ramanshu P. Singh, T.P. Singh, Umesh Reddy Sirigireddy, Tarun Souradeep, Navin Sridhar, S. Sridhar, Ganesh Subramanya, Pratik Takale, Moreshwar Tayde, Jihad Touma, S.K. Tripathy, Garima Tyagi, Akhil Uniyal, Rashmi Uniyal, Jithesh V., Vikas Raju Vishwakarma, Wajahat Yousuf Wani, J. S. Yadav, S.M. Yousuf.

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We welcome your feedback at the following address:

IUCAA, Post Bag 4, Ganeshkhind, Pune 411 007, India.
Phone : (020) 2569 1414; 2560 4100 Fax : (020) 2560 4699
email : publ@iucaa.in Web page : http://www.iucaa.in/