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TRIBUTES TO PROFESSOR T. PADMANABHAN

Life (1957-2021)

Padmanabhan was born to Thanu Iyer and Lakshmi on 10 March 1957 in Thiruvananthapuram. He did his schooling in Thiruvananthapuram and earned his B.Sc. [1977] and M.Sc. [1979] in Physics, from the University College Thiruvananthapuram under Kerala University.



Jayant Narlikar

THANU PADMANABHAN: An Ideal Student and Teacher

This is not a formal obituary but an appreciation of a scientist with many talents and achievements, with whom I had the privilege to interact. Like me, there will be many who will miss his wit and wisdom: indeed, his early demise has left a gap that will take a long time to bridge. For, Thanu Padmanabhan (commonly known as 'Paddy') was that academic rarity, a good student and a good teacher.

* * *

My interaction with Paddy started in 1979, at the Einstein Centenary Conference at the Physical Research Laboratory, Ahmedabad organized by Indian astronomers and relativists in 1979. The organizers had gone out of the way to attract postgraduate students to basic physics. Review talks were expected to make students aware of the current developments and challenges in physics in the hundred years since Einstein's birth.

I noticed that although different students would respond differently (if at all!), there was one who stood out distinctly 'ahead in the

pack'. Almost after each talk when the session chairman called for questions, this student had something to say. On my enquiry I was told that he was T. Padmanabhan from Kerala, an M.Sc. student in physics. That his intervention was nontrivial could be seen from the nature of reply by the speaker.

After the conference I returned to TIFR (Tata Institute of Fundamental Research) and in my daily routine lost touch with that student. Every year in July, TIFR Physics Faculty recruited students for the graduate school after a series of rigorous interviews. As a rule I took part in the deliberations of the Final Selection Committee which decided which students were good enough for the offer of TIFR studentship.

However, that year I was abroad in July and so missed the selection process. But the Director (Professor B.V. Sreekantan) informed me that one student was found to be exceptionally good and answered all questions correctly. The reason for informing me was that when the Final Committee made the offer of admission to this student, he had

his own condition! He would join only if he were permitted to work with me.

Normally, a graduate school student would work to clear all the required lectures and tests in the first year and the Faculty would then assign him/her to what it considered the most suitable guide. Thus a student asking for a specific guide right at the beginning was most unusual. But the Director felt that the student's performance at the interview was so good that he had agreed to it.

That was how Paddy came to be my student.

* * *

His interests were more in formal aspects of fundamental physics, than in astronomy although he was well read in both. I set him to work on quantum cosmology. I had been working on this since my visit to John Wheeler in 1977. As I discovered, Paddy was quick to pick up the basic idea. In fact his thesis was completed in less than four years.

Later in his post doctoral work he was never short of ideas and had a growing number of students of his own. In fact slowly but surely his reputation as an excellent teacher began to grow. Thus he was in great demand as a speaker both for technical and nontechnical meetings.

His books mainly from Cambridge University Press are excellent examples of pedagogical writings.

* * *

His major mission in research was to link gravity with thermodynamics. This may look like [but is much deeper than] Stephan Hawking's linkage between the laws of black hole physics and the laws of



thermodynamics. Paddy himself talked of gravity as an emergent phenomenon. This work was part of his presentation for the Infosys Award.

Paddy was honored on several occasions with awards like the S.S. Bhatnagar Award, Fellowships of academies, including the international Al-Khwarizmi award from Iran. His brief biodata gives a glimpse of these.

For me though, his joining IUCAA was a great help. As expected, he brought impeccable standards in teaching and research. An example of plain living and high thinking, he expected others to be equally disciplined. His 'hard judge' image sometimes made him unpopular! But this helped in maintaining good standards.

Paddy is survived by his wife Vasanti who had been his research colleague and a valuable assistant in his writings. Their daughter Hamsavahini [Hamsa] is herself an excellent research scientist.



Thanu Padmanabhan

Date of Birth: 10 March, 1957

- M.Sc. in University College, University of Kerala in 1979
- Ph.D. Mumbai University at Tata Institute of Fundamental Research, 1983
- Broad area of research: Fundamental physics – gravity, quantum theory
- Publications: Several advance level text books, review articles and popular science articles

Positions:

- Senior Faculty positions at TIFR and later at the Inter-University Centre for Astronomy and Astrophysics [IUCAA]
- 2006-2009 President of Cosmology Commission of the International Astronomical Union [IAU]
- Fellowship of Indian Academy of Sciences, Indian National Science Academy, Third World Academy of Sciences [TWAS]
- Member and sometime President of the Indian Association of General Relativity and Gravitation, Astronomical Society of India
- S.S. Bhatnagar Award in Physics, TWAS Award in Physics, INFOSYS Award, Khwarizmi International Award [KIA]
- Padmashri Award 2007

Paddy's biodata is very extensive... here I mention only a few highlights.

Somak Raychaudhury

A Great Teacher, Mentor and Friend

I have known Padmanabhan for over 35 years and he was my mentor and friend. I met him during my first year as a Ph.D. student in Cambridge, when he was spending a year there as a Visiting fellow. I was awestruck by his lightning-sharp mind. He had not changed a bit in any of these in all these years. He became a mentor and a friend and I would go to him, as would many others, to seek his opinion, both on the interpretation of scientific concepts, as well as dilemmas in administrative matters. His insights were always a deeply incisive, but down-to-earth.

Paddy was deeply engaged in all levels of academic progress. Not only did he carry out path-breaking research in many branches of science, but he also had a deep interest and understanding of the scientific thought process. He had uncompromising standards for all levels of scientific engagement and innovation.

Padmanabhan's textbooks are highly original, and among the most widely read and each of his popular books on science are unique in every way. His indomitable wit shines through all his books. He was also deeply interested in the long tradition of Indian science and wrote a book on the subject, co-authored with his wife Vasanthi.

He was very young in outlook and mind, and deeply committed to training young people. He had a long way to go. This is a loss beyond repair not just for his friends, students and associates, but for the Indian science community at large

Naresh Dadhich

Paddy: the incredible!

In the 1979 Einstein centenary conference in Ahmedabad, the organizers had also invited some talented undergrad students, Paddy was one of them. As was his wont, he couldn't help being noticed, in almost all lectures being given by the world leaders, Roger Penrose, Ted Newman and the like, he would ask meaningful and searching questions in clear confident voice. That is how like many others I first heard, not met, him. And this announced his arrival as one of the brilliant and sharpest young students.



I have known him since his graduate days in TIFR, and we have enjoyed mutual respect and admiration for each-other. He has worked through with his fellow students the fat black book, MTW -- Misner, Thorne, Wheeler from cover to cover, and so was also the case with Landau and Lifshitz volumes. Feynmann Lectures moved him from mathematics to physics. All this shows how serious and thorough student he was.

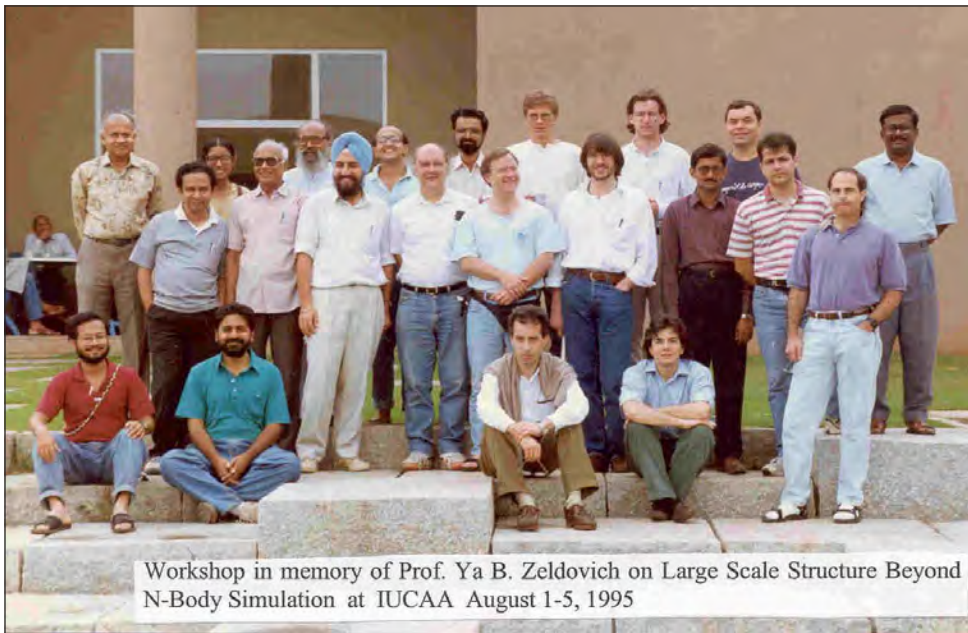
Feynmann had famously said that a good physicist should be able to derive any equation or formula at least in three different ways. He lived by this dictum and usually doing more than three. Similarly there was a seminal pronouncement by Donal Lynden-Bell, if one did not a few wrong papers, one had not fully stretched one's intellectual and creative prowess. Paddy adapted this dictum as well in right earnest and the result was astounding.

Where he had dared to go and explore new vistas, many others in his peer group hesitated and could not muster enough courage to break new path.

He had glorious legacy of Fred Hoyle and Jayant Narlikar to ride on and carry forward. Like his illustrious and iconic predecessors, he had done remarkably on this count, be it harbouring and raring new and bold ideas, or seminal and pathbreaking contributions to gravitational physics and cosmology, or writing research monographs and textbooks on the lines of classic Landau and Lifshitz series on one hand and Weinberg's authoritative text on the other, or science communication and popular comic books.

The question one has to ask, how did he fare on the critical measure, what he inherited and how enriched did he leave





Workshop in memory of Prof. Ya B. Zeldovich on Large Scale Structure Beyond N-Body Simulation at IUCAA August 1-5, 1995

behind? On this count, one would unhesitatingly say that he not only carried forward the formidable legacy but he had many fold enriched it. The true measure of one's contributions is what is left behind for people to draw upon and get inspired.

On all counts he was one of the most prolific and creative scientists of his time and had an intimidating aura around him. He was the sharpest mind which was at the same time deep and profound. It is to this memory I sign off.

A. Kembhavi

I first met Prof. T. Padmanabhan about 43 years ago, when he joined TIFR as a graduate student in 1979. I will address him as Paddy here, which of course was the name by which he was universally known, but I always addressed him by his full name, even while referring to him in conversation with others. He occasionally remarked on the fact, but that is where the matter remained. I left for a postdoc some months after he joined TIFR, and by the time I returned about three years later, he was doing very well, rising rapidly in his field and had a position in TIFR. We were both students of Jayant Narlikar, but we worked in rather different fields and had no common interests. But the many years of association, first in TIFR, occasionally in Cambridge and then in IUCAA brought us close.

A great deal has been spoken and written about Paddy, especially after his untimely

and tragic demise, and so I will not say much here except for a few personal reminiscences. I remember a paper that he and his wife Vasanthi coauthored in Nature in 1985, which on cosmological implications of unstable neutrinos. It was considered very interesting and there were comments about it in the research roundup of the same issue. That was a very impressive performance, especially given that his Ph.D. work was on formal aspects of gravitation theory and he was in the early stage of his work on the Universe. He quickly became an expert and leading worker in cosmology and in 1993 published his first book, Structure Formation in the Universe. He and I were in Cambridge when

the book was first published, and I remember Prof. Donald Lynden-Bell holding it up in the Institute of Astronomy library for all to see. Thereafter Paddy wrote many books, both highly technical and at the popular level. The books are all universally admired, read and used in teaching all over the world. His output was very prodigious and quite out of scale with his age. I remember introducing him to one of my foreign visitors in IUCAA, who was totally astonished to find a relatively young person in place of the senior citizen who he thought would be the author of so many papers and books. The books will remain the long-lasting legacy of Paddy. They are all on important and deep issues of physics, astrophysics and cosmology and will remain relevant for a long, long time.

Paddy was a fine and impressive speaker at all levels. But sometimes he was rather formidable in his approach, his argument being that the subject matter was so important that the listeners needed to invest time and effort in understanding what he was saying about it. There was no need for him to simplify the content, it was upto the audience to rise to the occasion. I remember a presentation he made many years ago in the badminton hall of IUCAA, which was specially set up for the meeting, to a fairly large number of people from the UGC and related organisations. I believe it was on how institutional frameworks could be managed. It began with a rather complex slide with many different



pathways for reaching goals. It was delivered very powerfully and there was a stunned silence at the end of the talk. I believe the audience was fully convinced of the intellectual power in IUCAA, even though they had not quite understood what had been said.

I did not see much of Paddy in later years, since he mostly worked from home and came to the office only for short periods and for the occasional seminar or colloquium. He of course remained extremely active, speaking, teaching and working mostly on emergent gravity. During the pandemic I did not get to see him at all, and he passed away so suddenly before that cloud had lifted, at least partially. I miss him very much. But much of his passion lives in his daughter Hamsa, I greatly enjoy talking to her whenever I am able to meet her.

Kandaswamy Subramanian

Paddy: My friend

It was a great shock when I heard that Paddy passed away. We had so much of shared history, in the early days, from the time we joined together for Phd at TIFR. Memories of time spent together in our youth, in movies, restaurants, discussing Physics and philosophy or being partners in a carrom tournament at TIFR. We went together to submit his PhD thesis to the Bombay University, simultaneously picking up my guitar at VT station and we joked that his thesis submission was being serenaded!

Paddy was not only smart but also extraordinarily hard working. The legend was that he had worked through and solved the whole book on Gravitation by "Misner, Thorne and Wheeler", a 1000 page mammoth of a book, in his undergraduate days! This made his knowledge of GR unparalleled and a preoccupation with Gravity in all aspects a lifelong activity. It was this ability to work very hard and with a great self-discipline which enabled such a high level of productivity throughout his life. His clarity of thinking right from student days was such that he could write a paper from scratch almost overnight!

He was to land in the UK one winter for his post doc and I was already there, and was



to get him a winter coat. My mother was having heart surgery in Bombay and I received a telegram from Paddy, "Operation successful, meet me at airport". It was fortunate that the telegram did not fall into wrong hands! When he was at Cambridge, we made a pact that almost every weekend we would meet. His original idea was that he will only eat salad during that year, which I quickly dissuaded him from doing and so we cooked our crude versions of everything and survived while working on our first paper together. We also started learning all about structure formation together which finally resulted in a joint 150 page review few years later, on galaxy formation published in the Bulletin of the Astronomical society of India.

We ended up writing several papers together on Structure formation. Author order was usually decided by tossing a coin. Then one of our papers submitted to Nature was rejected. We decided that we write a paper together only if it was of a quality deserving a Nobel prize, and of course, we never wrote another paper together!

When joining IUCAA it was Paddy who first explained to me that it is important to interact with the University sector unlike when working in other institutes. Little did I then realize that later I was to end up with this being one of my prime duties! The one joint activity we did was to establish IUCAA

academic link with the JNU for the benefit of our Ph.D. students; often our wavelength would match perfectly to sort out teething issues.

Paddy leaves behind a large legacy, of papers, books, reviews. My favorites are his masterful exposition on the vast range of Physics in Theoretical Astrophysics Volume I and his more recent book on Gravitation. He was excited in recent years about his work on emergent nature of gravity and it was clear, he was on the verge of a major breakthrough.

Our most recent long chat was on a problem he was sorting out to do with dealing with random trajectories and taking derivatives. After our chat I sent him some sections from a book with Anvar Shukurov, where I had reworked related maths in context of magnetic fields transport and some related old papers. His response was typical; he said "Thanks! Meanwhile I am trying to do it all from first principles, reinventing several wheels! But as we both know that is sometimes the best route.....". That was paddy.

Although in recent years, we did not interact much, nor agree on many issues, sometimes vehemently, I was looking forward to years after both our retirement, where we would be able to get together as before.

Farewell my friend.

R. Srianand

Paddy: The inspiration

When I first visited IUCAA and interacted with students it was clearly evident that most of them, interested in doing theory physics, were attracted to IUCAA because of Paddy. The reason behind this became clearly evident when I attended few of his lectures. Paddy's lectures were crisp and clear thanks to his deep understanding and clear mathematical presentations.

My personal level interactions with Paddy started after I joined IUCAA as a PDF mainly through his student Sriramkumar. Once in a while he used to put an astronomy paper published in Nature or PRL with a note [with his green ink pen] saying review this paper this Friday. Then my next few days were spent in learning that subject and preparing the review of the paper. On one occasion he came to my office and told me to prepare a review on "X-ray properties of AGNs" in a set of two lectures to be presented in a conference to be held in "Orange County, Coorg" in one week's time. This was because he was organising a meeting on high energy astrophysics and the person who was supposed give this talk withdrew from this meeting. Since it was told by Paddy to prepare this talk, no way

I could say NO even when I had no clue about the subject. I still remember working day and night to get this review talk done on time. The talk went well and based on subsequent discussions, I ended up writing some papers on this subject. I am narrating this story because Paddy made people do things that are well outside their comfort zone.

One of the things Paddy used to tell me in my earlier days is "You are writing papers but when are you going to do physics?". While I was always convinced about what I am doing, Paddy's words set a high benchmark on what one can do. He stopped saying this only after we wrote a couple of papers and had a very successful joint INDO-FRENCH project. My interaction with Paddy initiated me into the modelling of intergalactic medium.

At a personal level, he used to visit my flat to have coffee. In particular he used to catch hold of some of us and have a gossip session late in the night [after submitting his latest paper!]. Gossips from his TIFR days, his uncle's stories and Tamil cinema and story books. He also used to take us to restaurants very often. Two things I remember from these trips. (i) he was the first person to jump in to the auto when we

could find the first one and (ii) only person in the history who has eaten "vegetable au gratin" and "uttapam" together. He was trying to convince us that this combination is really good. To prove his point [being a good theoretical physicist] he insisted on ordering this combination every time we went to Pune coffee house in Camp!

Paddy's family used to visit abroad for a couple of months every year during summer. At that time some of us used to sleep in their house with his parents. They used to be very proud of Paddy. In particular, his mother was extremely sharp and to the point in any conversation. No guess for from where Paddy got his sharp brain and tongue. Those were very interesting days.

As time progressed our interactions were mainly on IUCAA issues [over long phone calls] and occasional gossip in any one of the corners of Akashganga housing colony. No one expected him to leave us so soon. I will definitely miss his provocations, Tamil banter and guidance. However, I have no doubts that he is [and will be] an inspiration for a lot of young people through his books, research papers and lectures.



TRIBUTES TO

Kameshwar Wali: Researcher, Teacher and Student



Jayant Narlikar

Kameshwar Wali passed away on January 14, 2022 at the age of 94, leaving behind a wealth of work ranging from high energy physics to the recent history of Indian science. As he believed in solid work rather than publicity, his name is not well known as it deserves to be. This article presents a partial view of this remarkable personality.

Kameshwar C. [Chanabasappa] Wali was born in Bijapur, Karnataka in 1927, one of seven children of a civil servant in the British Colonial system. Kameshwar did his undergraduate studies at the Raja Lakhamagouda Science Institute in Belgaum affiliated to Bombay University. After acquiring B.Sc. degree with distinction in 1948, he was appointed there as lecturer in physics. In 1950, Wali continued graduate studies at Banaras Hindu University [BHU]. He received his M.Sc. in physics in 1952 and was appointed lecturer in the Science College of the University. While teaching, he studied for M.A. [mathematics] and completed the course in 1954, winning the Chancellor Gold Medal, the highest honour of the University. To pursue his interest in theoretical physics, he proceeded to the USA in 1955, for his Ph.D. at the University of Wisconsin at Madison. By then he was married to Kashi Kulkarni, a fellow student at BHU and had three daughters, who joined him in the United States where he continued his long, distinguished career mainly at the Syracuse University [SU].

Not satisfied, however, with pursuing solely his own research, Wali became interested in the history of science and was invited to become a founding member of the Forum on the History of Physics within the APS. Fascinated by the history of the white dwarf and the Chandrasekhar limit, he interacted with Nobel Laureate Professor Chandrasekhar [known as Chandra by his scientist colleagues] to document details of the episode. This led to the publication of the seminal article [Chandrasekhar

vs. Eddington - an unanticipated confrontation], which he followed up by writing the book called Chandra which is a biography of S. Chandrasekhar, published in 1991 by the University of Chicago Press. It has been warmly received by international public and scientific readership, and has been translated into French, Chinese and Kannada and continues to be widely disseminated. Writings by Wali on Chandrasekhar provided great visibility for a highly private and modest man, who remains a giant in the world of science. Indeed, the Chandrasekhar story has inspired many Indian scientists to persevere in pursuit of a career in science no matter the obstacles. Even two decades after the publication of the biography, Wali kept receiving letters of admiration and appreciation for this literary work.

Continuing in this vein, Wali was involved in bringing to light the contributions of two other great men of science of India of the 20th century: Satyendra Nath Bose and Jagdish Chandra Bose. History tells us that in 1924, Satyendra Nath Bose [1894-1974], then a relatively unknown young man, wrote to Einstein forwarding his paper claiming that he had solved Planck law for blackbody radiation without recourse to classical electrodynamics. Bose requested that if Einstein thought the work important, could he arrange its publication in *Zeitschrift fur Physik*, as he, Bose, did not know German very well. Einstein did think it was important and he translated the paper himself and got it published. The interaction between Bose and Einstein, led to the birth of the new quantum statistics which became known as Bose-Einstein Statistics. In 2005, at the special session of APS meeting celebrating the centenary of Einstein's miracle year 1905, Wali was invited to present the history of the Bose-Einstein statistics. That resulted in his article for *Physics Today* in 2006, titled *The Man behind the Statistics* followed by an edited annotated

volume of the papers of Bose published by World Scientific Publishing Company in 2009. The book brings needed visibility to the full range of Bose's work, including his collaboration with Albert Einstein. Although the Bose-Einstein statistics is well known, the man himself was little known outside India. In India, he was often confused with the famous 19th century scientist, Jagdish Chandra Bose [1858-1937], whose legacy as the founder of experimental physics, poet and philosopher, and popularizer of science is perhaps unparalleled. Wali documented his incredible achievements in an invited talk on the occasion of the celebration of his 150th birth anniversary in Calcutta.

Wali made significant theoretical contributions to the field of high energy particle physics. He was a Member of the American Physical Society [APS], the recipient of the India Chapter award of the Society and the recipient of the Syracuse University Chancellor Citation for exceptional academic achievement.

In sum, Professor Wali has made invaluable contributions to Indian science, both through his own research and through his pioneering archival work on the history of towering figures of India. He has also mentored many young Indian physicists who have gone to the United States to study. Most importantly, his writings about Indian born scientists have made the early contributions of India to science internationally known. An indication of how highly he was regarded in his field, his University, the University of Syracuse has established an annual Kameshwar Wali Lecture in his honour. Distinguished academics have spoken in the Wali lecture series.

Wali has made threefold contributions: [i] Research in high energy particle physics [ii] Teaching and motivating many bright students to research in fundamental physics and [iii] Writing about the pioneering work of early Indian scientists.

Wali through his researches has made Indian academics [teachers and students] aware of the contributions of early Indian scientists, thereby improving their awareness of their heritage.

On a personal note, I had the pleasure and privilege of knowing Kamesh Wali from my

school days at the Banaras Hindu University. He usually visited India every year and had interaction with Indian scientists. He was ever interested in knowing, learning something new and as such he was a student at heart. I had attended some of his general talks which were entertaining and informative.

Back home, both Kashi and Kamesh were a hospitable couple especially for visiting scientists. My wife and I enjoyed the warm hospitality at Chez Wali when we discussed Chandra, Bose, our BHU days and of course Indian cricket.

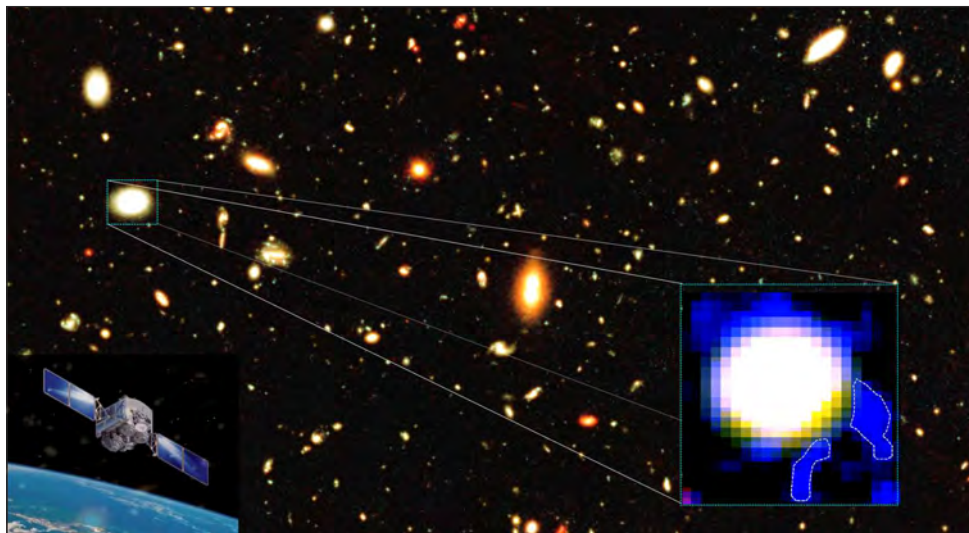
Research Highlights at IUCAA

Astrosat - opening new avenues for young researchers - Kanak Saha

Galaxies are the basic building blocks of the Universe- they come in all sizes. Our galaxy, the Milky Way, is one of the giant galaxies- with billions of stars, but little current star formation. Giant galaxies such as ours are surrounded by tens of dwarf galaxies- irregular in shape, often forming stars. As we look backwards in time we see that galaxies were smaller and more irregular [since light takes time to travel, a galaxy seen 3 billion light-years away from a Universe that is 3 billion years younger]. How these dwarf and giant galaxies assemble their stars and evolve into modern-day galaxies, like our own Galaxy, the Milky way is still one of the major puzzles.

A recent study by a team of scientists using AstroSat [India's first dedicated multi-wavelength space observatory] shows how the star-forming complexes in the outskirts of a dwarf galaxy migrate towards the central region and contribute to its growth in mass and luminosity. This process that is now witnessed in several dwarf galaxies is a very important link in understanding the bigger picture of galaxy growth and evolution.

Anshuman Borgohan, a young research scholar at Tezpur University, Assam working under the guidance of Prof. Rupjyoti Gogoi [Supervisor], Tezpur University, Assam and Prof. Kanak Saha [Co-Supervisor], Professor of Astronomy, at the Inter-University Centre for Astronomy and Astrophysics [IUCAA], Pune, along with an international team of astronomers from India, the USA and France, led by Prof. Saha, contributed significantly to the field of low mass galaxies also known as Blue Compact Dwarf Galaxies [BCDs]. These BCDs consist of huge clusters of young stars. His



findings, which are a part of his PhD thesis, show how the star-forming complexes in the outskirts of a dwarf galaxy migrate towards the central region and contribute to its growth in mass and luminosity. This process, which the researchers have witnessed in several dwarf galaxies, is a very important link in understanding the bigger picture of galaxy growth and evolution.

The article has been published on 20th July 2022 by the Nature journal, which is the world's leading multidisciplinary science journal. "It is quite overwhelming actually" expressed the young astronomer whose efforts have been recognized by the scientific community. He also added that "Capturing the assembly process in dwarf galaxies is believed to be one of the important links to complete the picture of galaxy growth and evolution. AstroSat/UVIT has been a remarkable addition to the list of UV observatories to date and has opened up promising windows to probe the understanding of the galaxy assembly process".

Prof. Kanak Saha, who conceptualised the research has his primary research focused on how galaxies form in the early universe and how they evolve into present-day ones. He has made a breakthrough discovery of a faint galaxy at high redshift, detected by deep observations using India's first space observatory, AstroSat, for which he was awarded the Shanti Swarup Bhatnagar Prize for Science and Technology in the physical sciences category. His recent works throw light on the formation of long-standing spiral structures and dynamics of galaxies.

Prof. Rupjyoti Gogoi from Tezpur University, Assam, who is an associate under the IUCAA associateship Programme, studies interstellar dust in Milky Way and nearby galaxies from observational data. She also works on Extragalactic astronomy, where she studies the structure and evolution of other galaxies. She is a part of the associateship programme at IUCAA working in collaboration with researchers in IUCAA on the study of the variability of Blazars, the

study of interstellar dust, the study of interstellar dust extinction, and the study of AGN and X-ray sources.

A programme wherein researchers from all over the country can avail the infrastructure facilities available at IUCAA to pursue their research while they continue to remain affiliated with their parent institution. The associate who is either a faculty member of an Indian university or a post-graduate department in a college carries out the research in their institution with scheduled short and long-duration visits to IUCAA and collaborates with scientists from the institution. It aids research scholars from remote areas of the country to contribute toward cutting-edge research and work with the best in the field.

Prof. Gogoi expressed her thoughts by saying that “the current work is an inspiration to young researchers of the country as this utilises data from India's indigenous satellite, AstroSat and also showcases the glorious association of IUCAA and a university, which surely will motivate the researchers working in Indian Universities. We look forward to enhancing this type of collaborative endeavour between IUCAA and Tezpur University”

The young stars, beyond the boundary of these dwarfs, are found in the form of star-forming complexes or clumps indicating unusually high condensation of cold gas. It has been a mystery how some small galaxies like these can have such active

star formation. These observations suggest that accreting gas in the far outer parts can be forced to move towards the centre because of the inward torques exerted by giant gas and stellar complexes. This migration builds up the central density over the lifetime of the galaxy.

The Ultraviolet (UV) Imaging Telescope on AstroSat was used to detect extended UV emission from the outskirts of 12 BCDs that are 1.5 - 3.9 billion light-years away. Such extended far-ultraviolet emission implies young stars that are forming now on the periphery of these galaxies where no stars older than 150 million years were spotted before.

UVIT's resolving power and deep field imaging techniques have been the key to spotting these very young, large star-forming clumps that move inside the optical boundary within a short timescale to grow these galaxies. We are witnessing the 'live' formation of these far-way dwarf galaxies. The key challenging task has been to establish the detection of these faint, extremely blue star-forming clumps with million solar masses. At slightly larger distances, the UVIT would not resolve the galaxies and we do not have an example of an extended UV disk in present-day dwarf galaxies. The redshift of these 12 dwarfs has been optimal to probe these blue clumpy structures in the outskirts.

The discovery teaches us how surprisingly the star formation can proceed in relatively pristine low-metallicity gas. These outer

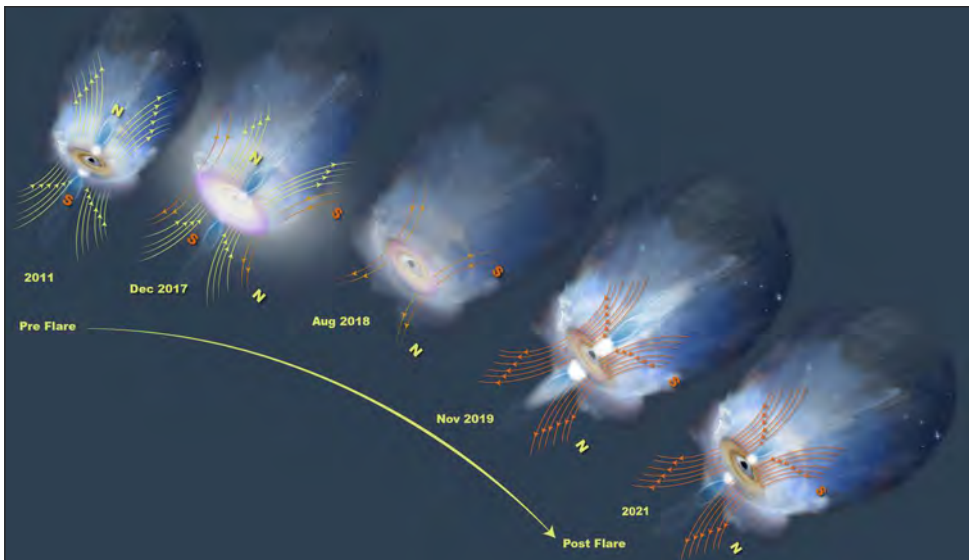
disks are unstable towards fragmentation, even though these dwarfs must be dominated by dark matter.

Prof. Somak Raychaudhury, Director of IUCAA Pune, points out how this is another major success story for the visiting Associateship programme of the UGC at IUCAA: “There are currently 200 such associates who visit IUCAA with their students from time to time and always interact online, and many collaborate among themselves on national and international projects, with or without IUCAA faculty. Major national facilities thus get connected to the educators and students who form the bulk of the researchers in India. At IUCAA, we train many of them on how to use facilities such as ISRO's AstroSat, and enable access to the resources that are necessary for world-class research”

The researchers feel privileged to have such a state-of-the-art observational facility from the Indian Space Research Organisation that led to this important discovery. Future endeavours to create such facilities would ensure scientific excellence and opportunities for young aspirants to nurture their curiosity as well as make a significant contribution to science and development.

Cutting-edge technology being accessible to young researchers has increased the involvement of the youth in the development of science to better understand the universe as a whole.

Changing-look AGNs - Dr. Ritesh Ghosh



Being a young inquisitive kid, his journey from reading a book about the moon landing to working in NASA has been quite exciting. With a formal education in physics, **Dr. Ritesh Ghosh**, intrigued by the enormity of the universe very religiously questions the behaviour of the most luminous and powerful objects in the universe known to us - SUPER MASSIVE BLACKHOLES (SMBH). As a post-doctoral fellow at the Inter-University Center for Astronomy and Astrophysics, Pune, India, Dr Ghosh has extensively worked on X-ray data analysis and the multi-wavelength study of the unresolved central region of the AGN to disentangle the disk-corona-jet emission in radio-loud AGNs, the origin of reflection features in the X-ray spectra of

type-1 AGNs, tracking the evolutionary scenario of quasars and hence the SMBH host galaxy interaction and the effect of the AGN on the kiloparsec-scale molecular outflows. He is currently a Postdoctoral Research Associate at NASA Goddard Space Flight Center

Research:

Astronomers have a growing consensus that each large galaxy harbours a supermassive black hole at its centre. Some of these galaxies are different as their central compact regions are much brighter compared to normal galaxies such as our Milky way galaxy. The compact region of these more luminous counterparts is called the active galactic nucleus (AGN), and the galaxy is called the active galaxy. AGNs have been traditionally classified into subclasses depending on different spectral properties to study them elaborately. The optical spectra of an AGN contain both narrow and broad emission lines. AGNs that are detected with broad emission lines in the optical spectra are classified as Type 1 and those with narrow emission lines as Type 2. According to the orientation-based unification scheme [Antonucci, 1993], Type-1 and Type-2 AGNs are the same objects, only viewed from a different angle. Recently discovered Changing-look AGNs challenge this idea as they tend to show change from a Type 1 to Type 2 state and vice versa.

A group of astronomers have been analysing 1ES 1927+654 which is an AGN situated 236 million light-years away and was previously classified as a Type II AGN

since there had been no detection of broad emission lines, nor was there any line-of-sight obscuration by the dust. At the end of 2017, this galaxy began a rare and dramatic transformation. The optical and UV luminosity or flux was found to increase by almost a factor of 100 within 150 days. As the visible and UV brightened, the X-ray luminosity or flux started to decrease and, in about approximately 200 days, reached a minimum of 1/100th time the initial value. The higher energy X-rays completely vanished. The X-ray flux soon recovered to a flux level of approximately 10 times that of the preflare flux in another 100 days, i.e., by April 2019.

Previously astronomers described it as a tidal disruption event which occurs when a star wanders extremely close to a supermassive black hole that it is torn apart. But the disappearance of the higher energy X-rays that originate from a cloud of super-hot particles near the black hole could not be explained. This is called the corona and is formed by a strong magnetic field.

With the new study of observations done by this international collaboration of astronomers spanning the entire event, a different cause has been suggested. The study argues that the event was triggered due to a flip in the magnetic field in the disk of material around the black hole. This

magnetic flip is not uncommon in astrophysical objects. The Sun's magnetic field reverses polarity (north pole becomes south and vice versa) about every eleven years. On the longer timescales, even the Earth's magnetic field flips. The following scenario is based on the observations from NASA's Swift, Europe's XMM satellite, and ground-based optical and radio telescopes. The visible and UV brightening happens when the flow of matter into the black hole increases. This may have started when the magnetic field in the outer parts of the disk began to flip. The accreted matter of reverse polarity reaches the corona and weakens it. The weakened magnetic field can no longer support the corona, which vanishes. When the flipped magnetic field gains strength, restoring the X-ray corona, but the inward flow of matter is still high, the X-ray emission is stronger than it was initially. Finally, the corona and the disk returned to their states before the flaring event, now with a flipped magnetic field.

So far, a few dozen Changing-look AGNs have been detected. They have shown rapid changes in UV and visible light like this one, but this is the first time X-rays have been seen to drop out as the other wavelength brightens. These surprising events offer a tantalizing glimpse at the extreme forces at work near an actively feeding supermassive black hole.

To know more!

Link to paper: <https://ui.adsabs.harvard.edu/abs/2022ApJ...931....5L/abstract>

Link to NASA video: <https://www.youtube.com/watch?v=cHmXuo39qz4>

Congratulations!

Sukanta Bose,

on being elected as Fellow,
Indian Academy of Sciences [2021]

Welcome...

Addition to IUCAA Core Faculty



Shasvath J. Kapadia joined IUCAA as an Assistant Professor in May 2022. He is a member of the LIGO-Virgo-Kagra collaboration that operates a network of ground-based gravitational-wave detectors and searches for gravitational-waves in detector data. His research interests include various aspects of gravitational-wave astronomy, astrophysics, cosmology and data analysis. Before joining IUCAA, he was a Simons prize postdoctoral fellow at ICTS-TIFR from 2019-2022. Prior to that, he was a postdoc at the University of Wisconsin, Milwaukee, USA, from 2016-2019. He pursued his PhD at the University of Arkansas, Fayetteville, USA, from 2010-2016. During his PhD, he interned at the Max Planck Institute for Gravitational Physics in Hannover, Germany. Outside of academia, his interests include reading, watching cinema and theatre, running, swimming and basketball.



Vaidehi S. Paliya completed his doctoral research on high-energy emissions from active galactic nuclei (AGN) at the Indian Institute of Astrophysics (IIA) under the joint supervision of Dr. C. S. Stalin (IIA) and Dr. C. D. Ravikumar (university of Calicut) in 2016. He then moved to Clemson University, USA for his first postdoctoral position (March 2016-November 2018) where he also worked with the Fermi-Large Area Telescope collaboration. In November 2018, he joined the multi-messenger astronomy group at Deutsches Elektronen Synchrotron, DESY, Germany as a postdoctoral fellow and worked on the AGN jet-neutrino connection. Before joining IUCAA in April 2022, he worked as scientist-C at Aryabhata Research Institute of Observational Sciences (ARIES), Nainital during December 2020-March 2022.

Paliya's main research work focuses on understanding the relativistic jet phenomenon (launching, propagation, and termination) associated with AGN following a multi-wavelength approach and using observations from both ground- and space-based telescopes

Visiting Associates selected with effect from 01 August 2022

- Susanta Kumar Bisoi,**
Department of Physics & Astronomy,
National Institute of Technology Rourkela, Odisha.
- Sumanta Chakraborty,**
Indian Association for The Cultivation of Science,
Jadavpur, Kolkata.
- Chandrachur Chakraborty,**
Manipal Centre For Natural Sciences,
Manipal Academy of Higher Education, Karnataka.
- Prasanta Kumar Das,**
BITS Pilani,
K K Birla Goa Campus, Goa.
- Archana Dixit,**
Department of Mathematics,
GLA University Mathura, Utter Pradesh.
- Mayukh Raj Gangopadhyay,**
Thanu Padmanabhan Center for Cosmology
& Science Popularization,
SGT University, Gurgaon, Haryana.
- Prabir Gharami,**
Department of Mathematics,
Belda College, Belda, West Bengal.
- Chetana Jain,**
Department of Physics,
Hansraj College, Delhi.
- Nagaraja Kamsali,**
Department of Physics,
Bangalore University, Karnataka.
- Arun Kenath,**
Department of Physics & Electronics,
Christ (Deemed to be University),
Bengaluru, Karnataka.
- Newton Singh Kshetrimayum,**
Department of Physics,
National Defence Academy, Khadakwasla, Pune.
- Bharat Kumar,**
Department of Physics & Astronomy,
National Institute of Technology, Rourkela Odisha.
- Tuhina Manna,**
St. Xaviers College (Autonomous),
Kolkata, West Bengal.
- Manesh Michael,**
Department of Physics,
Bharata Mata College, Kochi, Kerala.

15. **Mahadevappa Naganathappa,**
Gitam [Deemed to Be University]
Hyderabad Campus, Telanagana.
16. **Chandrachani Devi Ningombam,**
Physics Department,
Manipur University, West Manipur.
17. **Shibesh Kumar Jas Pacif,**
Center for Cosmology and Science Popularization,
SGT University, Gurgaon Haryana.
18. **Sreejith Padinhatteeri,**
Manipal Centre For Natural Sciences,
Manipal Academy of Higher Education, Karnataka.
19. **Rutu Mahendrabhai Parekh,**
Dhirubhai Ambani Institute of Information
& Communication Technology, Gandhinagar Gujarat.
20. **Pradyumn Kumar Sahoo,**
BITS-Pilani, Hyderabad Campus, Hyderabad, Telangana.
21. **Eeshankur Saikia,**
Department of Applied Sciences,
Gauhati University, Assam..
22. **Geetanjali Sethi,**
Department of Physics,
St. Stephens College, University of Delhi, Delhi.
23. **Suprit Singh,**
Department of Physics,
Indian Institute of Technology, New Delhi.
24. **Dharm Veer Singh,**
Department of Physics,
GLA University Mathura, Uttar Pradesh.
25. **Sourav Sur,**
Department of Physics & Astrophysics,
University of Delhi [North Campus], New Delhi.

Visiting Associates term Extended with Effect from 01 August 2022

1. **Sheelu Abraham,**
Department of Physics,
Marthoma College, Kerala.
2. **G. Ambika,**
IISER, Tirupati.
3. **Tanwi Bandyopadhyay,**
Adani University, Ahmedabad.
4. **Aru Beri,**
IISER Mohali, Chandigarh.
5. **Debbijoy Bhattacharya,**
Manipal Centre for Natural Sciences,
Manipal University, Manipal, Karnataka.
6. **Abhirup Datta,**
Centre of Astronomy,
Indian Institute of Technology, Indore.
7. **K.G Biju,**
Department of Physics,
WMO Arts & Science College, Kerala.
8. **Subenoy Chakraborty,**
Department of Mathematics,
Jadavpur University, Kolkata, West Bengal.
9. **Raghavendra Chaubey,**
DST Centre for Interdisciplinary Mathematical Sciences,
Institute of Science, Banaras Hindu University, Varanasi.
10. **Bhag Chand Chauhan,**
Department of Physics and Astronomical Sciences,
Central University of Himachal Pradesh,
Dharamshala, Himachal Pradesh.
11. **Kanan Kumar Datta,**
Jadavpur University, Kolkata.
12. **Sukanta Deb,**
Department of Physics,
Cotton College State University, Guwahati, Assam.
13. **Moon Moon Devi,**
Department of Physics,
Tezpur University, Assam.
14. **Himadri Sekhar Das,**
Department of Physics,
Assam University, Silchar, Assam.
15. **Umananda Dev Goswami,**
Department of Physics,
Dibrugarh University, Assam.
16. **Ankur Gogoi,**
Department of Physics,
Jagannath Barooah College [Autonomous],
Jorhat, Assam.
17. **Rupjyoti Gogoi,**
Department of Physics,
Tezpur University, Assam.
18. **Aruna Govada,**
Department of Computer Engineering,
Government Polytechnic Varkund, Daman & Diu.
19. **Mamta Gulati,**
School of Mathematics,
Thapar Institute of Engineering and Technology,
Patiala, Punjab.

20. **Gurudatt Gaur,**
St. Xavier's College (Autonomous)
Ahmedabad, Gujarat.
21. **Rinku Jacob,**
Department of Basic Sciences & Humanites,
Rajagiri School of Engineering & Technology (RSET),
Kochi, Kerala.
22. **Shivappa Bharamappa Gudennavar,**
Department of Physics,
Christ University, Bangalore.
23. **Sanjeev Kalita,**
Department of Physics,
Gauhati University, Guwahati, Assam.
24. **Md. Mehedi Kalam,**
Aliah University, Kolkata.
25. **Ram Kishor,**
Department of Mathematics,
Central University of Rajasthan, Ajmer, Rajasthan.
26. **Nagendra Kumar,**
Department of Mathematics,
M.M.H. College, Ghaziabad, Uttar Pradesh.
27. **Sushant Ghosh,**
Centre for Theoretical Physics,
Jamia Millia Islamia, New Delhi.
28. **Vinjanampaty Madhurima,**
Department of Physics,
Central University of Tamil Nadu, Tamil Nadu.
29. **Shiva Kumar Malapaka,**
International Institute of Information Technology,
Bangalore.
30. **Bivudutta Mishra,**
Department of Mathematics,
BITS-Pilani, Hyderabad.
31. **Mubashir Hamid Mir,**
Govt. Degree College Barmulla, Jammu & Kashmir.
32. **Aditya Sow Mondal,**
Department of Physics,
Siksha-Bhavana Visva-Bharati Santiniketan,
West-Bengal
33. **Barun Kumar Pal,**
Netaji Nagar College for Women, Kolkata.
34. **Devraj Damaji Pawar,**
R.J. College, Ghatkopar, Mumbai.
35. **M. K. Patil,**
School of Physical Sciences,
S.R.T.M. University, Nanded, Maharashtra.
36. **Anirudh Pradhan,**
Centre for Cosmology, Astrophysics and Space Science,
G.L.A. University, Mathura, Uttar Pradesh.
37. **Ramprasad Prajapati,**
School of Physical Sciences,
Jawaharlal Nehru University, Delhi.
38. **Prince P R,**
Department of Physics,
University College, Trivandrum, Kerala.
39. **Anisur Rahaman,**
Department of Physics,
Durgapur Government College, West Bengal.
40. **Biplab Raychaudhuri,**
Department of Physics,
Visva-Bharati, Santiniketan West Bengal.
41. **Harinder P. Singh,**
Department of Physics and Astrophysics,
University of Delhi, Delhi.
42. **Biplob Sarkar,**
Department of Applied Sciences,
Tezpur University, Assam.
43. **Tamal Sarkar,**
High Energy & Cosmic Ray Research Centre [HECRRC],
Siliguri, West Bengal.
44. **Anirban Saha,**
Department of Physics and Astrophysics,
West Bengal State University, Kolkata.
45. **Anjan Ananda Sen,**
Centre for Theoretical Physics,
Jamia Millia Islamia, New Delhi.
46. **Surendra Nadh Somala,**
Indian Institute of Technology,
Hyderabad.
47. **Anisul Ain Usmani,**
Department of Physics,
Aligarh Muslim University Aligarh, Uttar Pradesh.
48. **Nilkanth Dattatray Vagshette,**
Department of Physics & Electronics,
Maharashtra Udaygiri, Mahavidyalaya,
Udgir, Maharashtra.
49. **Murli Manohar Verma,**
Department of Physics,
University of Lucknow, Lucknow.
50. **Jaswant Kumar Yadav,**
Department of Physics and Astrophysics,
Central University of Haryana, Haryana.
51. **Lalthakimi Zadeng,**
Department of Physics,
Mizoram University, Aizawl, Mizoram
52. **Rajesh S.R.,**
Sanatana Dharma College,
Alappuzha, Kerala.

Colloquium

15.09.2022 Shaun Hotchkiss **on Experiments in sharing research**

Seminars

- 14.07.2022 Namrata Roy **on Star formation suppression and feedback in nearby passive galaxies.**
- 11.08.2022 Prashant Pathak **on Direct Imaging of exoplanets in the mid-infrared regime.**
- 23.08.2022 Chirag Falor **on Analytically solving Quadruple Image Configurations; starting from circles and going beyond.**
- 25.08.2022 Priyanka Singh **on Multi-wavelength analysis of Circum-Galactic Medium.**
- 08.09.2022 Abhishek Majhi **on Refinement of the first axiom of geometry and a non-singular theory of gravity.**
- 22.09.2022 Deovrat Prasad **on Cool Core Cycles - Cold-mode AGN feedback in Galaxies, Groups and Clusters.**

Astronomy Centre for Educators

Teaching Learning Centre and National Resource Centre

Fundamentals of Astronomy using Stellarium

A short course on teaching some fundamentals of astronomy using the interactive planetarium simulation software – Stellarium, for college and university faculty members, was organized by the Teaching Learning Center of IUCAA in August. The course was created in response to the favourable reception of Stellarium demonstrations which were part of earlier courses. For this 3-week



mini-course, Prakash Arumugasamy and Atharva Pathak expanded the original introductory demonstrations to include four simulated observations using Stellarium. The attending faculty members learned the basics of local sky observations using pre-recorded, interactive animation-based lectures and a detailed worksheet on sky phenomena simulated on Stellarium. Once familiar with Stellarium, they learned and performed the following four experiments: Mapping the Solar analemma; verifying Kepler's third law with observations of Venus and Mercury; determining the mass of Jupiter through

observations of Jupiter's moons; Roemer's experiment of measuring the speed of light.

The time-intensive nature of the experiments meant that about 70 participants completed at least one, whereas 9 participants submitted reports for all the experiments. The 40-odd participants who attended all the presentations and discussion sessions gave positive feedback and said that they have benefitted from this short course.

Seminars on Education

The Astronomy Centre for Educators started a new seminar series titled "Seminars on Education" to discuss a wide variety of topics related to education with some emphasis on science and astronomy education.

The third talk in this series was delivered by Professor N V Varghese, Professor and Vice-Chancellor, National Institute of Educational Planning and Administration, New Delhi, on "Higher education and equity". He discussed a wide range of themes during his presentation, including inequalities in higher education and how higher education contributes to inequalities, the importance of social trust as a necessary condition for success of any democracy and how more equal societies have higher social trust, and the close linkages between levels of education and wages. Equity, inclusion and embracing of diversity are ideas emboldened in all



democratic institutions. He outlined the demographic changes in the student population due to both affirmative action and massification of higher education, and



the challenges that students from disadvantaged groups face in many of our higher educational institutions. He stressed the importance of an institutional culture that needs to respect diversity and students from diverse backgrounds, and the importance of training and sensitizing teachers to embrace this diversity.

Outreach Activities



The Union Cabinet Minister of Education, Shri. Dharmendra Pradhan visited IUCAA on May 27, 2022.

Summer School Program 2022:

The 'Astronomy Summer School 2022' was held offline with the winners of the IUCAA National Science Day competitions as participants. All seven participants worked on their own projects in Astronomy with IUCAA researchers as their mentors. On the last day of the program, they presented their work in front of IUCAA academics and got encouraging feedback.



Rural Astronomy camp 2022:

A three-day astronomy camp was organized for the rural school students of 8th to 10th standard at Government polytechnic Awasari Khurd (Pune) by the IUCAA outreach team during 17-19 May. In this event, students learned about the basics of Astronomy including what can be done during the daytime and several hands-on activities and observations. A total of 30 students participated in this camp from rural areas of Junnar and Ambegaon taluka.



Yoga with Stars (International Yoga Day Celebration)



Yoga sessions consisting of demonstrations and practice of easy yoga poses along with different stories of constellations, were held for children of 3-10 years of age. The children learned about the constellation Ursa Major (Saptarshi) and the Pole Star through stories of 'Dhruva - the star' and 'the seven sages'. They also had fun learning and performing easy but helpful yoga asanas while the sky stories were narrated. Two such sessions were held on 6th June and 21st June 2022.

IUCAA also celebrated International Yoga Day on 21st June 2022, where all the staff and students of IUCAA participated in communal yoga practice. Some members also presented performances based on Yoga-aasanas.



LIGO Star Fest @Hingoli:

The IUCAA SciPOP Team along with LIGO [LIEPO] conducted Teachers' Training Workshops from the 3rd to the 6th of August at New Model Degree College, Hingoli, Maharashtra. 80 Teachers from five selected clusters in Hingoli district attended the event. The program started by the launching of a fun-interactive pop-up book in the regional language Marathi called ऐका ब्रम्हाण्ड काय म्हणते ? "[Aika Brahmanda Kay Mhanate], that introduces and explains the concept related to gravitational waves and LIGO India to young



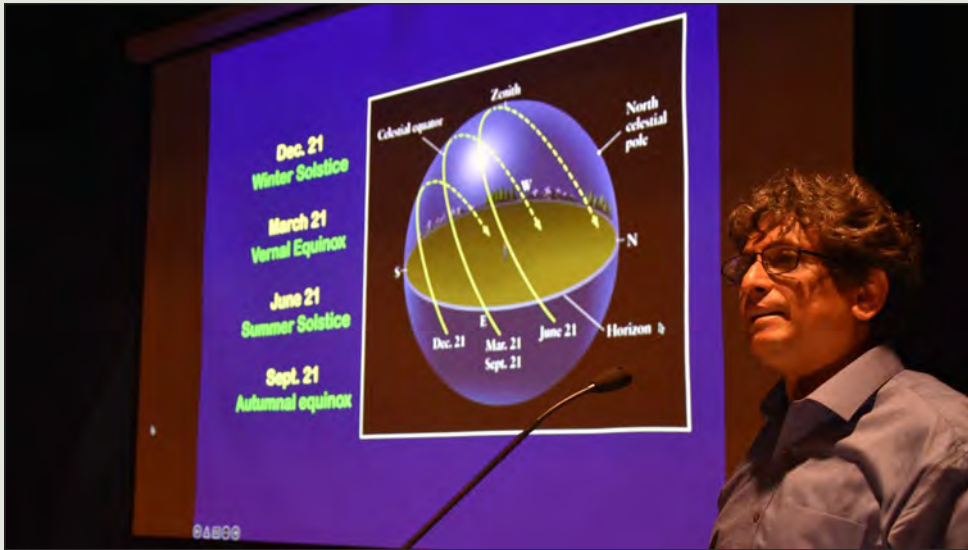
children. The book was distributed through the teachers attending the workshop to make sure the book reaches the maximum number of students. Following this, lectures on LIGO India, Basic astronomy, the formation and details of our Solar System, and an introduction and hands-on training on Telescopes were conducted. The teachers responded enthusiastically to all the talks, hands-on-session, as well as exhibits displayed making the event highly resourceful and interactive.

The Velo Gyaneshwari (Bicycle) launch event:

IUCAA Scipop launched a first-of-its-kind project called "The Velogyaneshwari, bicycle of science". The bicycle consists of 40 different science toys that include a rocket, a bottle telescope, and a few math activities that can be demonstrated with the help of simple installations on the bicycle itself. The launch event included a demonstration of the different features of the bicycle to students from two schools, Shrimati Gendibai Tarachand Chopda Highschool and Hindustan Antibiotic School of Pimpri Chinchwad region on the 23rd and 24th of June 2022 respectively. Initially, this project will run in different villages within the Pune district and later cover rural areas of Maharashtra as well. An innovative and fun way to transport, teach and learn science.



Ujjain Conference on the INDIAN calendar:



Vijnana Bharati, in association with the Ministry of Culture Government of India, organized a Two-Day National Conference and Exhibition on the 'National Calendar of India' as a part of the celebrations of Azadi Ka Amrit Mahotsav. The conference was

conducted at Vikram University Ujjain, Madhya Pradesh, on Vaisakha 02 and 03, 1944 saka [April 22nd and 23rd, 2022]. IUCAA was one of the organizing partners for the event. The first session was on 'Time & Its Measurement - An Indian



Perspective' by Prof. Somak Raychaudhuri. The program included a poster exhibition at the Vikram University and Varahamihira Observatory, Dongla. There were about 1000 registrations for the program. A night-sky observation was moderated by Tushar Purohit with support from Aryabhata Foundation Bhopal and organized at Dongla.

Science toys demonstration, Telescope Making, Astronomy, and Skywatch events:

1. Bharat Children's Academy and Shri Wardhaman Vidyalaya, Walchandnagar arranged a toy session followed by skywatch on 19-20 April. This session was conducted by Samir Dhurde, Atharva Pathak, Maharudra Mate, and Rupesh Labde.
2. A demonstration of science toys and a hands-on toy-making session was conducted at IISF 2022 Goa on the 26th and 27th of April. A total of 160 students

and 10 teachers from rural schools in and around Goa participated over two days. The session was coordinated and conducted by Shivani Pethe.

3. The school committee of Knowledge Public School, Timarni, Madhya Pradesh, organised two-day science toys and telescope-making workshop for which Rupesh Labade and Tushar Purohit were invited as resource persons. A total of 50 students and 20



teachers participated in this hands-on workshop.



4. The Goa Education Department and District Institute of Education & Training (DIET) Porvorim, Goa, invited the Scipop Team to conduct a 2-day workshop on toy-based pedagogy on the 15th and 16th of September, 2022. Six teachers and 80 final-year D.Ed Students [Primary school teacher-trainees] along with a few science and geography teachers from nearby Government Schools participated in the workshop. The event was coordinated and executed by Shivani Pethe, Atharva Pathak, Mayuri Patwardhan, and Swanand Athalye.

Teacher Training:

1. Two-day science toys and telescope-making workshop was organized by the District Education Department, Rajgarh, Madhya Pradesh, for the school teachers in the district, on the 27th and 28th of May. Rupesh Labade, Tushar Purohit, and Maharudra Mate were the resource persons. 62 teachers and 20 students participated in this hands-on workshop.
2. A Teachers' training workshop on Telescope handling, operating and science toys demonstration was organized by Discovery Science centre [Kerwadi] and Samaj Kalyan Ashram school, Maharashtra on the 8th of April 2022 for the teachers from Samaj Kalyan school, Jalna and Kerwadi and Zilha Parishad School, Sangli, Maharashtra on the 23rd and 24th Sep 2022. The workshop was conducted by Tushar Purohit and Rupesh Labde. 60 teachers from 10 schools attended this workshop.



3. A similar workshop was conducted on 9th April 2022 at Paratwada, Near Amrawati. The workshop was conducted by Maharudra Mate. 30 teachers participated and learned about operating a telescope in this workshop.
4. A week-long series of sessions in Schools in Lucknow city and suburbs was conducted by Shivani Pethe from 22nd June to 30th June for more than 130 students from Basic School, Sadrauna and Primary School, Dadupur. Two Science Toys Demonstrations for teachers were also organized at the Awadh Public school for 80 teachers from across Lucknow and for 15 teachers from Pancha Sankul yojana in which representative



teachers from different government schools assembled to also have discussions about policies and curriculum in Uttar Pradesh.

Science Toys Demonstrations and Talks



1st April: Kisan Veer Mahavidyalaya, Wai conducted by Rupesh Labde.

3rd April: Scifun Vipnet Science Club Goa conducted by Shivani Pethe

8th April: P K Technical campus, Chakan conducted by Rupesh Labde.

13th April: Rancho Gurukul English Medium School, Kedgaon conducted by Rupesh Labde.

21,22 April: Kothari International School, Kharadi, and Kondhwa conducted by Rupesh Labde.

25th April: A talk titled 'Astronomy and Solar Systems' by Atharva Pathak at Symbiosis International School, Viman Nagar.

25th April: A talk titled 'Science Communication as a career option' by Shivani Pethe for BSc. Students at Dhyansaras Mandal, Mhapusa, Goa

25th May: A demonstration of the Optical Telescope by Atharva Pathak at ISSAA & RCAA summer school Program at IUCAA.

30th June: A Lecture on "Solar System" at Tilak Maharashtra Vidyalyaya by Atharva Pathak.

17 September: Science Toys Demonstration at Dr. K. B.Hedgewar Vidyamandir, Sakhli, Goa for students of grades 5th to 8th with a total of about 180 students.



Visitors [Upcoming]

October 2022

Simran Arora, BITS-Pilani, Hyderabad; Abdul Aziz, Bodai High School, West Bengal; Maheswata Biswas, Sonarpur Mahavidyalaya, Kolkata; Koushik Chakraborty, Institute of Education [PG] for Women, Chandernagore, West Bengal; Amit Das, Ashoknagar Vidyasagar Bani Bhaban High School, West Bengal; Sanskriti Das, Stanford University, USA; Shyam Das, Malda College, West Bengal; GiridhariDeogharla, University of Burdwan, West Bengal; PrabirGharami, Belda College, West Bengal; Koushik Ghosh, Burdwan University, West Bengal; Shounak Ghosh, Department of Consumer Affairs, Govt of West Bengal; Zahoor Ahmad Malik, University of Kashmir, Srinagar; Priyanka Mandal, Ananda Chandra College, Jalpaiguri, West Bengal; Sanjay Kumar Pandey, L.B.S.P.G., College Gonda, U.P.; B. C. Paul, North Bengal University, Darjeeling; Nupur Paul, Jadavpur University, Kolkata; NinanSajeeth Philip, AIRIS, Kerala; Saibal Ray, GLA University, Mathura, U.P.; Sanjay Kumar Sahay, BITS-Pilani, Goa; P. K. Sahoo, BITS-Pilani, Hyderabad; Rikpratik Sengupta, Aliah University, Kolkata; Bhavesh Suthar, M. S. University of Baroda, Vadodara;

November 2022

Sathya Narayanan K., The Cochin College, Kerala; Anvar Shukurov, Univ. of Newcastle United Kingdom; R.G. Vishwakarma, Universidad Autonoma De Zacatecas, Mexico; Andrzej Zdziarski, Nicolaus Copernicus Institute, Warsaw, Poland.

December 2022

- Mason Helen, University of Cambridge, United Kingdom.

Long Term Visitors

- Poshak Gandhi, University of Southampton, United Kingdom. [Adjunct Faculty]
- David Hilditch, University of Lisbon, Portugal. [Adjunct Faculty]
- Ashish Mahabal, CALTECH, USA. [Adjunct Faculty]
- Ninan Sajeeth Philip, Artificial Intelligence Research & Intelligence Systems, Kerala. [Visiting Professor]
- A. R. Rao, Mumbai. [Visiting Professor]

Khagol (the Celestial Sphere)
is the quarterly bulletin of



We welcome your feedback at the following address:

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