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Editor :
Aseem Paranjape
(aseem@iucaa.in)

Editorial Assistant :
Manjiri Mahabal
(mam@iucaa.in)

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Govind Swarup (1929-2020): A Tribute

Govind Swarup FRS, one of the pioneers of science research and education in India, passed away in Pune on September 7, 2020, bringing about the end of an era. Here, we share the thoughts and reminiscences of the present and former Directors of IUCAA upon the passing of this legend.

Somak Raychaudhury:

India is currently one of the world's leading communities in studying the Universe at radio wavelengths, and it is largely because of Govind Swarup's groundbreaking innovations. This he achieved by conceiving and constructing some of the most innovative telescopes and instruments ever built for the purpose, and by inspiring generations of young engineers and physicists, whom he taught not only to dream of impossible things, but how to achieve them.

Contents...

At Ooty, the TIFR group built the first unique giant telescope of Swarup's design- made of fine wire mesh on a monolithic parabolic cylindrical frame, half a kilometer long and 30m wide, operating at 327 MHz. Some of the measurements of the counts of radio sources made by Kapahi and Swarup, made with this telescope, went on to provide strong support for the Big Bang theory of Cosmology.

The same team moved on to build the Giant Metrewave Radio Telescope (GMRT) near Pune, which is now one of the top astronomical facilities of the world for two decades, studying all sorts of sources from planets, stars to radiogalaxies and supermassive black holes. GMRT is now a pathfinder observatory for the Square Kilometer Array, the next big innovation in radio astronomy, which also originated from Swarup's ideas.

The presence of Swarup, his team and students, at the National Centre for Radio Astrophysics, next door to IUCAA, and the close collaboration in a joint graduate school and research, has inspired frontline activities for IUCAA members and Associates from Colleges and Universities.

A hundred years from now, Govind Swarup will be remembered as the Man who came up with all the ideas, and knew how to turn these visions into the very tangible legacies he has left for us.

J. V. Narlikar:

The passing away of Govind Swarup removed from the scene the oldest active astronomer in India. Although 'oldest' indicates age, so far as Govind was concerned he was the youngest nonagenarian astronomer in India. Having observed him at work for nearly five decades I feel that he was ageless. There are several ways to look at this statement.

Firstly, whenever you met him he would have some idea to air. The idea may be to do with some new kind of radio telescope, or some new type of institution to attract young students. The trouble was that his imagination was fast changing and if you met him even after a week, he would have changed the ideas he last talked about.

Secondly, he was one of those rarities in India who are at home with instrumentation. His ideas fructified in Kalyan, Ooty, Khodad, … and also in Brazil where Hanumant Sawant learning from Govind set up a telescope.

Thirdly, he had developed contacts with radio astronomers worldwide and it was through them that he kept Indian radio astronomy on active interaction with the international community of radio astronomers.

My interaction with Govind was closer when we both moved to Pune. He was setting up GMRT and its controlling institute NCRA and I was setting up IUCAA. Having Govind on our various committees was a mixed experience. But on the whole I would definitely rate it as positive. Certainly we are grateful to him for providing some office rooms in NCRA until IUCAA had its own buildings. This also included the shelter for IUCAA's growing library.

He will be greatly missed.

Naresh Dadhich:

Govind Swarup is the greatest experimental scientist after J C Bose and C V Raman, and an extraordinarily imaginative instrument builder with remarkable foresight.

Both Ooty Radio Telescope and GMRT – Giant Metrewave Radio Telescope are the points in question. For the former he looked for and found a hill having North-South slope that matched the latitude of the location. For the latter he chose metre wavelength so wisely and timely because there was little or no radio noise in metre wavelength at that time and secondly technology available in the country was just about right. If it was not done then, one had to go to the other side of Moon for such an instrument.

This is a fine example of his deep insight and foresight as well as scientific wisdom.

What struck one most was his childlike sense of wonder and curiosity, and he was ever excited about something new and interesting that he might have thought at the breakfast that morning. This wonderful faculty he never let it go.

When he was exploring a suitable site for GMRT in mid 1980s, I was in Pune University and arranged accommodation and vehicles etc. for the field visits. This way I did a bit of midwifery job for the challenging project.

There are some people who are so passionate that perhaps couldn't have done anything else than science, he was certainly the one.

It should also be said and remembered that the original proposal for creation of institute for science education analogous to IIT – IISER was due to him and late V G Bhide. It is a different matter that this fact is no longer duly acknowledged. Like this he had several other proposals for instance, Giant Equatorial Radio Telescope – GERT, a precursor to GMRT.

Finally if I take the liberty of a wish, I would have much liked to locate him in a university or an IIT/IISER where he could have fired and excited a large number of young minds. That would have done due and adequate justice to his unbounded imagination, innovation, creativity and enthusiasm. This is how I would always remember him with great fondness and warmest reverence.

Ajit Kembhavi:

Like everyone else, I have known Professor Govind Swarup as a great astrophysicist, radio telescope builder and a towering figure in Indian and world astronomy. But after his passing away, my thoughts about Govind have been focused mainly on my personal interactions with him over the years.

I used to visit TIFR, Mumbai as an undergraduate for four years before I joined the institute as a graduate student in the early seventies. Over that early period, I had never heard about Govind, possibly because in those days my friends and I were so enamoured with nuclear physics. When I joined the graduate school, Govind asked me to work with him, but by then I was enamoured with theoretical astrophysics and wanted to work with Jayant Narlikar, which I did. Once again, some years later, I had the chance to work with Govind when he asked me to shift from TIFR to the Indian Institute of Science in Bengaluru to head the Joint Astronomy Programme there, which I did not do.

If I had accepted either of the offers, my phase space trajectory would have been quite different, except that in configuration space it would have ended in Pune anyway, as it has now done. But I am sure that working with Govind Swarup would have been quite a different experience from working with Jayant Narlikar. Their ethos, aspirations and achievements have been very similar, but the outwards manifestation of these great qualities in the two gentlemen could not have been more different.

My regular interactions with Govind, in person or on the phone, were limited to his talking and my listening and trying to get in a word or two occasionally. What surprised me very much was that the few words I managed to utter were recorded, processed and remembered, without any interruption in his own streams of words and ideas, and were brought up in future conversations. In this manner Govind took me from his early ideas for a great new radio telescope to the GMRT. I learned a lot from these conversations, about astronomy, about large projects, about science and about life.

An important set of conversations I had with Govind was about the Thirty Meter Telescope (TMT). Govind was not comfortable with India joining the project, he wanted us to build an optical telescope in India. But this would necessarily have been a significantly smaller telescope, leaving us a factor 10 behind in aperture for the foreseeable future. My friends and I tried very hard to convince him that we should join the project. He finally relented to say that we could join at the 5 per cent level. That would have deprived us of a seat on the TMT Board, which needed our joining at the 10 per cent level at least. After many discussions and arguments Govind finally agreed to the 10 per cent. Perhaps he always had that in mind, and was simply getting us to sharpen our arguments and focus our attention on the important issues which we were missing in our enthusiasm.

I last met Govind at a dinner party just before the pandemic. He had gone frail, but his spirits were undiminished and he did speak to me as in the old times. I am sure he continues to be the same wherever he is now, though he can speak to us only in our imagination.

Photo credits: IUCAA Library, Prof. Jasjeet Singh Bagla (IISER-Mohali), Dr. J.K. Solanki (NCRA) and Prof. Somak Raychaudhury.

Welcome to …

Krishnakanta Bhattacharya, who has joined IUCAA as a Post-doctoral Fellow in September 2020. He has obtained his PhD from the Indian Institute of Technology, Guwahati in August 2020. During his PhD, he has worked on several aspects of gravity, such as black hole thermodynamics, phase transition, fluid-gravity correspondence, etc. His primary interest lies in theoretical aspects of general relativity, QFT in curved spacetime. He was also associated with California State University, Fresno, for six months as a Fulbright visiting researcher. At IUCAA, he will work on several aspects of general relativity, and also on Fermionic fields in curved spacetime.

Souradeep Bhattacharya, who has joined IUCAA as a Post-doctoral Fellow in September 2020. He carried out his undergraduate studies at BITS, Pilani, with a dual-degree in Physics along with Electrical and Electronics Engineering. During this time, he had his first research experience as a summer intern at IUCAA. Also, he had summer internships at the University of Alberta, Canada; and National Central University, Taiwan. His early research work focused on open cluster morphology, blue stragglers, and X-ray sources in globular clusters. Till early 2020, he was an IMPRS PhD student at the European Southern Observatory (ESO), Garching, Germany. His PhD research focused on using Planetary Nebulae as discrete tracers to unveil the recent formation history of the Andromeda Galaxy (M31).At IUCAA, he will primarily work on the archaeology of nearby galaxies using discrete tracers to understand the build-up of galaxies at different mass scales. He is generally interested in stellar populations in galaxies and their dynamics.

Annu Jacob, who has joined IUCAA as a Post-doctoral Fellow in October 2020. She did her integrated MTech – PhD in Astronomical Instrumentation from the Indian Institute of Astrophysics(IIA), Bengaluru, in collaboration with the University of Calcutta. Her doctoral thesis was on Optimum Design and Development of Segmented Mirror Telescope Optics and Phasing System. Her primary interest lies in developing new optical instrumentation technology, and utilizing it to do cutting edge research in Astronomy and Astrophysics. During her PhD, she did optical design and analysis for the 1m class prototype segmented mirror telescope being developed by IIA, and also for the envisioned 10m class National Large Optical Telescope(NLOT), which is indented to be a technological asset for the entire Indian astronomical community. She also developed technology for phasing of the segmented mirrors to make them work like a monolith. At IUCAA, she is working on Devastal Optical Telescope Integral Field Spectrograph (DOTIFS), on assembly, calibration, and testing of various spectrograph subsystems, thus realizing a powerful back-end instrument of the current largest optical telescope of India.

Sushma Kurapati, who has joined IUCAA as a Post-doctoral Fellow in July 2020. She has obtained her PhD from the National Centre for Radio Astrophysics, Pune in 2020. Her primary research interests are related to galaxy formation and evolution. In particular, she is interested in understanding the evolutionary processes that shape the structure and dynamics of galaxies. She mainly uses neutral hydrogen (HI) 21 cm observations to trace various interactions, mergers, and accretion, and thereby understand how galaxies acquire and lose their gas in various environments. In her PhD thesis, she used HI kinematics to derive the rotation curves to obtain properties such as angular momentum and dark matter distribution in dwarf galaxies. Currently, she is working on ultra-diffuse galaxies to test their formation scenarios.

Preetish K. Mishra, who has joined IUCAA as a Post-doctoral Fellow in September 2020. He did his PhD degree in early 2020 from the National Centre for Radio Astrophysics (NCRA), Pune, of the Tata Institute of Fundamental Research (TIFR). He is an observational astronomer with research interest broadly lies in the area of galaxy evolution. More specifically, he is interested in understanding what gives the galaxies their present-day structure. He utilizes the data from large sky surveys to answer his curiosities. Currently, he is collaborating with colleagues in IUCAA to find a link between galaxy structure and their host dark matter halo by making use of weak gravitationallensing. Outside the research work, he likes to spend time cultivating his interests in cinema, regional music, and poetry.

Priyanka Rani, who has joined IUCAA as a Post doctoral Fellow in September 2020, after obtaining her doctorate degree from the Indian Institute for Astrophysics, Bengaluru. During her doctoral studies, she has studied the temporal and spectral characteristics of Active Galactic Nuclei (AGN) using X-ray data. She specifically has analyzed the NuSTAR data to explore the variable nature of AGN and their coronal properties in the X-ray bands using spectral and timing studies. At present, she is working on multi-wavelength analysis of AGN using data from AstroSat.

Eshita Banerjee, Rajendra Prasad Bhatt, Sayak Dutta, Biswanath Malaker, Manish, Soumil Maulick, Pushpak Pandey, and **Swarnim Sunil Shirke,** who have joined IUCAA as Research Scholars.

Congratulations to . . .

Sanjeev Dhurandhar, on being elected a *Fellow of the American Physical Society,* for *foundational contributions to the theoretical underpinnings of gravitational wave detection, especially in data analysis techniques,* and for the *development of India's gravitational wave community leading to LIGO – India.*

Farewell to . . .

Niladri Paul and **Yasa Shiva Rama Krishna Reddy** (Research Scholars) have left IUCAA to take up new assignments.

T.R. Saravanan and **Ashish Mhaske** have resigned as Postdoctoral fellows.

Addition to the IUCAA family

IUCAA extends a warm welcome to the new Visiting Associates of the thirty-first batch, joining us for a tenure of three years, beginning August 2020.

New Visiting Associates

1. **Priya Bharali,**
   Department of Physics,
   Mahatma Gandhi Government Arts College, Mahe.
2. **Rashmi Bhardwaj,**
   School of Basic and Applied Sci.,
   Guru Gobind Singh Indraprastha Univ., New Delhi.
3. **Srijit Bhattacharjee,**
   Department of Physics, IIIT, Allahabad.
4. **Subhra Bhattacharya,**
   Department of Mathematics,
   Presidency University, Kolkata.
5. **Hum Chand,**
   Department of Physics and Astronomical Sci.,
   Central Univ. of Himachal Pradesh, Kangra.
6. **Raka Vasant Dabhade,**
   Departmentof Physics, Fergusson College, Pune.
7. **Shyam Das,**
   Department of Physics,
   PD Women's College, Jalpaiguri.
8. **Abhik Ghosh,**
   Department of Physics,
   Banwarilal Bhalotia College, Asansol.
9. **M. Honey,**
   Department of Physics,
   SARBTM Government College, Kozhikode.
10. **R.K. Sunil Kumar,**
    Department of Information Technology,
    Kannur University.
11. **S. Sunil Kumar,**
    Department of Physics, IISER, Tirupati.
12. **Sanjay Kumar,**
    PG Department of Physics, Patna University.
13. **Liton Majumdar,**
    Department of Physics, NISER, Bhubaneswar.
14. **Ram Ajor Maurya,**
    Department of Physics, NIT, Kozhikode.
15. **K. Sathya Narayanan,**
    Department of Physics,
    The Cochin College, Ernakulam.
16. **R. Rakhi,**
    Department of Physics, NSS College, Pandalam.
17. **Gauranga Charan Samanta,**
    PG Department of Mathematics,
    Fakir Mohan University, Balasore.
18. **Umesh Kumar Sharma,**
    Department of Physics, GLA University, Mathura.

Extension of Associateship to the twenty-eighth batch of Visiting Associates

1. **Bijan Kumar Bagchi,**
   Department of Mathematics,
   Shiv Nadar University, Noida.
2. **Arunima Banerjee,**
   Department of Physics, IISER, Tirupati.
3. **Sarmistha Banik,**
   Department of Physics,
   BITS – Pilani, Hyderabad.
4. **Naseer Iqbal Bhat,**
   Department of Physics,
   Central University of Kashmir, Srinagar.

5. **Nand Kumar Chakradhari,**
School of Studies in Physics and Astrophysics,
Pt. RS University, Raipur.

6. **Ramesh Chandra,**
Department of Physics, Kumaun University,
Nainital.

7. **Suresh Chandra,**
Centre for Astronomy and Astrophysics,
Amity University, Noida.

8. **Ayan Chatterjee,**
Department of Phys. and Astron. Sci.,
Central Univ. of Himachal Pradesh, Dharamshala.

9. **Ritaban Chatterjee,**
Department of Physics, Presidency University,
Kolkata.

10. **Suchetana Chatterjee,**
Department of Physics,
Presidency University, Kolkata.

11. **Asis Kumar Chattopadhyay,**
Department of Statistics, University of Calcutta,
Kolkata.

12. **Surajit Chattopadhyay,**
Department of Mathematics,
Amity University, Kolkata.

13. **Tanuka Chattopadhyay,**
Department of Applied Mathematics,
University of Calcutta, Kolkata.

14. **Sudipta Das,**
Department of Physics,
Visva-Bharati University, Santiniketan.

15. **Dhurjati Prasad Datta,**
Department of Mathematics,
University of North Bengal, Siliguri.

16. **Ujjal Debnath,**
Department of Mathematics,
Indian Inst. of Engineering Science and Tech.,
Howrah.

17. **Shantanu Desai,**
Department of Physics, IIT, Hyderabad.

18. **Gaurav Goswami,**
School of Engineering and Applied Science,
Ahmedabad University.

19. **Nandita L. Kalita,**
Department of Phys.,
Girijananda Chowdhury Inst. of
Management and Tech., Guwahati.

20. **Arun V. Kulkarni,**
Department of Physics, BITS – Pilani, Goa.

21. **Suresh Kumar,**
Department of Mathematics, BITS, Pilani.

22. **Smriti Mahajan,**
Department of Physics, IISER, Mohali.

23. **Manzoor A. Malik,**
Department of Physics,
Central University of Kashmir, Srinagar.

24. **Soma Mandal,**
Department of Physics,
Government Girls' General Degree College, Kolkata.

25. **Titus K. Mathew,**
Department of Physics,
Cochin University of Science and Technology, Kochi.

26. **IromAblu Meitei,**
Department of Physics,
Modern College, Imphal.

27. **Hameeda Mir,**
Department of Physics,
Government Sri Pratap College, Srinagar.

28. **Saptarshi Mondal,**
Department of Physics, Bethune College, Kolkata.

29. **Pradip Mukherjee,**
Department of Physics,
Barasat Government College, Kolkata.

30. **Dibyendu Nandi,**
Centre of Excellence in Space Sciences,
IISER, Kolkata.

31. **Mahadev B.Pandge,**
Department of Physics,
Dayanand Science College, Latur.

32. **Kishor D. Patil,**
Department of Mathematics,
Vivekanand Science College, Buldhana.

33. **Surajit Paul,**
Department of Physics,
Savitribai Phule Pune University.

34. **Ninan Sajeeth Philip,**
Artificial Intelligence Research and Intelligent Systems, Thelliyoor.

35. **Shantanu Rastogi,**
Department of Physics, DDU Gorakhpur University.

36. **Saibal Ray,**
Department of Physics,
Government College of Engineering and Ceramic Tech., Kolkata.

37. **Prabir Rudra**,
Department of Mathematics, IISER, Tirupati.

38. **Saumyadip Samui,**
Department of Physics, Presidency University, Kolkata.

39. **Anand Sengupta,**
Department of Physics, IIT, Gandhinagar.

40. **T.R. Seshadri,**
Department of Physics and Astrophysics,
University of Delhi.

41. **Gyan Prakash Singh,**
Department of Mathematics,
Visvesvaraya National Institute of Tech., Nagpur.

42. **Heisnam Shanjit Singh,**
Department of Physics,
Rajiv Gandhi University, Itanagar.

43. **Monika Sinha,**
Department of Physics, IIT, Jodhpur.

44. **Vikram Soni,**
Centre for Theoretical Physics,
Jamia Millia Islamia, New Delhi.

45. **K. Sriram,**
Department of Astronomy,
Osmania University, Hyderabad.

46. **Arun V. Thampan,**
Department of Physics,
St. Joseph's College, Bengaluru.

47. **Sunil Kumar Tripathy,**
Department of Physics,
Indira Gandhi Institute of Technology, Dhenkanal.

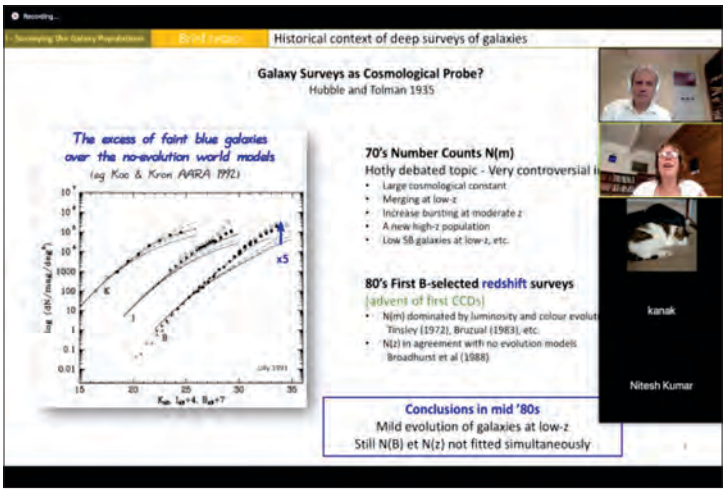
48. **Vinutha Tummala,**
Department of Applied Mathematics,
Andhra University, Visakhapatnam.

49. **Rashmi Uniyal,**
Department of Physics,
Government Degree College, Narendranagar.

50. **Deepak Vaid,**
Department of Physics,
Deen Dayal Upadhyaya College, New Delhi.

Indo – French Astronomy School

The Indo – French Astronomy School (IFAS – 6) was held during July 9–17,2020, fully online, with the support of CRAL, LIO, and IUCAA. The programme consisted of 16 hours of courses, and 36 hours of research projects. The students spent significantly more time on the projects. There were 23 student participants, who werefrom Chile, USA, Venezuela, Brazil, France, Italy, Russia, Iran, Turkey, South Africa, India, and Nepal. The major representation was from Europe and India. Globally, the school



spanned a range of ±6 hours of time zones. The majority of the students were in the course of their PhD, and most of the others were doing Masters' degree. This is a change from the previous schools, where Masters' students were very few, reflecting very good applications by a number of very young students. As usual, there was a good balance of the genders.

The lecturers were from CRAL (3), IUCAA (2), and UK (Liverpool, 1), and the tutors of the five projects were from CRAL (2), IUCAA (2), and UK (1). The lectures and most of the projects were carried-out using Zoom. This worked fine, and the usage of the "breakout" rooms, where the full audience could be redistributed (randomly) in small rooms or tables. The "tea breaks" and the school dinner helped to establish social exchanges in a format finally close to a real physical session. As usual, the students were self-organising off-school evening session, where they presented their own research work, or addressed subjects of concern to them. The projects presentations were great. All the projects achieved remarkable results.

We requested the participants to fill an anonymous feed-back form at the end of the school. It seems that 90% of the students found adequate balance between the lectures and the projects, and the other 10% would like to increase the time for the projects. We also asked a question about their environment during the lockdown. 76% of the students informed that the seminars, and journal clubs continued in their home institute during the lockdowns, but 55% mentioned a clearly negative effect of the lockdown on their work. Finally, 95% of the students thought that we should make IFAS – 7, even if travel and meeting restrictions persist.

The school went beyond our expectations; the remote organisation did not affect the quality of the achievements. We mostly feared for the cohesion and social exchanges, but we felt that finally it went remarkably well. The directors of the school were: Philippe Prugniel (CRAI, France), and Kanak Saha (IUCAA).

The IFAS– 7 has been planned in IUCAA, tentatively during July 29–August 6, 2021.

Colloquia (Online)

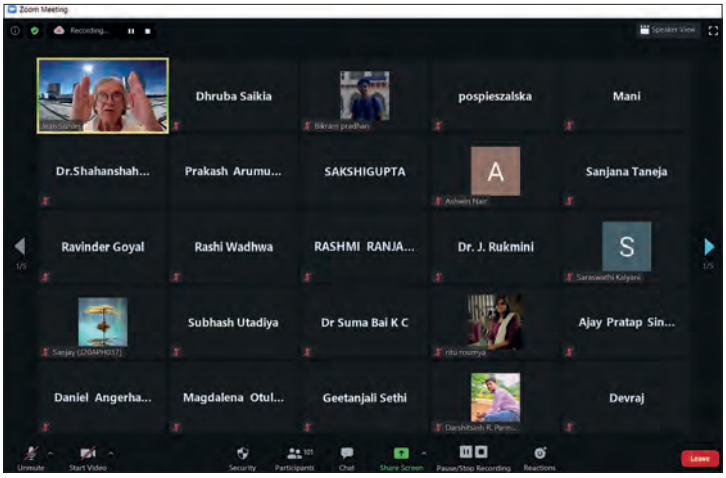
02.07.2020	**Subhadeep De** on *Probing fundamental science using optical atomic clock.*
09.07.2020	**Dipankar Banerjee** on *Long term study of the Sun using Kodaikanaldigitised archive.*
16.07.2020	**Tom Theuns** on *The IKEA model of self-regulated galaxy formation.*
22.07.2020	**Brian O'Reilly** on *Thethird observing run of the LIGO and Virgo detectors: Results and future plans.*
23.07.2020	**Sumanta Chakraborty** on *Strong cosmic censorship conjecture: Past, present and future.*
30.07.2020	**Debarati Chatterjee** on *Constraining dense matter physics using f-mode oscillations in neutron stars.*
13.08.2020	**Biman Nath** on *Neon signs in galactic cosmic rays: Massive young star clusters as important acceleration sites.*
27.08.2020	**Christopher Reynolds** on *Particle physics beyond the standard model with clusters of galaxies.*
03.09.2020	**Volker Springel** on *Hydrodynamical simulations of galaxy formation.*
10.09.2020	**G. Ravindra Kumar** on *Mimicking astrophysical scenarios on a table top.*
15.09.2020	**Michael Wood-Vasey** on *The Vera Rubin Observatory and the legacy survey of space and time.*
24.09.2020	**Bhal Chandra Joshi** on *Quest for gravitational waves with pulsar timing arrays.*

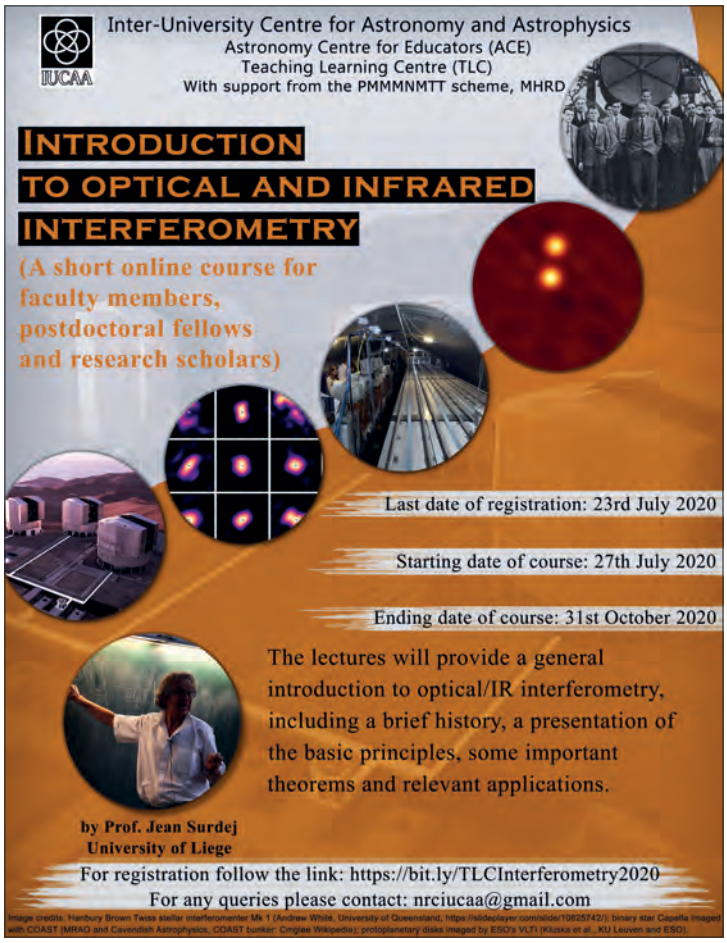
Astronomy Centre for Educators

Teaching Learning Centre and National Resource Centre

An Introduction to Optical and Infrared Interferometry

An online course titled An Introduction to Optical andInfrared Interferometry, was organized by the Teaching Learning Centre of the Astronomy Centre for Educators, IUCAA, from the end of July 2020 till the end of September 2020 with Jean Surdej (Honorary Director, Extragalactic Astrophysics and Space Observatories Group, University of Liege, Belgium) as the instructor. Avinash Deshpande (IUCAA) also gave a set of four lectures on Fourier Transforms. These interactions were also via Zoom, while the Learning Management System Moodle was set up where all video presentations, quizzes, assignments, etc. were available. Over a hundred participants consisting largely of college and university faculty members from India, as well as a few from outside the country were registered for the course. This course was coordinated by Prakash Arumugasamy (IUCAA).





Neem Seminars (Online)

07.07.2020 **Deepak Vaid** on *Quantum error correction in loop quantum gravity.*

14.07.2020 **Smriti Mahajan** on *The curious case of red spiral galaxies.*

14.07.2020 **Biplob Sarkar** on *The consequences of magnetic flux advection in dynamics of shocked accretion flow around a rotating black hole.*

21.07.2020 **Sunandan Gangopadhyay** on *Information theoretic quantities from gauge/gravity correspondence.*

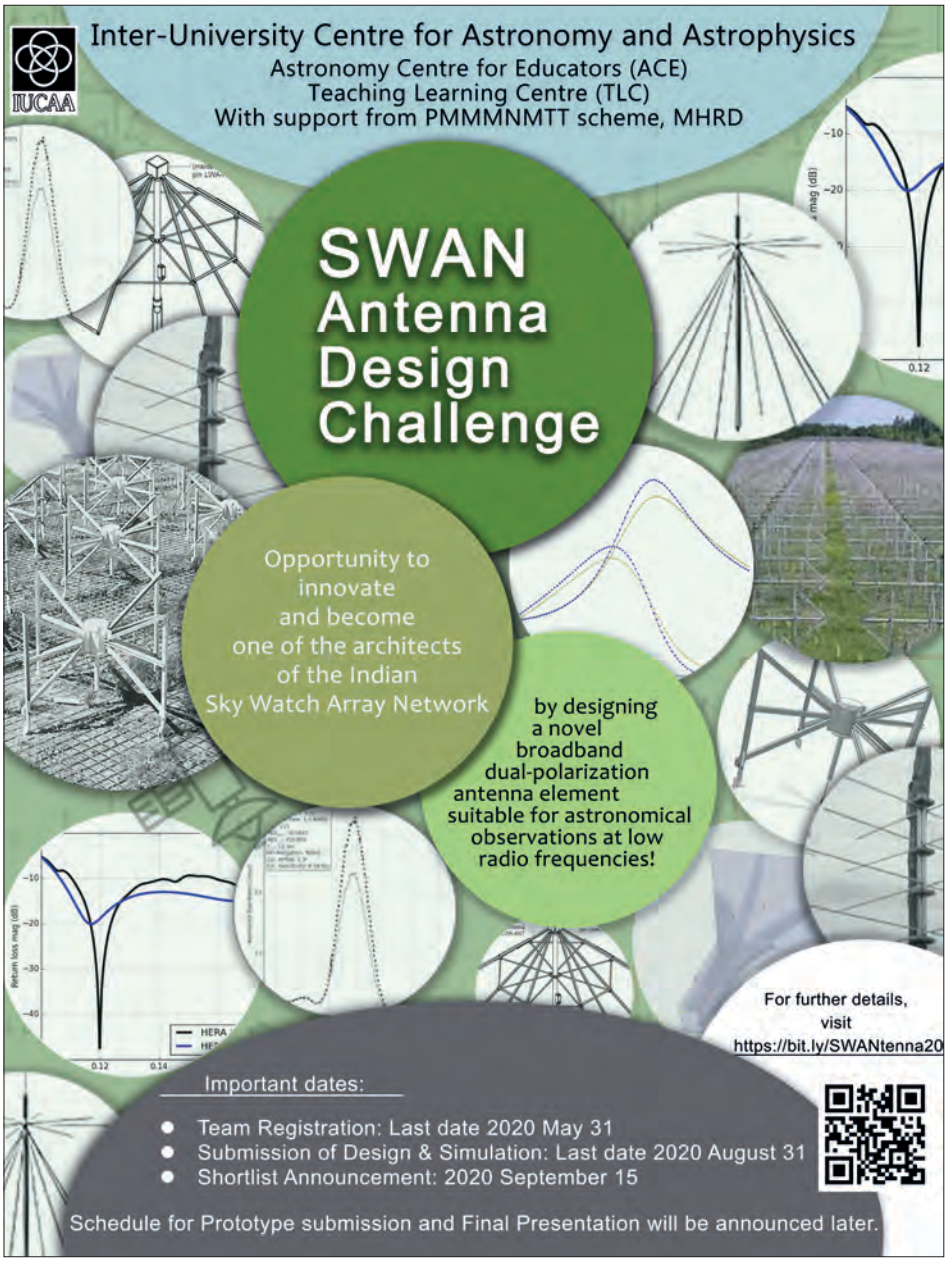
28.07.2020 **Arunima Banerjee** on *Towards a dynamical model of an interacting galaxy pair using machine learning.*

28.07.2020 **Debasish Borah** on *Origin of matter-antimatter asymmetry and dark matter with non-standard cosmology.*

04.08.2020 **Gaurav Goswami** on *Obstructions arising from small distances and their possible cosmological implications.*

Antenna Design Competition: SWANtenna–2020

During the time of this pandemic, efforts were also being made by the Teaching Learning Centre of the Astronomy Centre for Educators, IUCAA, to either design and later build, or do experiments with equipment and/or software, which the participants have access to or may be available at their homes. One such initiative was the design of a low-frequency antenna for radio astronomical observations as part of the Sky Watch Array Network (SWAN), which started at the Raman Research Institute, Bengaluru, by Avinash Deshpande (IUCAA). This competition titled SWANtenna – 2020, was announced in May 2020, and was open to teams of faculty members and students from across the country, with the possibility of teams being across institutions to promote inter-institutional collaboration. In an overwhelming response, over 35 teams, involving about 70 faculty members, who were mentors, and over 300 students, from across the country registered and worked during the four months, from June to September 2020, towards designing an antenna element with the desired specifications. WIPL-D, a Serbian firm specializing in EM simulation and software in the field of electromagnetism, generously provided free access to one of their software packages for all participants. Entries from 18 teams consisting of more than 150 participants reporting details of their completed antenna design and assessment of performance characteristics from simulations, have been received by the extended deadline of September 30, 2020.



These are now being judged by a jury of leading antenna experts of the country, headed by Raghunath Shevgaonkar (Former Director, IIT, Delhi, and presently Vice-Chancellor, Bennett University), Subramaniam Ananthakrishnan (Former Dean, NCRA-TIFR, Pune, and presently at the Savitribai Phule Pune University), Ajit T. Kalghatgi (Former Director, R&D, BEL), Shiban Koul (Emeritus Professor, Centre for Applied Research in Electronics, IIT, Delhi), Surendra Pal (Professor Satish Dhawan Professor and Senior Adviser, Satellite Navigation Centre, ISRO), and K. P. Ray (Dean, DIAT). A set of promising designs will be short-listed for proto-type fabrication and tests. The SWANtenna competition was being coordinated by Avinash Deshpande, and other colleagues at TLC.

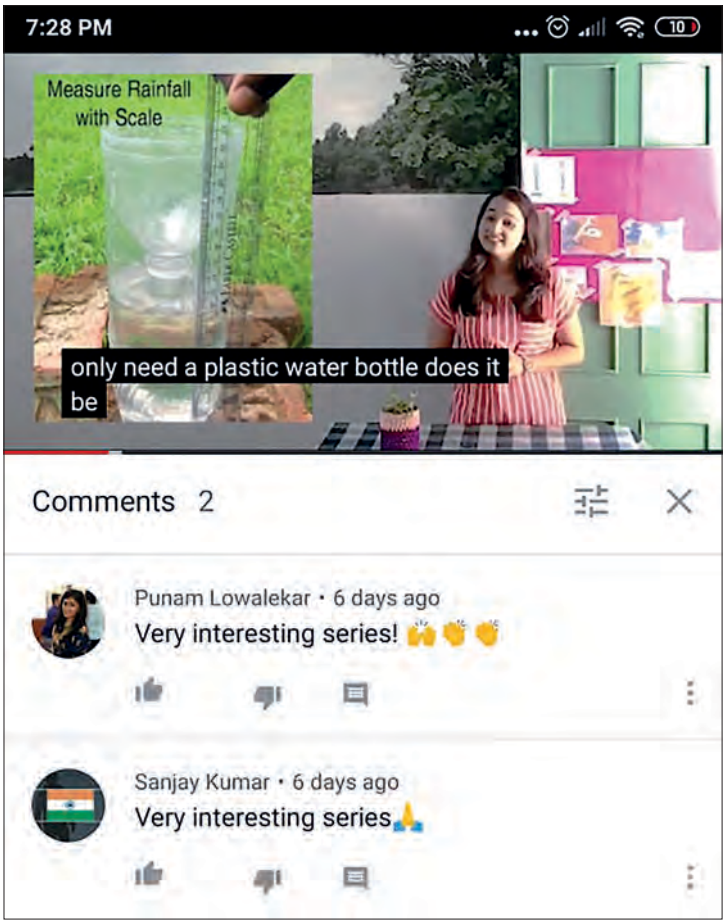
Seminars (Online)

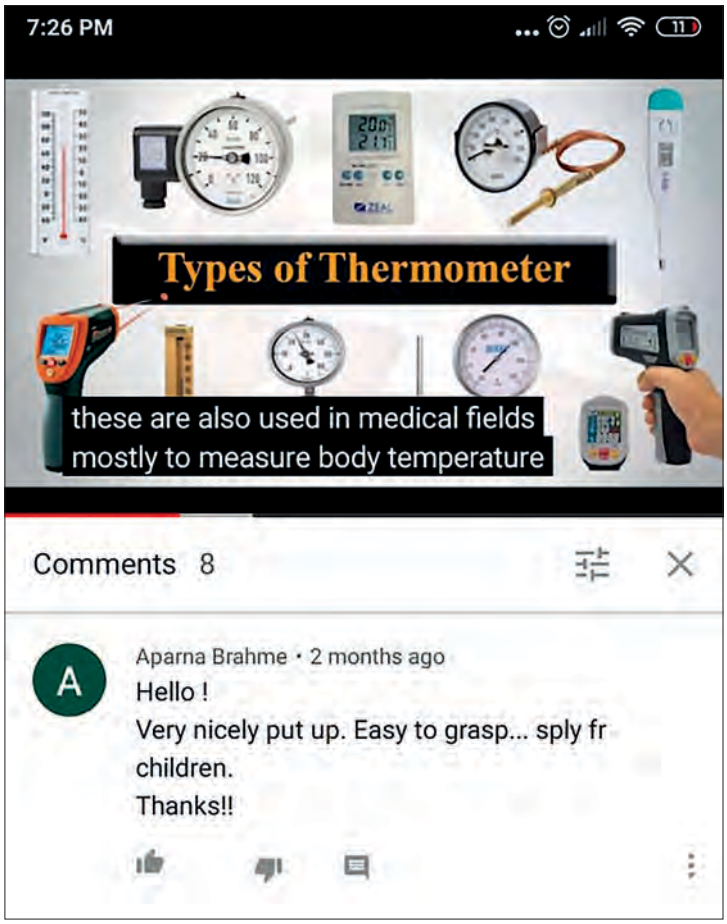
08.09.2020	**Vaidehi Paliya** on *Jetted active galactic nuclei in the era of Fermi Gamma-ray Space Telescope.*
17.09.2020	**Kanak Saha** on *AstroSat detects az=1.42 galaxy emitting Lyman continuum photons.*

Public Outreach Activities

Introduction to Basic Measuring Instruments

Starting from July 22 to September 23, 2020, videos in series were premiered on every Wednesday. This series dedicatedly talked about different instruments used to measure different physical quantities like mass, weight, density, temperature, volume, pressure, time, etc. Over 50 instruments were covered in a span of 10 videos. The videos covered the journey of evolution of these instruments from the ancient times to the modern advancements, and the fields of application of these instruments today were covered. An activity or a DIY toy was discussed at the end of every video. The target audience was students of ages from 8 to 15 years. The activity was designed and coordinated by Shivani Pethe (IUCAA).





Webinars

The following Astronomy webinars on different topics were organised at different institutes with Sci POP resource persons as guest speakers:

July 16, 2020: Sonal Thorve on Introduction to Astronomy and Future Career Opportunity, at ABHAV Foundation, Chhattisgarh.

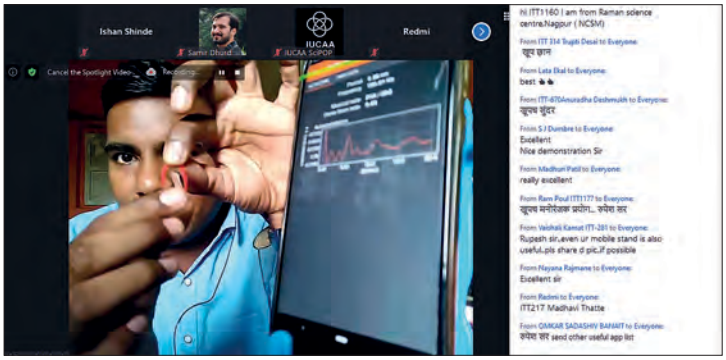
July 23 and 26, 2020: Rupesh Labade on Scientific Toys in Science Education in a Teachers' Training organised jointly by Agastya International Foundation and DIET, Pune.

July 26, 2020: SonalThorve on Astronomy – Exploring Time and Space, as a part of the lecture series "The Space Scientists",organised by Jansona Institute of Technology, Coimbatore, jointly with Galileo Science Club, Tamil Nadu.

September 26, 2020: Samir Dhurde on Moon Challenge: A Close-up View, on the occasion of International Observe the Moon Night 2020, at the Rajasthan Department of Science and Technology.

Online Teachers' Training

State level Online Teachers' Training was conducted during August 8 – 9, 2020. The language of communication was Marathi. Purpose of this training was to share knowledge and pedagogical methods to help teachers make teaching-learning experience more effective. The content was Astronomy and Physics included in the school syllabi. About 600 teachers from schools across Maharashtra participated in the workshop. The training was coordinated by Rupesh Labade, and Sonal Thorve.



Global Hands-on Universe Conference

The goal of the Global Hands-on Universe (GHoU – 2020) Conference was to train teachers on the use of modern tools and resources for science education and engage students in international scientific projects, and was conducted online during August 22 – 28, 2020. Also, to promote interactive science projects among different countries and engage educators and students in a global cooperation.

Samir Dhurde presented a short talk on Zero Shadow Day, where he explained the occurrence, enlisted ideas and tools to plan a ZSD event. He shared experiences from India, where this has been run as a national campaign by the ASI – POEC. As the activity has the capacity for networking astronomy communicators representing 40% of the world's population under one event, appealing participants to help initiate plans of organising ZSD events, all over the world.

Rupesh Labade conducted a workshop on Use of Technology in Science Education. He shared how simple science toys can be converted into experiments using free android applications or software to learn more about the science concepts. Participants from different countries enjoyed and appreciated the workshop.

Further, an oral presentation on LIGO-India's EPO efforts was given by Vaibhav Sawant on behalf of the LIEPO team. He gave an overview of the unique and diverse LIEPO initiatives undertaken based on the requirements of the project at three levels – local, national and international. Vigyan Samagam Mega Science Exhibition, GW@Home with LIGO-India live online lecture series, teacher's training workshop, pop-up comic book, and the gravity matters, and student blog were some of the topics covered during the presentation.

The GHoU – 2020 sessions were streamed live on Facebook, and thousands of participants from different parts of the globe attended the sessions.

Revisiting Second Saturday Lecture / Demonstration with Live Interaction

A series – Revisiting IUCAA Lectures with live Q&A with the speaker is started. In this series, archived second Saturday lectures will be revisited every second and fourth Saturday of the month. The series is getting a good response with many people joining from different parts of the country, and participating with enthusiasm in live interaction with the speakers. In this series, the following interactions were revisited:

September 12, 2020: Talks on Artificial Intelligence in Astronomical Research, by Kaustubh Waghmare (in English), and Kaushal Sharma (Hindi). Kaushal Sharma (ARIES) interacted with the audience answering their questions live.

September 26, 2020: Taking the opportunity of International Observe the Moon Night, talk on Moon and Non-Rocket Science of it, by Samir Dhurde, followed by a live interaction.

MViSa

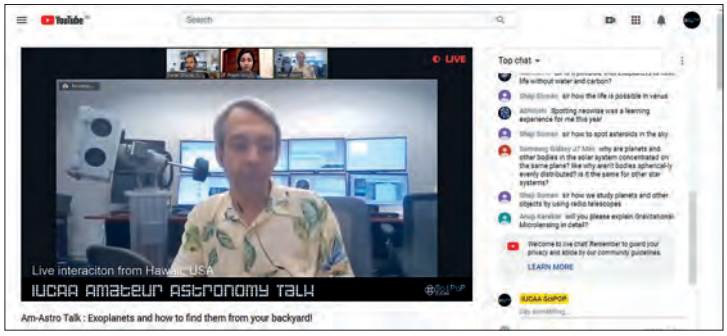
As part of IUCAA's efforts to support amateurs astronomy, a fortnightly series of lectures is being organised. The talks in this will be by representatives of well-known projects or organisations across the world where serious amateurs are significantly contributing to Science. The "Awesome Amateur Astronomy Talks" series will be followed up be activities selected amateurs who may want to take up astronomy research at their convenience level. The effort is being coordinated by Samir Dhurde.

The first lecture on 27 September, 2020 was about PANOPTES (Panoptic Astronomical Networked Observatories for a Public Transiting Exoplanets Survey) - a citizen science project that aims to make it easy for anyone to build a low cost, robotic telescope, to be used to detect transiting exoplanets. Olivier Guyon, the Project Founder of PANOPTES Project and Preethi Krishnamoorthy (ex-IUCAA) gave short introductory talks and got a great response. Both work at the Subaru Telescope in Hawaii and joined in live to an audience of around 250 people from across the world.

A recording of all talks by IUCAA Scipop will be available on our Youtube channel -

https://www.youtube.com/IUCAASciPOP

*All the SciPOP events videos can be found in: https://www.youtube.com/c/IUCAASciPOP/



List of Public Talks by IUCAA Members

May 16, 2020: Primordial Black Hole: Black Holes from the Big Bang, by Swagat Mishra.

May 23, 2020: Introduction to Astrophotography, by Jameer Manur.

June 6, 2020: Tuning to Mysteries of the Universe, by Pratik Dabhade.

July 18, 2020: Do Your Own: Fun with Variables and Transients, by Ashish Mahabal.

July 26, 2020: Unravelling the Dark Side of the Universe with Gravitational Lensing, by Anupreeta More.

August 1, 2020: Accomplishing the Impossible: Detection of Gravitational Waves, by Shivaraj Kandhasamy.

These talks were organized by Antariksh Astro Club, VIT, Pune, and were part of a series of online astronomy talks by astrophysicists from various renowned institutes, including IUCAA.

All these talks in this series can be found in:

https://www.youtube.com/channel/UC9HFGiTLzmuG9PsNGZk0B4A/videos

August 24, 2020: Inflation, Quantum Fluctuations and Primordial Black Holes, by Swagat Mishra, for the Astronomy Club, NISER, Bhubaneswar.

https://www.youtube.com/watch?v=Mezgj6_05TU

August 30, 2020: Exploring Inflationary Cosmology, by Swagat Mishra, for Naxxatra Science, India.

https://www.youtube.com/watch?v=6spDjmQrvHI

LIGO – India Education and Public Outreach (LIEPO) Activities

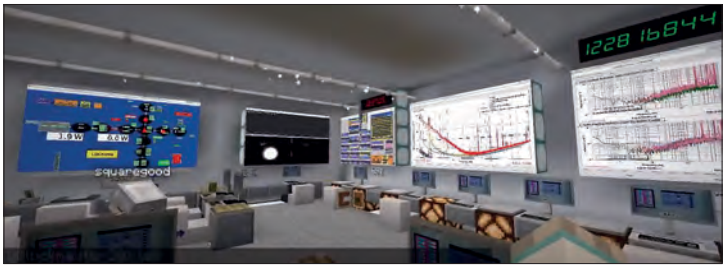
GW@Home with LIGO – India Online Live Video Lecture Series

The LIEPO team was one of the earliest to conceptualise and implement "GW@Home with LIGO – India" - an online live video lecture series of 32 talks after the lockdown began. The first series started from April 1, 2020, and was hosted on the - LIGO India Education and Public Outreach YouTube Channel. The second series "GW@Home-2 with LIGO-India" ran during July 1– August 28, 2020. The talks covered various topics like GW Science, Multi-messenger Astronomy, LIGO Technology, and so on. The content and target audience ranged from some popular level lectures for the general public to some special, technical talks for students. The participants could interact with the speaker to clear their doubts and queries in the live Q&A sessions that followed each talk. This also marked the launch of LIEPO's YouTube Channel, which had gained more than 4,800 subscribers immediately after the talks ended. The recordings of the lecture series are

available on YouTube as playlists and have an average viewership of around 500 per lecture, with some getting close to 8,000 views. The speakers were organised by Sanjit Mitra (IUCAA) and the activity was coordinated by Vaibhav Savant (IUCAA) with support from Samir Dhurde (IUCAA) for live streaming the talks.

Virtual Tour of LIGO in Minecraft

On the occasion of the fifth anniversary of GW150914, the first gravitational-wave detection by LIGO, LIEPO and ARC Centre of Excellence for Gravitational Wave Discovery (OzGrav) jointly conducted an exciting live virtual tour of LIGO in Minecraft - a sandbox video game about placing blocks, on September 15, 2020. People could explore the LIGO observatory by joining the Minecraft server and "walking" with the tour guide around the LIGO model with live commentary. There was also the option of joining the tour live on –LIGO India Education and Public Outreach - Youtube Channel. After the tour, participants could ask questions using #AskLIGOIndia or #AskOzGrav on Twitter. A team of LIGO – India and OzGrav researchers answered these in realtime, and also followed up a few days later for the remaining ones. The activity was coordinated and conducted by Vaibhav Savant and OzGrav colleagues.



Pravega

As part of Pravega, the Indian Institute of Science annual TechFest, Somak Raychaudhury (Director, IUCAA) and Varun Bhalerao (Assistant Professor, IIT – Bombay, Mumbai) delivered invited talks in the Paradigms and the Coherence lecture series respectively. Somak Raychaudhury threw light on blackholes and their detections with gravitational waves (GW) and X-Ray observations of binary stars. He emphasised on the significance of GW studies and discussed the science case for the LIGO – India detector. The talk included a unique insider's update on the LIGO – India project, which is under construction. The main highlight of Varun Bhalerao's talk was the GW170817 binary neutron star merger detected by LIGO and Virgo detectors, and the resultant successful EM counterparts observed by other telescopes, which gave birth to an era of multi-messenger astronomy. He gave an update on India's first robotic telescope GROWTH – India and the proposed DAKSHA mission. Both the speakers also shared the numerous career opportunities that will be available to students across various disciplines as the LIGO – India detector is built over the coming decade. Overall around 330 enthusiastic students attended these webinars. The talks were coordinated by Ankit Bhandari (IUCAA), and conducted by Pravega collaborators.

Gravity Matters : Student Blog

On September 14, 2020, the launching of a gravitational waves (GW) related student blog called "Gravity Matters" was announced on the occasion of the fifth anniversary of the first direct detection of GW150914. The blog is intended to educate under-graduate and post-graduate students as well as the general public about the amazing GW discoveries, science and history in a simple and fun manner in order to get them interested in GW science. Three articles have been released under this blog as of September 30, 2020 on LIEPO's social media network - Facebook, Twitter, and Instagram (@ligoindia). The Facebook posts alone have reached almost 11,000 people. In future, a variety of activities will be rolled out, which includes among other things podcast interviews of GW scientists, photo quiz, comic strips and much more. The activity is being coordinated by Debarati Chatterjee (IUCAA).

Visitors

July To September 2020

Annu Jacob, and Ramya Manjunath.

Long Term Visitors

Avinash Deshpande, Raman Research Institute, Bengaluru (Visiting Professor); David Hilditch, University of Lisbon, Portugal (Adjunct Faculty); Ashish Mahabal, Caltech, USA (Adjunct Faculty); Ninan Sajeeth Philip, Artificial Intelligence Research and Intelligence Systems, Telliyoor (Visiting Professor); and A.R. Rao, Tata Institute of Fundamental Research, Mumbai (Visiting Professor).

Khagol (the Celestial Sphere) is the quarterly bulletin of

IUCAA

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/