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INDIAN INSTITUTE OF ASTROPHYSICS

Block II, Koramangala, Bengaluru - 560034

(Autonomous Institute under the Dept. of Science and Technology, Govt. of India)

INDIAN INSTITUTE OF ASTROPHYSICS

ANNUAL REPORT
2023-2024

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Front Cover: Photograph of HCT and GIT on Digpa Ratsa Ri, Indian Astronomical Observatory, Hanle (credits: Dorje Angchuk, IIA).

Back Cover: Clockwise from top left: First polished TMT mirror at ITOFF (credits: ITOFF), Cartwheel Galaxy (credits: D. Mayya and S. Barway), fluctuation dynamo simulations (credits: S. Sur), solar flare from Kodaikanal Radio Spectrograph (credits: KSO), Visible Emission Line Coronagraph (credits: MGKML), Dual AGN MRK 739 (credits: M. Das).

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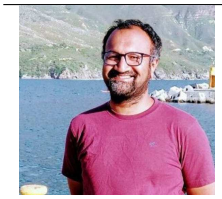

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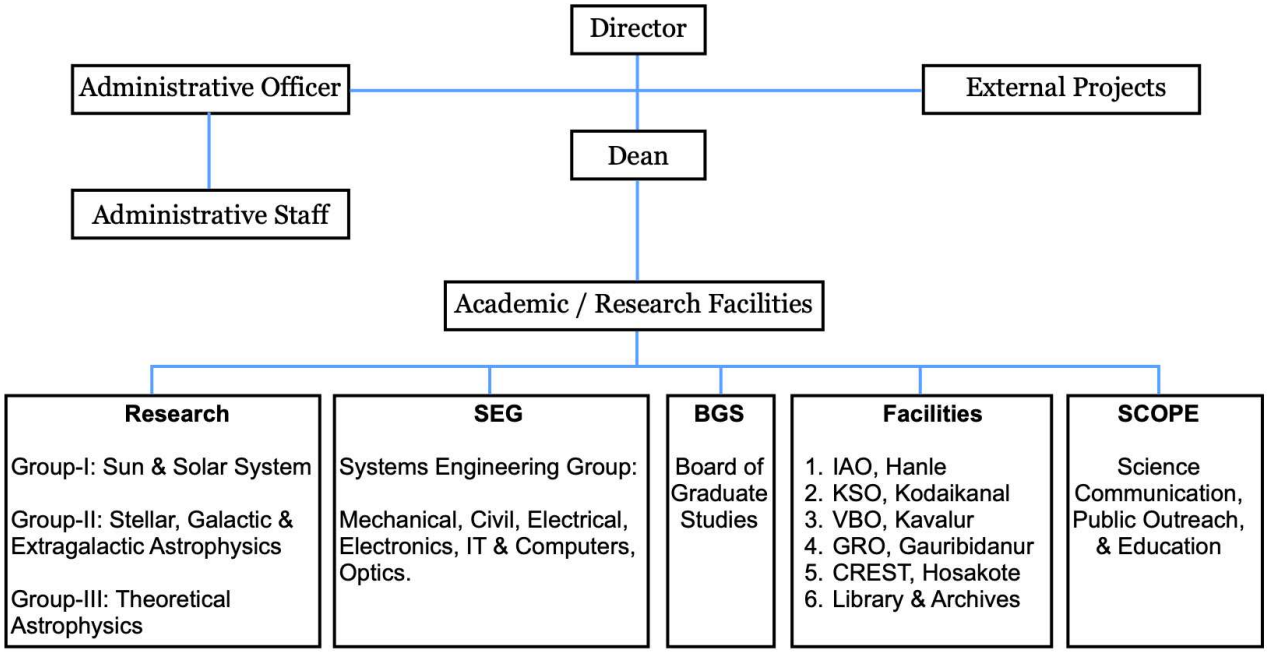

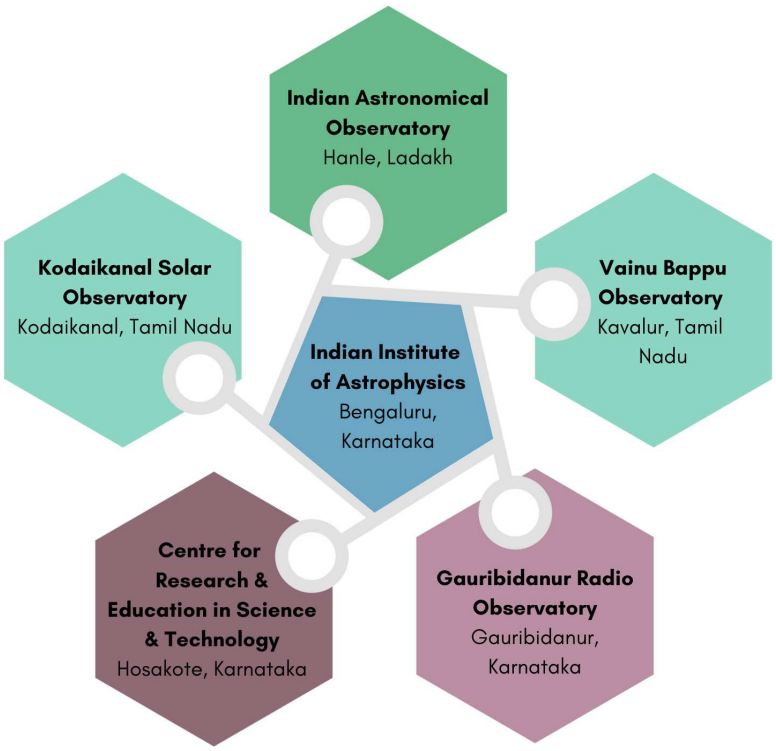

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Year-In-Review

It gives me great pleasure to summarise the achievements of the Indian Institute of Astrophysics in the year 2023-24. The year was marked with a wide variety of achievements that include research and development in areas of astronomy, astrophysics, and instrumentation, successful operations of various national astronomical facilities across the country for day-time and night-time astronomy, and imparting knowledge and providing training to students. I provide a sneak peak into the highlights of this year.

The Institute reached a major milestone in the history of Indian and International astronomy by operating the Kodaikanal Observatory for 125 years. The observatory, established on 1 April 1899 has been the birth place of solar astrophysics in India and had laid the foundation for the growth of other observatories in the country as well.

The scientific faculty of the Institute carry out cutting edge research under three major disciplines, the Sun and the solar system, stars and galaxies, and theoretical astrophysics. In this year 176 research papers were published in refereed journals, averaging about 3.8 publications per faculty, with an average impact factor of 4.76 per paper. The research highlights include the study of coronal mass ejections (CMEs), magnetic field in the Sun, study of long time variations in the Sun and studies of the space weather.

Study of formation of stars included new insights into the magnetic fields in the molecular clouds, young stellar objects and planet formation. The surface chemical properties of stars in various evolutionary stages were used as pointers to production of elements through nucleo-synthesis in the interiors of stars and recent studies not only enhanced the known number of chemically peculiar stars, but also our understanding of the production of elements such as Lithium inside stars.

Images from the Ultra-violet Imaging Telescope have been extensively used to study resolved stellar population in the Small Magellanic Cloud, novae in the Andromeda Galaxy, star formation in the Cartwheel galaxy etc., which provided insights on the presence of massive stars, binaries, star clusters and properties of extragalactic novae. Studies of Active galaxies and blazars carried out using multi-wavelength data provided understanding of their internal physical processes and external environment. Theoretical studies of atmospheres of exoplanets, stars, dynamo and magnetic field in astrophysical gas flows resulted in significant advancement of our understanding in these areas.

The first space instrument made by the Institute to study Sun, the Visible Emission Line Coronagraph (VELC), a major instrument on the Aditya-L1 mission, was launched on 2 September 2023 by ISRO on a PSLV launcher from Sriharikota. After a space travel of approximately 4 months, the mission reached the L1 point in January 2024. The in-orbit performance verification of the VELC started in late January with closed-door and open-door observations.

India-TMT has successfully completed the fabrication & metrology of the first mirror segment roundel. This is a part of India's contribution to the international Thirty Meter Telescope project, and was done at the India-TMT Optics Fabrication Facility (ITOFF) at IIA's CREST campus.

The star sensor StarberrySense, developed and built by IIA Space Payload Group, was launched by ISRO on-board PSLV-C55 into low-Earth orbit as part of the ISRO experiment to use the spent fourth stage of PSLV (PS4) as an orbital platform POEM for scientific experiments. The sensor successfully performed as expected by providing useful data for a month.

We witnessed major milestones in the path towards the setting up of the first tilted-dome LED planetarium in Mysuru. The contracts for the LED equipment and the civil construction are signed and the construction is in progress. The planetarium in expected to be completed during the next year.

An MoU was signed with Academy of Scientific & Innovative Research (AcSIR) to establish academic connectivity and synergy of academic complementation and collaboration in August 2023. The scope of the agreement includes AcSIR to collaborate and recognize IIA as its Associate Academic Center where AcSIR would accept students from IIA for its PhD program.

The Founder's day was celebrated on 10 August 2023 with a lecture by Padma Shri Prof. Sujatha Ramdorai, a renowned mathematician. She brought out the connection and importance of Mathematics in Astronomy and astrophysics. Prof. Peraiah Foundation Lecture 2023, a biennial lecture instituted by the Peraiah Foundation, was jointly given by Prof. Archana Pai (IIT Bombay) and Prof. Dibyendu Nandi (IISER Kolkata). There were several visitors to the Institute. Dr. Laurie Leshin, Director of NASA JPL, visited IIA and delivered a colloquium.

Figure 1.1: *Left: Prof. Sujatha Ramdorai; Right: Dr. Laurie Leshin.*

The first Star Party at the Hanle Dark Sky Reserve was attended by amateur astronomers with their telescopes and cameras resulting in stunning astrophotography of the Bortle 1 dark skies of Hanle and witnessing the Zodiacal Light and Gegenschein.

12 Ph.D. thesis were awarded under the two streams of Ph.D. and Integrated M.Tech-Ph.D. programs. Other than Ph.D.s, over

480 students were trained through online and offline workshops and schools. About 1 Lakh people visited the HQ and field stations to participate in various outreach activities. Two new initiatives were started for school students: IIA Research Experience for School Students (IIA-RESS) and “A Day with an Astronomer".

The asteroid (215884) Jayantmurthy was named after Prof. Jayant Murthy on 18 March 2024 by the International Astronomical Union, in recognition of his work in the NASA New Horizons Science. Annapurni Subramaniam was selected as one of the “Top 100 Women achievers of India” by India Today in December 2023. She was also awarded the Devi Award 2024 by The New Indian Express in January 2024, the Future Female award 2024 by the CNBC-TV18 group in February 2024, and the Vanitha Ratna -2023 award from the Kerala Government in the field of education, science and technology.

Students of IIA were awarded various prizes in conferences and meetings. Both the papers in the category of Astronomy and Astrophysics from India that were the most cited during 2023 from IOP Publishing, had co-authors from IIA. Dr. Wageesh Mishra was elected as an Associate of the Indian Academy of Sciences.

Annapurni Subramaniam
Director

2

Research Highlights

Indian Institute of Astrophysics has a long tradition of scientists undertaking research in almost all topics in astrophysics. This broad research canvas in IIA has astronomers working on data from across the entire electromagnetic spectrum to understand the physics behind an array of celestial objects. Science results from each area of research are summarised here.

2.1 Sun and Solar System

The Sun and Solar System group at IIA is dedicated to exploring a broad spectrum of solar phenomena, from the Sun's deep interior to the outer reaches of the solar atmosphere, including those that control the near-Earth space and beyond. Studies of the Sun's long-term behaviour and of energetic events such as solar jets, solar flares, and Coronal Mass Ejections (CMEs), which are fundamental drivers of space weather, have been central to the group's activities. Other key areas include solar interior dynamics, magnetic field generation, and the processes driving the solar dynamo, through helioseismology as well as theoretical and computational studies.

The group builds instruments and conducts high-resolution spectropolarimetric observations of the solar surface and atmosphere, investigates magnetohydrodynamics and magnetic field reconnection processes, and studies wave propagation and energy transport across different layers of the solar atmosphere.

Research efforts also address the impacts of solar energetic events on space weather. State-of-the-art numerical simulations are employed to model and predict these phenomena, enhancing our ability to forecast and understand solar and space weather interactions. The group plays a significant role in developing and utilizing advanced instruments. A recent effort has been the Visible Emission Line Coronagraph (VELC) onboard the Aditya-L1 mission. The following are the highlights of the research activities of the Sun and Solar System Group.

Prominence Eruption and Coronal Mass Ejection

On 4 December 2013, a solar event featured a prominence eruption (PE) from the Sun's western limb, linked with a moderate coronal mass ejection (CME) and a C4.7 class flare. The LASCO coronagraph observed the CME on the Solar and Heliospheric Observatory (SOHO), with a detailed view showing the prominence eruption in the AIA 304 Å waveband (see Figure 2.1).

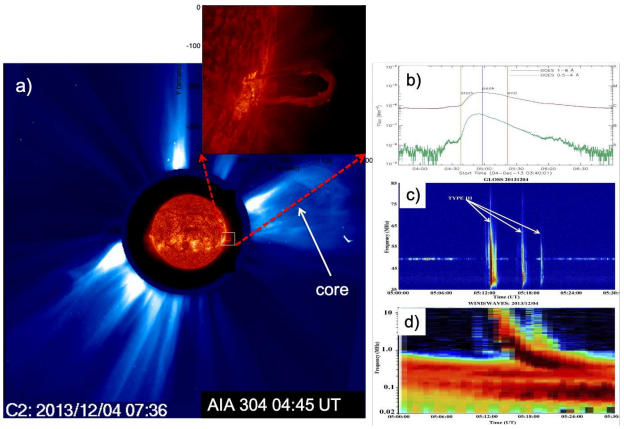

Figure 2.1: *Prominence eruption on 4 December 2013. (a) seen in the combined images of LASCO/C2 and AIA 304 Å (inset: AIA 304 Å image at 04:45 UT), (b) GOES X-ray flux profile of C4.7 class flare (start, peak, end times as green, blue, red), (c) GLOSS dynamic spectrum with recurrent radio type III bursts, (d) wind/WAVes dynamic spectrum with low-frequency type III burst. (Figure Courtesy: P. Vemareddy, and M. S. Ibrahim, 2023, MNRAS, 527 (2), 1774)*

The flare started at 04:38 UT and peaked at 04:58 UT. During the event, the Gauribidanur LOw-frequency Solar Spectrograph (GLOSS) recorded type III radio bursts in the 35–85 MHz range. Before the eruption, the prominence appeared as an S-shaped filament above fragmented magnetic fields. It began to rise slowly due to changes in the magnetic field, eventually erupting at a height of 35 Mm. The rapid rise of the prominence was in sync with the flare, though the acceleration was lower compared to more intense events.

The CME accelerated to 450 km s^{-1} as observed by LASCO but slowed down at greater distances from the Sun. The prominence eruption triggered type III bursts 14 minutes after the flare's peak. The fragmented magnetic fields around the prominence contributed to a weaker flare, highlighting the role of magnetic reconnection in influencing CME speed and solar burst timing.

The April 2023 geomagnetic storm and its solar origins

Studying geomagnetic storms is vital for understanding space-weather impacts, especially in identifying the solar origins responsible for these events. A significant geomagnetic storm (-212 nT) occurred on 23 April 2023, following a solar eruption on 21 April, and was associated with a GOES class M1.7 flare. The flare began at 17:44 UT, peaked at 18:12 UT, and ended at 18:44 UT (see Figure 2.2). The active region was in a decaying phase, characterized by fragmented magnetic fields and a pre-existing filament channel. Over several days, a flux rope (filament) formed through the accumulation of helicity, eventually becoming unstable and erupting. Notably, due to its positive helicity, the CME linked to this eruption exhibited a 56° clockwise rotation of the flux rope apex.

As the CME traveled outward, it was seen to decelerate to 1226 km s^{-1} at 20 solar radii, observed by LASCO. The Heliospheric Imager revealed that the CME expanded more laterally than towards Earth, complicating its arrival time prediction. The ICME shock reached Earth at 07:30 UT on April 23, followed by the onset of the geomagnetic storm at 08:30 UT. The storm's intensity was largely due to the strong negative B_z component of the flux rope's magnetic field, which was consistent with its orientation near the Sun. By understanding the formation, evolution, and rotation of flux ropes and the factors influencing CME propagation, we can better predict the onset and intensity of geomagnetic storms, enhancing our preparedness

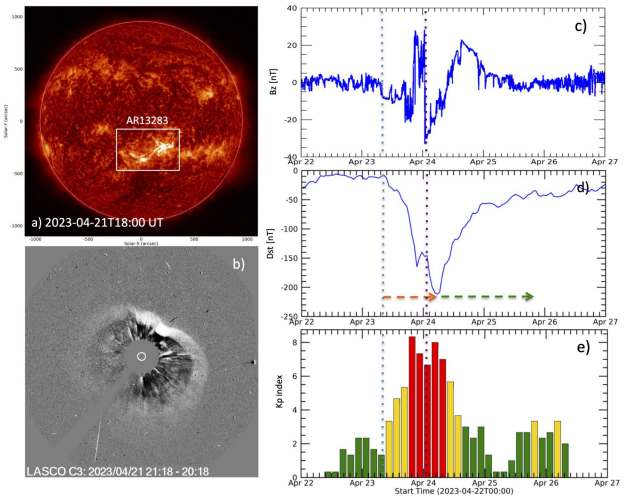

Figure 2.2: *(a) Solar image at 304 Å with the active region AR13283 (from AIA/SDO/NASA) (b) LASCO/C3 SOHO image processed to enhance the bright leading edge and core of the CME, (c) In situ observations of B_z from WIND/NASA, (d) Disturbance storm index showing the earth's magnetic field during the storm, and (e) the Kp index as a function of time. (Figure Courtesy: P. Vemareddy, 2024, ApJ, 961 (2), 199).*

for space-weather events.

Impact of solar wind on CME propagation

Coronal mass ejections (CMEs) are major drivers of space weather, and their propagation and effect on geomagnetic storms are influenced by the solar wind. In collaboration with national partners, IIA astronomers contributed to the development of the SWASTi-CME model. This new model integrates into the Space Weather Adaptive SimulaTion (SWASTi) framework, and combines a non-magnetized elliptic cone model with a magnetized flux rope model to comprehensively analyze CME interactions with the solar wind.

The model was tested using observations from two distinct periods: one during solar maximum with multiple CMEs and another during solar minimum with a single CME. The findings indicate that solar wind conditions significantly impact CME behavior. For instance, the drag on a CME can cause it to deform unevenly, and its internal pressure primarily changes during the early propagation stages. Over time, the CME expands in a predictable manner, reaching a balanced state with the surrounding solar wind. This new model enhances the accuracy of space weather forecasts by offering a detailed understanding of CME dynamics in various solar wind conditions, which is essential for improving space weather prediction and preparedness.

Advanced modeling of CME data

IIA astronomers, as a part of an international collaboration, helped model the observations and diagnostic potential for the proposed COronal Solar Magnetism Observatory (COSMO) coronagraph (see Figure 2.3). COSMO aims to study CMEs by diagnosing the solar corona's magnetic field and plasma properties. This work uses a realistic magnetohydrodynamic CME model to simulate signals from various coronal emission lines (CELs) for COSMO's coronagraph observations. The analysis prioritizes the Fe XIII 10747 Å line for diagnosing the CME flux rope's magnetic field and plasma properties. The Visible Emission Line Coronagraph (VELC) on the Aditya-L1 mission, which is currently operational, also observes this line with high spectral resolution. COSMO will use tunable filters for imaging spectropolarimetry with lower spectral resolution.

The study suggests that COSMO can ef-

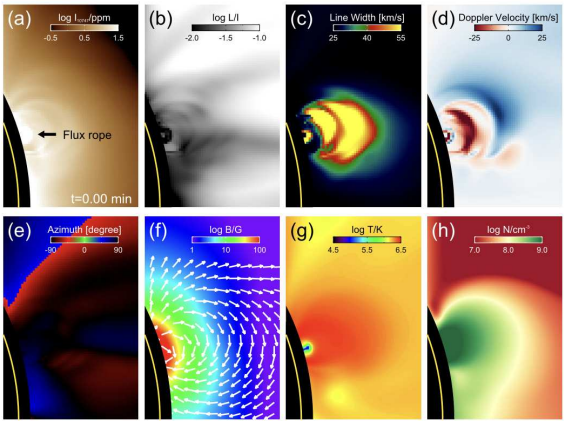

Figure 2.3: *Synthesized Fe XIII 10747 Å line, with several POS cross-section quantities in the model at t = 0 (before the eruption). (a)–(e) Intensity (Stokes I), linear poln. degree (L/I), line width, Doppler velocity, & radial azimuth. (f)–(h) Magnetic field, temperature, & density distributions in the POS. The yellow curve is the solar disk and the region below 1.05 $R_\odot$ is masked. (Figure Courtesy: X. Liu et al., 2023, Solar Physics 298, 112)*

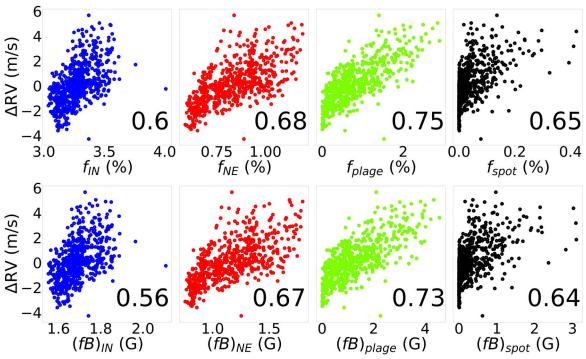

Figure 2.4: *Correlations between the fluctuations in radial velocity, ΔRV, and the fill factors (fm, upper panel), and average unsigned magnetic flux ((fB)m, lower panel) of the different magnetic features on the Sun. (Figure Courtesy: Anisha Sen and S. P. Rajaguru, 2023, ApJ, 956, 145)*

fectively measure the magnetic field of CME progenitors with high spatial resolution. Additionally, the synthetic signals of several CELs will help diagnose physical conditions in the CME's leading front, including the shock. Observations of line pairs such as Fe XIII 10798/10747 Å and Ni XV 8026/6703 Å will provide valuable density diagnostics and insights into temperature and ionization states. The study highlights the Fe XIII 10747 Å line as the highest priority for CME observations with COSMO, while other lines also offer significant diagnostic information.

Photospheric magnetic fields and radial velocity fluctuations

The distribution and behavior of photospheric magnetic fields in sunspots, plages, and network regions play a crucial role in influencing radial velocity (RV) fluctuations observed in Sun-as-a-star spectra, which need to be understood to account for stellar activity signals in high-precision RV exoplanet searches as well.

A joint analysis of sun-as-a-star RVs from HARPS-N observations and high-resolution images of magnetic fields from Solar Dynamics Observatory's Helioseismic and Magnetic Imager (SDO/HMI) reveal that both the strong (spots and plages) and weak (internetwork) fields contribute equally to RV fluctuations despite their vastly differing intrinsic field strengths (see Figure 2.4). Hence careful consideration is needed when using average field strengths as proxies for RV variations. UV intensities at 1600 and 1700 Å from SDO/AIA were also evaluated as proxies for magnetic feature variations. UV intensities provide a more reliable measure of plage contributions to RVs than the Ca II H-K emission indices, especially during high solar activity periods when the latter may become saturated. This study enhances the

understanding of how solar magnetic fields impact RVs, and hence of high-precision exoplanet searches as well.

2.2 Stellar and Galactic Astrophysics

The research of the members of this group mainly focuses on different aspects of star formation in our Galaxy, stellar evolution and Galactic chemo-dynamics. Some research highlights on these topics are given below.

Radiation Driven Cloud Evolution: IC 59 & IC 63

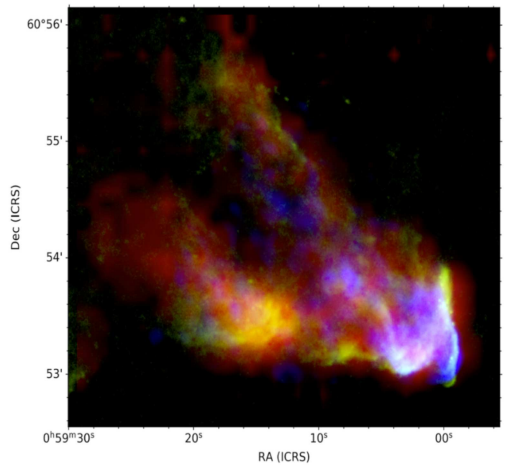

Figure 2.5: *RGB image of IC63 with [C II] in red and H2 (1-0) S(1) in green, IPHAS Hα emission in blue. (Figure Courtesy: Caputo M., Archana Soam, B-G Andersson et al. 2023 ApJ, 950, 140C)*

Gas heating and chemistry in Photo-Dissociation Regions (PDR) in nebulae are controlled by FUV radiation from young massive stars. Many properties of PDRs like clumpiness, temperature structure, and reaction networks, remain uncertain. High-resolution [C II] 158 μm mapping of two nebulae IC 59 and IC 63 (see Figure 2.5) from SOFIA/upGREAT in conjunction with ancillary data on the gas, dust, and polarization were used to probe the kinematics, structure, and magnetic properties of their PDRs. These nebulae are part of the Sh 2-185 H II region illuminated by the B0 IVe star γ Cas. The velocity structure of each PDR changes with distance from γ Cas, consistent with driving by the radiation. Based on previous FUV data, known distance to γ Cas, and predictions of 3D distances to the clouds, the FUV radiation field strength (G0) at the clouds was estimated. The kinetic energy in IC 63 is estimated to be ten times higher than magnetic energies. This suggests that kinetic pressure is dominant.

The magnetic field around cometary globules L328, L323 & L331

Energetic photons emitted from massive OB stars quickly ionize the immediate vicinities, resulting in a shock that propagates away from the ionizing sources and affects the surrounding ISM. This results in elongated cloud structures, such as bright-rimmed clouds (BRCs), cometary globules (CGs), etc, and the shock-compression can lead to gravitational collapse, triggering star formation. CGs are comet-shaped molecular clouds, with a tail-like structure directed away from the source of ionization.

To obtain the plane-of-sky component of magnetic field (BPOS) towards three cometary globules L328, L323, L331, researchers from IIA and IISc used the optical polarization data taken from ARIES-AIMPOL and mapped the magnetic fields in these CGs (see Figure 2.6). The field geometry was found to mostly follow the cometary shape of the cloud, with some randomness at certain

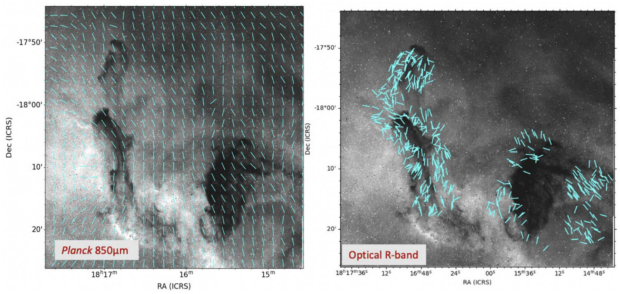

Figure 2.6: *Plane of the sky magnetic field inferred from Planck polarization vectors (left) and optical polarization vectors (right), overplotted on R-band-subtracted Hα image. (Figure Courtesy: Kumar S., Archana Soam, & Roy N., 2023 MNRAS 524 1219)*

locations. The large-scale magnetic fields inferred from 850-μm Planck polarization maps are in agreement with the small-scale magnetic fields which suggests that overall magnetic field structure is consistent across different scales. The spatial distribution of polarization angles suggests that ionizing sources in the east are influencing a fairly complex magnetic field morphology.

Submm polarimetry of IRC+10216

Starlight seen through the interstellar medium is polarized due to the carbon or silicate dust within. Silicates, being paramagnetic, are expected to cause polarization, while carbon is not expected to do so. Hence any such signal due to carbon needs further investigation. A clean way to separate out the polarisation due to carbon is by using the CH molecule, though its fingerprint is very faint to see.

One way to separate the effects of the different grain types comes from studying Asymptotic Giant Branch (AGB) stars. In a recent work, IIA astronomers and international collaborators looked at grain alignment

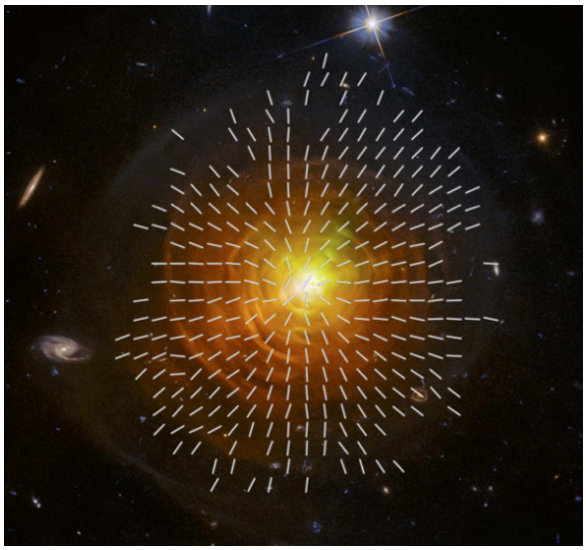

Figure 2.7: *Polarization vectors in the envelope of an C-rich AGB star IRC+10216. (Figure Courtesy: B-G. Andersson, ..., Archana Soam, et al. 2024, ApJ, 963, 76)*

around the star CW Leonis (see Figure 2.7), a carbon-dominated AGB star, with SOFIA, to find out if and how carbon grains contribute to the polarization in interstellar space. They found different sub-effects take over in different areas around the AGB star, with a weak, radial polarization close to the star, and a pattern reminiscent of that from a bar magnet further out. By testing how well the carbon aligns in the AGB star, constraints can be placed on what the polarization observed in the ISM implies.

Fullerenes in circumstellar medium of Herbig Ae/Be stars

Herbig Ae/Be (HAeBe) stars are of interest as they represent a 'missing link' between low and high mass Young stellar Objects (YSOs) and possess circumstellar accretion discs. A comprehensive mid-infrared spectral catalogue of 126 Herbig Ae/Be stars was created, along with an analysis of molecular features, substantially expanding the

database of YSOs known so far.

Buckminsterfullerene, or C60, is one of the most stable cage-like carbonaceous molecules, is expected to be ubiquitous in space and has been identified in many astrophysical environments. However, the C60 molecule is reported in only a few YSOs and interestingly, there is only one instance of detecting C60 near a HAeBe star, viz., HD 97300. This study led to the detection of C60 bands at 17.4 and 18.9 μm in nine sources, with a notable 7.0 μm feature in HD 319896 (see Figure 2.8). The research identifies two distinct emission classes within the star sample, linking six stars' spectra to reflection nebulae and confirming their associations. Tentative evidence suggests that C60 emission features may originate from circumstellar discs or nearby diffuse regions in three stars. The study highlights that C60 is found in 7% of the total sample and 30% of stars associated with nebulosity, specifically in B-type Herbig Ae/Be stars, enhancing understanding of C60 formation and excitation pathways. This catalogue contributes to advancing our understanding of circumstellar environments of HAeBe stars and can act as a reference for future high-resolution observations with JWST.

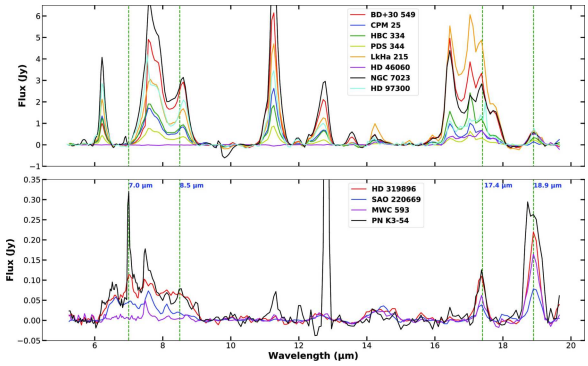

Figure 2.8: *IRS spectra classified as 'RNe-like' (top; NGC 7023, HD 97300) and 'PNe-like' (bottom; PNe K3-54). (Figure Courtesy: Arun et al. 2023, MNRAS, 523, 1601)*

A large sample of new carbon-deficient red giants

A search was conducted for anomalously low carbon-deficient red giants (CDGs) using the APOGEE survey, and 103 new CDGs were found, tripling their known numbers (see Figure 2.9). CDGs are very rare, representing 0.03% of giants. The study shows that they are found in all Galaxy components, contrary to previous findings. The location of CDGs in the H-R diagram shows that they are primarily intermediate-mass stars (2–4 $M_{\odot}$), with evidence for lower masses as well. The bulk of the CDGs were found to likely be in the subgiant branch or red clump phase, whereas others may be in the red giant branch or early AGB phases, the uncertainities arising from degeneracies in the HRD. Previous studies showing that the envelope material has undergone extensive hydrogen burning through the CN(O) cycle was confirmed. The new CDGs have [C+N+O/Fe] that generally sum to zero, indicating that they started with scaled-solar composition, though the previously known ones generally have positive valiues, indicating that some He-burning products were added to their envelopes.

A symbiotic star during outburst

Outburst of the symbiotic star TCP J18224935-2408280 was studied using optical spectra obtained from IIA's Himalayan Chandra Telescope during 2021–22. This outburst started as a disc instability, and later the signature of enhanced shell burning and expansion of photospheric radius of the white dwarf was identified, suggesting that this is of combination nova type. Parameters of the binary system were derived using archival multiband photometric data. (Sonith & Kamath 2023, MNRAS, 526, 6381).

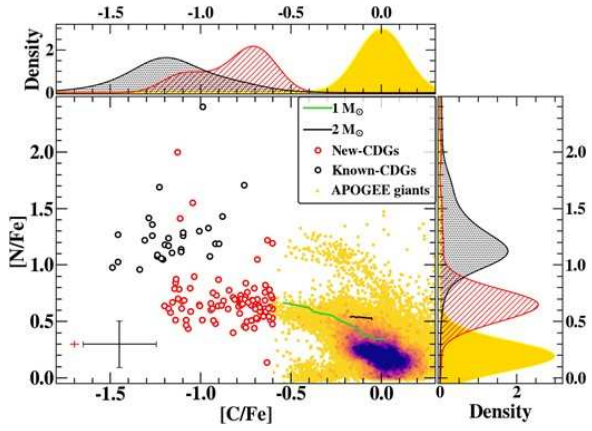

Figure 2.9: *C, N, and O abundance ratios against [Fe/H] for the known-CDGs (open black circles) and the new-CDGs (open red circles). Colour scale is number density from the sample giants from APOGEE DR17. (Figure Courtesy: Maben , S., Kumar, Y. B., Reddy, B.E et al. 2023, MNRAS, 525, 4554)*

AstroSat observations of Nova Her 2021

The fast nova Her 2021 (V1674 Her) which erupted in 2021 was observed at multiple epochs with AstroSat in the soft X-ray and far-UV bands. Various physical parameters of the source were derived using timing and spectral studies of the data (Bhargava et. al. 2024, MNRAS, 528, 28).

RS Ophiuchi: Shock-driven synchrotron radio emission

Low-frequency radio observations of the Galactic symbiotic recurrent nova RS Ophiuchi during days 23–287 of its 2021 eruption were carried out with the upgraded Giant Metrewave Radio Telescope in Pune, spanning a frequency range of 0.15–1.4 GHz. Modelling shows that the radio emission is best explained as shock-driven synchrotron emission, initially absorbed by a clumpy ionized circumbinary medium. Various physical parameters of the system were also derived (Nayana et al. 2024, MNRAS, 528, 5528).

FUV to NIR observations of SN 2023ixf

A new study provides an early time panchromatic view from far-ultraviolet to near-infrared wavelengths, using various ground and space-based telescopes, of a very nearby hydrogen rich core-collapse supernova SN 2023ixf (see Figure 2.10). The early optical spectra showed narrow emission lines of elements like C, N, O, He, etc. and the UV spectra revealed highly ionized narrow absorption and broad emission features, indicating interaction with pre-existing circum-stellar material (CSM). The study inferred a shell-shaped CSM around SN 2023ixf, with an inner radius of ∼75 AU and an outer radius of ∼140 AU, likely accumulated due to enhanced mass loss during the later stages of the progenitor's evolution, possibly due to a standard red supergiant wind. The light curve analysis and its comparison with grid of light curve models also indicated influence of nearby dense CSM on the peak luminosity of SN 2023ixf, suggesting it to be an energetic explosion combined with CSM interaction. This study offers insights into the early phases of a nearby core-collapse supernova.

The story of supernova SN 2018gj

A study of the Type IIP supernova SN 2018gj included UV, optical, and near-IR photometric observations and low-resolution optical spectroscopy from the photospheric to the nebular phase. The supernova exhibited a shorter plateau phase of ∼70 days compared to the typical 100-day plateau for Type IIP SNe, with a persistent blueshifted Hα emission. Parameters like plateau length (∼70 days), peak M_V (-17.0 ± 0.1 mag), and mass of synthesized ^{56}Ni in the explosion (0.026 ± 0.007 $M_\odot$) were estimated. Detailed modeling was carried out to ascertain ejecta mass, explosion energy and progenitor pa-

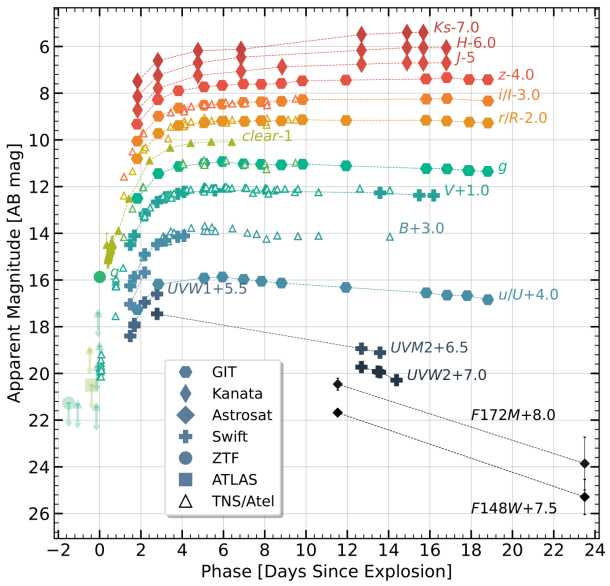

Figure 2.10: *Multiband photometry of SN 2023ixf along with publicly available data. (Figure Courtesy: Teja et al. 2023, ApJL, 954, L12)*

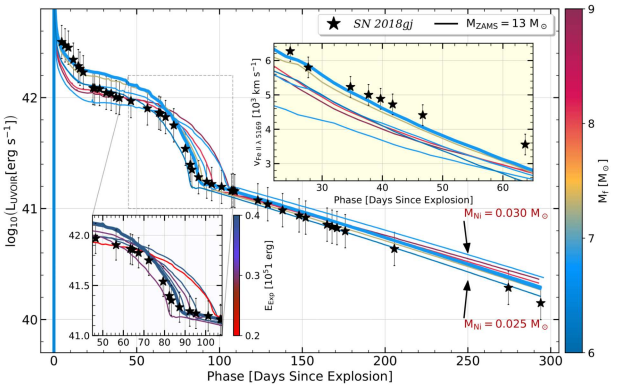

Figure 2.11: *Variations in 13 M_{sun} ZAMS model to achieve a shorter plateau length. Variation in explosion energy for different model light curves around the plateau is in bottom left inset. (Figure Courtesy: Teja et al. 2023, ApJ, 954, 155)*

rameters (see Figure 2.11). The models favored a low-mass progenitor of ZAMS mass of <13 M_{odot}, contrary to the higher-mass RSG channels available in the literature. The mass of the hydrogen envelope was found to be only $\sim$ 2.5–3.0 M_{odot} and a total pre-SN mass of < 7 M_{odot}.

Supernovae SN 2018cni & SN 2020kyg

Optical photometric and spectroscopic characteristics of two Type Iax supernovae 2018cni and 2020kyg were obtained. SN 2018cni was identified as a bright Type Iax supernova, which are usually of low luminosity ($M_{V,peak}$ = -17.81 ± 0.21 mag), while SN 2020kyg was classified as faint ($M_{V,peak}$ = -14.52 ± 0.21 mag). Mass of ^{56}Ni was estimated as 0.07 M_{odot} and 0.002 M_{odot} and that of the ejecta as 0.48 M_{odot} and 0.14 M_{odot} respectively. The correlation between peak luminosity and decline rate shows that bright and faint Type Iax SNe exhibit distinct behavior, suggesting heterogeneity within the class (see Figure 2.12). Deflagration models suggest SN 2018cni is consistent with a CO white dwarf, while SN 2020kyg aligns better with a hybrid CONe white dwarf scenario. An incomplete burning of the white dwarf can explain most properties of Type Iax SNe. Spectral analysis indicates similar chemical species but varying mass fractions, showing stratification in outer layers and mixed inner ejecta for both SNe.

A study of SN type-IIn & SN2017hcc

A study explored the properties of the shock-CSM interaction seen in the super luminous SN-IIn 2017hcc, and compared them with the properties of less well studied cases. The event had already been characterized as occurring in a progenitor with a strongly asymmetric CSM. This study suggests that the presence of asymmetric CSM in massive progenitors may not be as rare as previously thought, and that such configurations may be seen even in events not easily identifiable as classic Type-IIn supernovae.

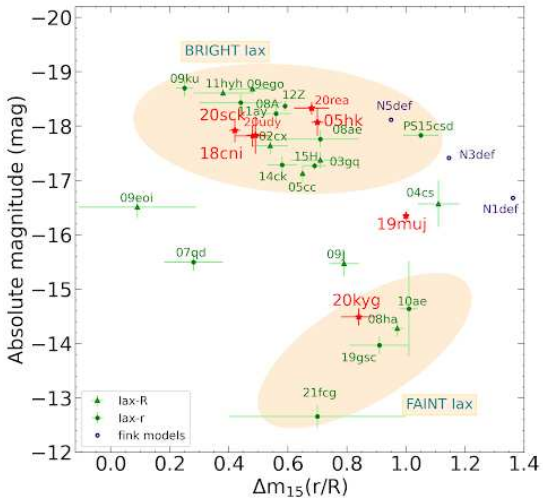

Figure 2.12: *The possible bimodality amongst type Iax class.(Figure Courtesy: Singh et al. 2023, ApJ, 953, 9)*

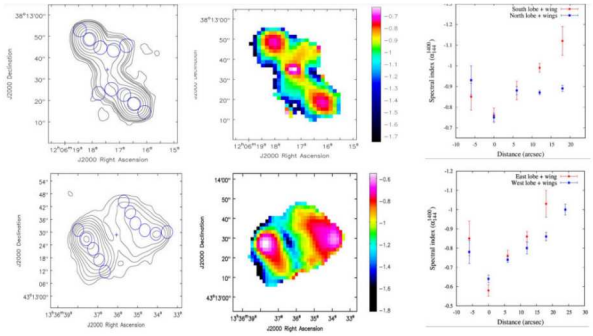

Figure 2.13: *Maps of radio emission and spectral index (144–1400 MHz), and the corresponding spectral index profile measured along the ridge-lines (circles in contour map) for both XRGs (top and bottom). (Figure Courtesy: Patra, D., Joshi, R., Gopal-Krishna, 2023, MNRAS 524, 3270.)*

2.3 Extra-galactic Astronomy

The members of this group focus on different aspects of galaxy formation and evolution across cosmic distances. The research highlights are given below.

Spectral index variation across X-shaped radio galaxies

'X-shaped radio galaxies' (XRGs), or 'winged' radio galaxies are ∼10% of the radio galaxy population and their formation mechanism can be constrained by whether there is a spectral index variation across their twin radio lobe pairs. An absence of such variation will point to an origin in a central unresolved binary of supermassive black holes. Hence, spectral index was mapped for a well-defined sample of 25 XRGs, by combining their 1.4 GHz Very Large Array (FIRST survey) and upgraded Giant Metrewave Radio Telescope maps with their 144 MHz maps (LOFAR LoTSS DR2). This yielded the best combination of sensitivity, angular resolution, frequency range, and sample size for spectral mapping of any XRG sample. A rich diversity of spectral index patterns was revealed, but at most one case was found where a secondary lobe (wing) exhibits a flatter spectrum compared to its associated primary lobe (see 2.13). This suggests that such a spectral pattern is exceedingly rare and by no means a common trait of XRGs.

Bar and inner disk in the collisional ring galaxy Cartwheel

Galaxy kinematics in the Cartwheel Galaxy was studied using the MUSE IFS data. The line-of-sight velocity distribution (LOSVD) function for this collisional ring galaxy was constructed with line-of-sight velocity (V), velocity dispersion (σ), and h_3 and h_4 Gauss-Hermite moments, and the spatial maps of the first three were made for the inner part. The flux map shows a central disk and a prominent ring structure around it

(Figure 2.14), inside which, another ring-like structure was noticeable around the central disk. Values of h_3 mostly ranged between -0.15 to 0.10 with a slightly lopsided distribution with respect to the zero velocity line seen in the LOS velocity map. The observed correlation between h_3 and V for the bar region points to the highly eccentric stellar orbits preferably seen within a bar. The V/σ values also match with the typical value for a bar. The nature of correlation holds well for the approaching side, but shows deviations in the receding part which has a region with enhanced dispersion velocity falling. The kinematic features in this study supports the presence of a bar in this galaxy.

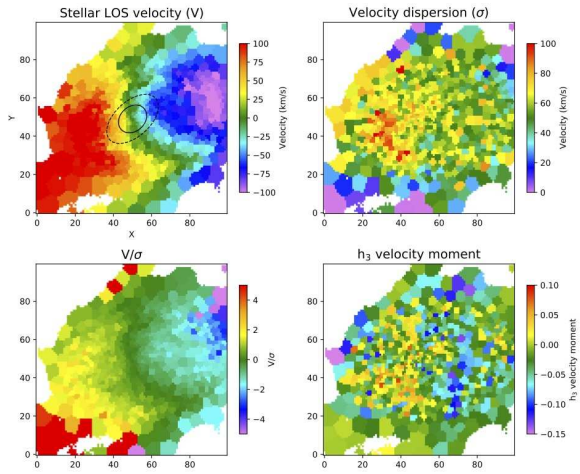

Figure 2.14: *Stellar V distribution for the inner region of Cartwheel (top left) from the MUSE data cube (bar and bulge shown as dashed and solid black curves). The (σ; top right), V/σ (bottom left), and h_3 velocity moment (bottom right) maps are shown for the same region. (Figure Courtesy: Mondal C. and Barway S., 2024, A&A, 681A, 53)*

Star formation history of Cartwheel Galaxy using Astrosat/UVIT

The star formation history of Cartwheel Galaxy since it suffered the ring-making collision was studied using high resolution images from UVIT/Astrosat along with the complementary archival optical and infrared data. The FUV emission of the Cartwheel is principally concentrated in the star-forming outer ring, with no trace of emission from the nucleus and inner ring. A few sources are detected in the region between the position of the nucleus and the outer ring, which all lie along the spokes (see Figure 2.15). All UV-selected regions in the ring contain more than one population of stars, with the bulk of the FUV emission coming from non-ionising stars, formed over the last 20 to 150 Myr. The mass of the older populations is found to be $\sim$25 times more than that of the populations producing the ionization. On the other hand, regions belonging to the spokes have negligible current star formation, with the age of the dominant older population systematically increasing as its distance from the outer ring increases. The presence of populations of a wide range of ages in the ring suggests that the stars formed in the wave in the past were dragged along it to the current position of the ring. The galaxy show an average steady star formation rate of 5 $M_\odot\,yr^{-1}$, over the past 150 Myr, with an increase to 18 $M_\odot\,yr^{-1}$ in the recent 10 Myr.

Effect of a bar on fueling of supermassive black holes: IllustrisTNG100

To understand the role of the bars in the growth of central supermassive black hole mass and its implications on AGN fueling, a study was conducted using IllustrisTNG100 cosmological MHD simulations. The primary sample consists of 1191 barred galaxies and 2738 unbarred galaxies. An unbiased sample was used with an equal number of barred and unbarred galaxies, over a wide controlled parameter space.

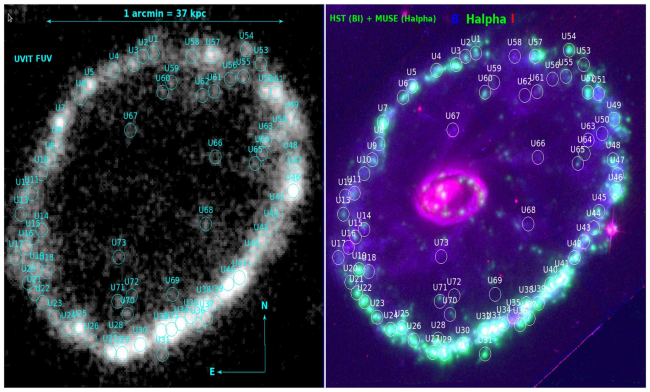

Figure 2.15: *FUV compact sources identified in the UVIT FUV image (cyan). Right: RGB image formed using HST/WFPC2 F450W (blue), VLT/MUSE Hα(green), and HST/WFPC2 F814W filters. (Figure Courtesy: Y. D. Mayya, Barway S., et al, 2024, MNRAS, 527, 2816.)*

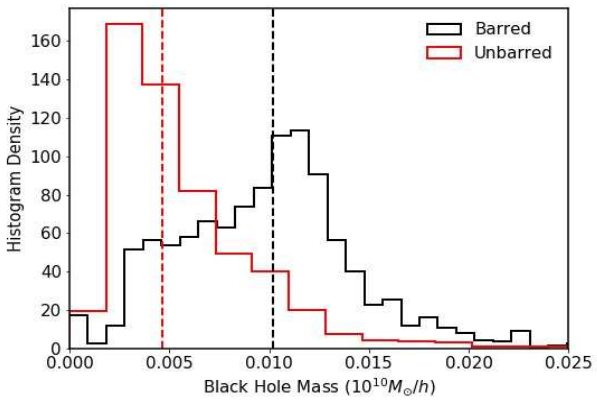

Figure 2.16: *The black hole mass distribution of full barred (black) and unbarred sample (red) at z = 0 shows the dichotomy, vertical lines: median values. (Figure Courtesy: Kataria S., Vivek M; 2024, MNRAS, 527, 3366)*

The median black hole mass and stellar mass distribution for barred galaxies was found to be higher than that of the unbarred ones, indicating that stellar mass is a key parameter influencing the black hole growth (see Figure 2.16). The higher mean accretion rate of the black holes in barred galaxies, averaged since the bar forming epoch (z∼2), explains the higher mean black hole masses in barred galaxies. These findings are not affected by other environmental processes like minor/major merger histories and neighboring gas density of black hole. Although the relationship between stellar mass, bar formation, and black hole growth is complex, the present study show that the bars can play a crucial role in feeding black holes, particularly in galaxies with massive stellar disks.

Effect of low-mass galaxy interactions on their star formation

In order to better understand the effect of interactions between dwarf galaxies on their evolution, their effect on star formation rate (SFR) was studied. SFR for 22 interacting and 36 single gas-rich dwarf galaxies in the Lynx Cancer Void region was estimated, using their FUV images from GALEX (see Figure 2.17).

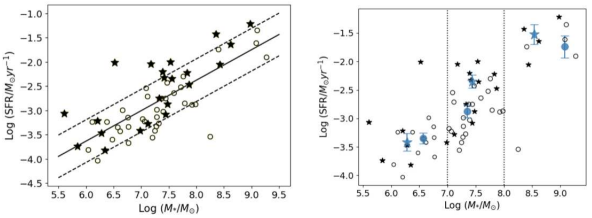

Figure 2.17: *The current/instantaneous SFR vs $M_\star$ for low mass galaxies (black stars: interacting, and open circles: isolated galaxies). Dotted lines (right) show the mass bin of $10^{7-8}M_\odot$. (Figure Courtesy: Subramanian, S., Mondal, C., Kalari V., 2024, A&A, 681, 8Y)*

The SFR for interacting systems was found to be 3.4±1.2 times higher compared to

single dwarf galaxies in the stellar mass range of 10^7-10^8 $M_\odot$. In spite of the small sample, this study provides the first quantitative insights into the nature of interactions of dwarf galaxies in sub-10^8 $M_\odot$ regime and increased the number of interacting dwarfs in the local Universe studied in the FUV, and are similar to predictions from simulations at lower redshifts. Better UV data will help understand the effect of dwarf galaxy interactions on the spatial distribution of star forming clumps and to identify star formation in tidal tails.

Discovery of a large sample of dual AGNs

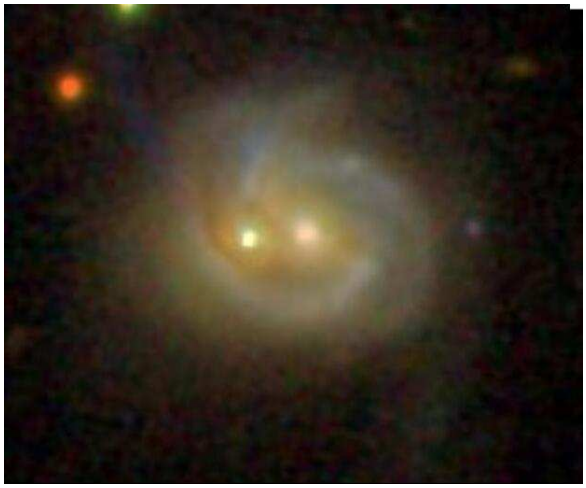

Figure 2.18: *SDSS color composite image of a dual AGN MRK739 galaxy. (Figure Courtesy: Anwesh Bhattacharya, Nehal, C.P., Mousumi Das, Snehanshu Saha, Francoise Combes; 2023, MNRAS, 524, 3, 4482)*

A pipeline for automated detection of Double Nuclei Galaxies using Gothic was created, leading to the discovery of a large sample of Dual AGNs. The code that was developed, called GOTHIC, can detect two or more peaks in images of galaxies (see Figure 2.18). Using this sample, 159 dual AGNs have been detected, which represents a large sample of accreting supermassive black hole (SMBH) pairs. Studying these progenitors of binary SMBHs and their host galaxies can reveal the properties of the host nuclei and the evolutionary path followed by galaxies to form binary SMBHs. These dual AGN are mainly found in red, evolved galaxies which may imply that star formation is quenched, as dual AGNs form in galaxy mergers.

Comparative study of star forming dwarf galaxies using UVIT

A survey of star formation in 16 nearby dwarf galaxies was conducted using UVIT/AstroSat. These galaxies can be classified as dwarf spirals, irregulars and blue compact dwarfs. The star forming main sequence was found to vary across these different types, with the dwarf spirals being closer to massive galaxies in the nature of their star formation, whereas the irregulars are closer to low surface brightness galaxies in their main sequence (see Figure 2.19).

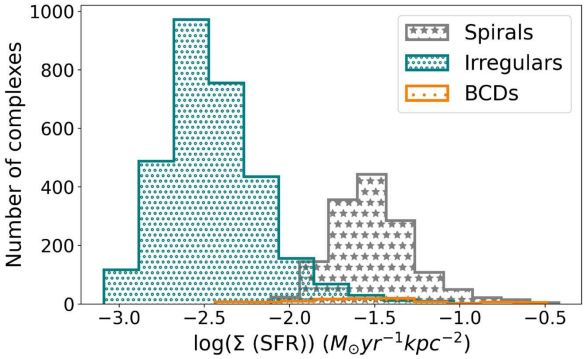

Figure 2.19: *Distribution of log[Σ(SFR)] for star forming complexes of all sample galaxies (except NGC 6822). (Figure Courtesy: Amrutha S., Das, Mousumi, Jyoti Yadav; 2024, MNRAS, 530, 2199)*

Probable low-frequency QPOs in ZTF blazars

The possible presence of quasi-periodic

oscillation (QPO) signals in 2103 blazars from the Zwicky Transient Facility (ZTF) time-domain survey was investigated. A low-frequency QPO signal is detected in five blazars observed over 3.8-yr-long optical r-band ZTF light curves. Figure 2.20 show a QPO detected in blazar J092915+501336. These periods range from 144-196 days, detected at 4σ significance levels, in both the Lomb–Scargle periodogram and weighted wavelet Z-transform analyses. A consistent result is found using the phase dispersion minimization technique. A QPO signal was also detected in the g-band at 3σ. Such signals most likely originate from a precessing jet with a high Lorentz factor, closely aligned to the observer's line of sight, or the movement of plasma blobs along a helical structure in the jet.

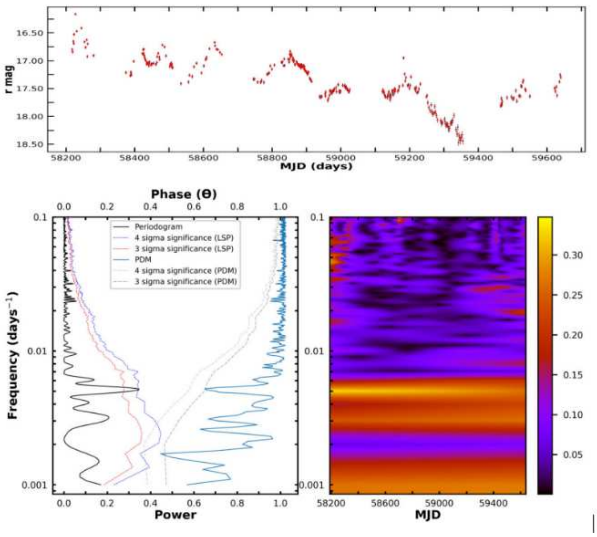

Figure 2.20: *Top: 3.8 yr long r-band ZTF light curve of blazar J092915+501336. Bottom left: A 4σ peak in the r-band light curve, suggestive of a QPO at 0.0051 d^{-1}. Bottom right: its weighted wavelet Z-transform. (Figure Courtesy: Banerjee, A., Negi, V., Joshi, R. et al., 2023, MNRAS, 526, 5172)*

CatNorth: An Improved Gaia DR3 Quasar Candidate Catalog

A new study presents CatNorth, an improved Gaia Data Release 3 (Gaia DR3) quasar candidate catalog with more than 1.5 million sources in the 3π sky built with data from Gaia, Pan-STARRS1, and CatWISE2020. The XGBoost algorithm was used to reclassify the original Gaia DR3 quasar candidates as stars, galaxies, and quasars. An ensemble classification model is obtained by averaging two XGBoost classifiers trained with different master stellar samples.

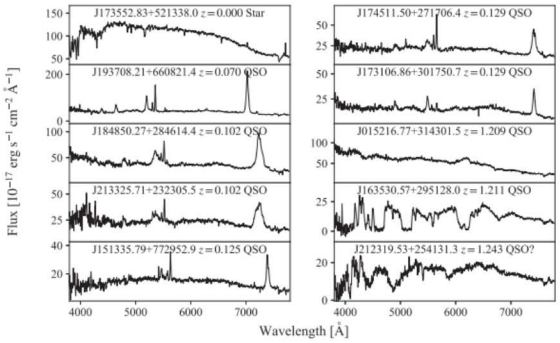

Figure 2.21: *The HCT spectra of 10 newly discovered galactic plane quasars (GPQ) in HCT-CatNorth GPQ survey. (Figure Courtesy: Fu, Y., ... Joshi, Ravi, et al.; 2024, ApJS, 271, 54)*

A large sample of 1,545,514 reliable quasar candidates was retrieved from the parent quasar candidate catalog, all of which were then provided photometric redshifts. For a subset of 89,100 candidates, accurate spectroscopic redshifts are estimated with the convolutional neural network from the Gaia BP/RP spectra. Additionally, a pilot spectroscopic survey based on 2m HCT/IAO proved that the CatNorth catalog has a high purity of ∼90%, while maintaining high completeness (see Figure 2.21). The CatNorth catalog is used as the main source of input

catalog for an upcoming Large Sky Area Multi-Object Fiber Spectroscopic Telescope phase III quasar survey, which is expected to build a highly complete sample of bright quasars with $i < 19.5$.

Minutes-duration optical flares with supernova luminosities

Certain luminous extragalactic optical transients have been observed to last only a few days, which implies a different powering mechanism from the most common, viz., supernovae, which have weeks long timescales. Some short-duration transients, most notably AT2018cow, show blue optical colours and bright radio and X-ray emission. Several AT2018cow-like transients have shown hints of a long-lived embedded energy source, e.g., X-ray variability, prolonged UV emission, tentative X-ray QPO, and large energies coupled to fast (but sub-relativistic) radio-emitting ejecta. The present study reports observations of minutes-duration optical flares in the aftermath of an AT2018cow-like transient, AT2022tsd (the 'Tasmanian Devil'). These occur over many months, are highly energetic and are probably non-thermal, implying that they arise from a near-relativistic outflow or jet. These observations confirm that, in some AT2018cow-like transients, the embedded energy source is a compact object, either a magnetar or an accreting black hole (see Figure 2.22).

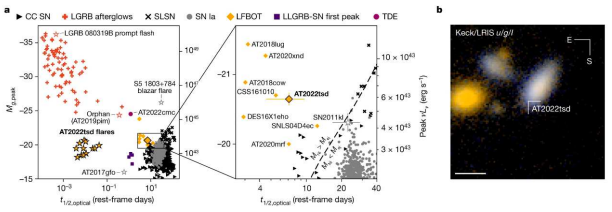

Figure 2.22: *Left: duration above half-maximum light vs. peak M_V of AT2022tsd, its flares and other extragalactic transients. Right: Keck/LRIS $u/g/I$ image centred on AT2022tsd. (Figure Courtesy: Ho, A.Y.Q., ..., Anupama G.C., Supachai A., Barway S., et al, 2023, Nature, 623, 927)*

2.4 Theoretical Astrophysics and Cosmology

The research of the theoretical astrophysics group ranges from studying the evolution of the Universe from the Big Bang to late time cosmology, astrophysical magnetic fields, radiative transfer processes, exoplanets, black holes and gravitational dynamics.

Angle-dependent partial frequency redistribution model

The polarization signal in resonant spectral lines in stellar atmospheres is particularly affected by scattering from thermal electrons, which intertwines the frequencies and directions of incident and scattered photons. The full description, involving angle-dependent partial frequency redistribution (AD-PRD), is computationally challenging and hence Angle Averaged PRD is often used as an approximation.

In a new study, numerical methods were developed to solve the full AD-PRD, which also accounts for sphericity effects that are important in highly extended stellar atmospheres. These were done for polarized transfer in spherically symmetric extended and expanding atmospheres including resonance line and electron scattering. Due to the heavy computational load, optically thin isothermal spherical medium with different extensions and an inverse square law opacity distribution was considered. It was shown that the linear polarization is highly sensitive to the choice of AD-PRD versus AA-PRD

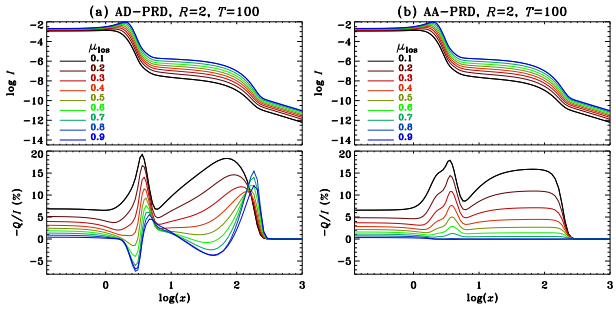

Figure 2.23: *Center-to-limb variation of the emergent intensity (top panels) and linear polarization (bottom panels) profiles computed with AD-PRD (panel (a)) and AA-PRD (panel (b)). Each line is for a different los. Figure courtesy: Sampoorna M. et. al. MNRAS, 526, 6004–6014, 2023*

(see Figure 2.23), with significant differences being seen in both amplitude and shape, and AD-PRD effects being relatively larger for a line of sight (los) closer to the disc centre.

Hanle Effect with AD-PRD in 3D media

Polarized radiative transfer (RT) was solved in three-dimensional media with angle-dependent partial frequency redistribution (AD-PRD), for the first time. The results from 2D and 3D polarized RT were compared. By comparing with the results of angle-averaged PRD it was demonstrated that 3D RT is important for magnetic field diagnostics in the solar atmosphere (see Figure 2.24).

Fluctuation dynamos in compressible turbulent flows

The exact manner in which fluctuation dynamos saturate, particularly in compressible flows, remain unclear. A new route for dynamo saturation has now been identified, based on the role of magnetic pressure forces. It was shown that irrespective of the compressibility of the flow, the growing magnetic pressure forces resist compression of flux tubes and lead to regions of strong magnetic flux emptied out rather than a decrease of their cross-sectional areas. Further, this lead to an anti-correlation between the density and magnetic field strengths in subsonic flows.

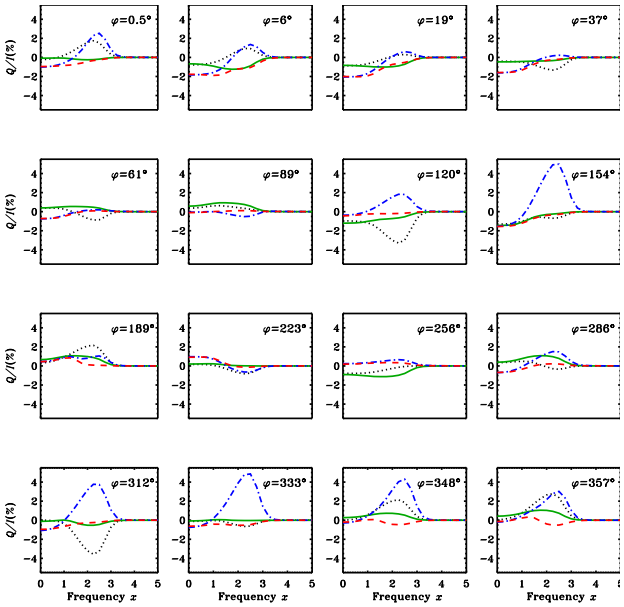

Figure 2.24: *Hanle effect with PRD showing emergent spatially averaged Q/I profiles with AA-PRD in 2D (dashed lines) and 3D (solid) media and AD-PRD (2D: dot-dashed and 3D: dotted lines). 16 different azimuth values are marked on each panel. Figure courtesy: Anusha. et. al., ApJ, 949, 84, 2023.*

However, in supersonic flows, due to stronger compressive motions, density and magnetic field strength continue to remain positively correlated, with the degree of positive correlation decreasing as the dynamo saturates. It was also shown that while field line stretching is dominant in saturating the dynamo in subsonic flows, the picture is different in supersonic flows. Here both line stretching and compression amplify the field initially. But growing magnetic pressure opposes further

compression of magnetic flux which tends to reduce the compressive motions. This mechanism is now shown to be of importance, especially in astrophysical systems hosting compressible turbulent flows. (see Figure 2.25).

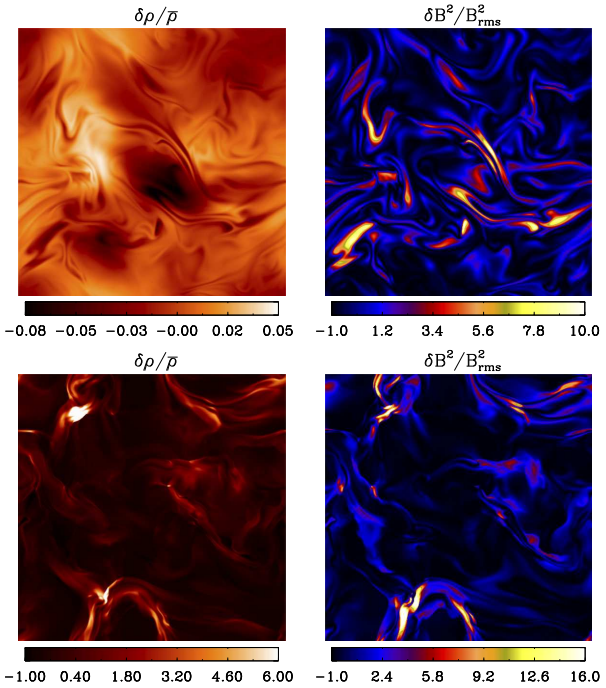

Figure 2.25: *2D slices of fluctuations in density (left column) and magnetic energy (right column) during saturated dynamo state from subsonic (top row) and supersonic simulations (bottom row). Figure courtesy: S. Sur et. al., MNRAS, Vol 527, 3968-3981, 2024.*

Non-gaussianity in all-sky forgrounds

The statistical properties of various all-sky Galactic foreground emissions at different wavebands (from WMAP, Planck and Stockert-Villa) were studied, with particular focus on synchrotron emissions, and the nature and level of non-Gaussianity were determined for each case. The variation with observing frequency of the statistical properties encoded in the morphological properties of the fluctuations was studied. The study provided two important improvements compared to the usual power spectrum analysis. The first is that of a more detailed comparison of the performance of different simulation pipelines with observed data, paving the way for more realistic models of Galactic synchrotron emissions. Secondly, it provided physical information contained in higher moments of the synchrotron map, which in turn helps to compare the performance of different component separation pipelines of Galactic foregrounds in a more stringent way.

Multifractal analysis of Crab nebula

The morphological structural complexity of the Crab nebula was investigated using the technique of 2D multifractal detrended fluctuation analysis, using publicly available radio frequency images. The data exhibits long-range correlations as expected, and they were found to follow a power-law scaling with length scales. The structural complexity was found to be multifractal, as evidenced by the dependence of the generalized Hurst exponent on the order of the moments of the detrended fluctuation function. The analysis was repeated on shuffled data to further probe the origin of the multifractality. The probability density was found to be close to a Gaussian, implying an origin due to the differing nature of long-range correlations of the large and small detrended fluctuation field values. The multifractal parameters were investigated across different partitions of the radio image, and the highly heterogeneous structures across the image show that the object is structurally quite complex, providing a fresh perspective on its morphology from a complexity science viewpoint. (see Figure 2.26).

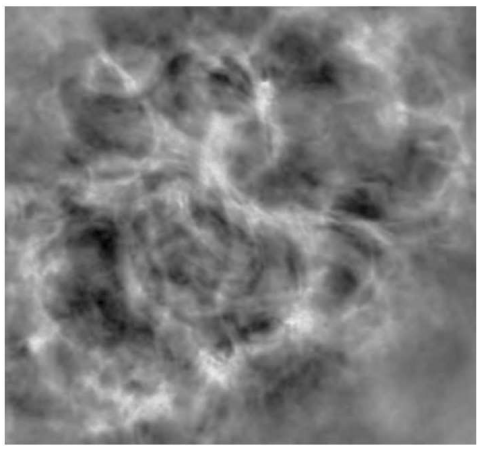

Figure 2.26: *VLA image of Crab nebula at 4.76 GHz. (Figure courtesy: A. L. Chanu, et. al., Journal of Physics: Complexity, 5, 1, 2024).*

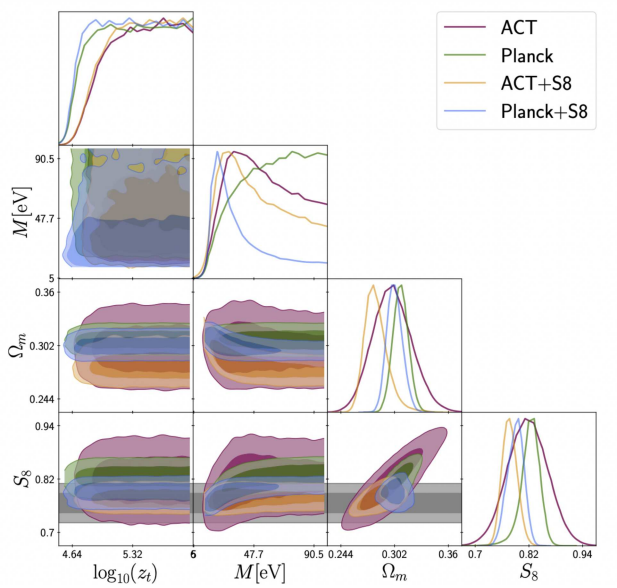

Figure 2.27: *Reconstructed 2D and 1D marginalized posterior distributions (S8 from weak lensing as grey bands). Figure courtesy: A. Das et. al., Phys. Rev. D, 108, 083501*

Light mass warm dark matter models

Light mass warm dark matter is an interesting and viable alternative to the cold dark matter paradigm, and especially those of mass-varying models where the dark matter mass varies with time during its cosmic history. This is realized in multiple particle physics models. Cosmological constraints were studied on such a model where the dark matter mass transitions from zero to a finite value in the early Universe. The matter power spectrum was found to exhibit power suppression below a scale that depends on the epoch of transition, and the angular power spectrum of the CMB shows a distinctive phase shift. The latest CMB and the weak lensing data were used to place lower limits on the transition redshift and ease the S_8 tension, unlike the warm dark matter model.

This analysis also facilitates a marginal detection of the dark matter (DM) mass. While Planck data alone is seen to reduce the S_8 tension to $\sim 2\sigma$, it does not sufficiently constrain the DM mass. However, when combined with the S_8 measurement from $KIDS1000 + BOSS + 2dfLenS$, it decreases to $\sim 1.3\sigma$, and a DM mass is detected at $41.7^{+7.81}_{-27.5} eV$. An analysis combining ACT data and weak lensing, results in a more pronounced reduction in the tension to $\sim 0.4\sigma$, alongside a higher detected mass of $51.2^{+16}_{-33.5} eV$. A better fit was found to the combined data compared to the ΛCDM model. (see Figure 2.27)

Possible role of Early Dark Energy

The effect of a possible dynamical Early Dark Energy (EDE) in cosmology was explored, with a parametrised equation of state differing considerably from cosmological constant (cc, w = -1), varying both the initial w_i and final w_f e.o.s of the EDE fluid. It was found that the present data have a mild preference for non-cc EDE ($w_i = -0.78$)

using Planck+BAO+Pantheon+SH_0ES data sets, leading to $\Delta\chi^2_{\rm min}$ improvement of -2.5 at the expense of one more parameter. w_i (< -0.56 at 1σ) is only weakly constrained. Though allowing for $w_i \neq$ -1 can help decrease the σ_8 parameter, this decrease is only $\sim 0.4\sigma$ and σ_8 is still larger than weak lensing measurements. While promising, a dynamical EDE cannot resolve both H_0 and σ_8 tensions simultaneously (see Figure 2.28).

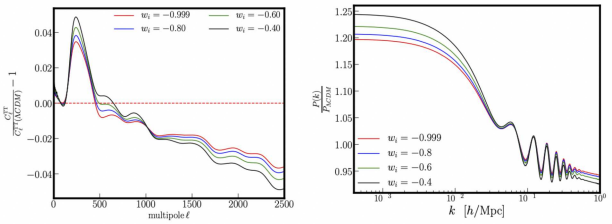

Figure 2.28: *Effect of varying w_i on CMB TT (left) and matter (right) power spectra. Figure courtesy: R. K. Sharma et. al., Phys. Rev. D 109, 043530*

Sterile dark matter models

Small-scale structure constraints were presented on sterile dark matter (DM) produced from a heavy mediator particle, inspired by models of moduli decay. Such DM can contribute to the entire dark matter energy density but the particles have a non-thermal phase-space distribution; however, the resulting linear matter power spectra can be mapped to effective thermal-relic warm DM models. This production mechanism is hence subject to warm DM constraints from small-scale structure through ultra-faint dwarf galaxy abundances and strong gravitational lensing flux ratio statistics. The correspondence to thermal-relic models was used to derive a lower bound on the non-thermal particle mass of 107 keV, at 95% confidence. These are the most stringent constraints derived on sterile dark matter produced via the heavy mediator decay scenario.

Helicity fluctuations in turbulent flows

The correlation times of velocity and kinetic helicity fluctuations in various hydrodynamic turbulent flows were studied, including rotating, shearing, Keplerian, and shearing burgulence (a simplified model of compressible flow). The motivation is to understand the potential mechanisms driving large-scale dynamos in these flows, particularly the incoherent alpha effect, which relies on the separation of timescales between velocity and helicity fluctuations.

Applying information geometry to black holes

Dynamical aspects of information geometry were applied to thermodynamic geometry of black holes. Information geometry treats statistical models as Riemannian manifolds, and this is seen in the form of thermodynamic geometry which usually derives from entropy acting as the potential function. Dual gradient flows from information geometry were compared to equations from classical mechanics, Riemannian metrics were derived and compared with optical metrics. Using a classical mechanics perspective describing Hamiltonian mechanics using a constraint, the duality was compared with a canonical transformation. How the deformation of the gradient flows leads to a linear modification of the Riemannian metric known as the Randers-Finsler metric, and the distorted results that follow, were studied. Testing was done on the formulation for consistency with and without deformation in the example of the Gaussian model. Finally, black hole thermodynamics was discussed, where depending on the type of the black hole, one deals with either Ruppeiner or Weinhold geometry, which are conformally related to each other.

Results were applied for the Riemannian information metric to describe dynamical evolution of thermodynamic geometry for Kerr and Reissner-Nordström black holes.

LUA trajectories & black hole shadows

An interesting connection was explored between the shadow parameters for black holes in static spherically symmetric geometries and the acceleration bounds for radial linear uniformly accelerated (LUA) trajectories, which are the curved spacetime generalization of Rindler trajectories, in the black hole background. These parameters were calculated explicitly for specific black hole solutions in d-dimensional Einstein's theory of gravity, in pure Lovelock theory of gravity, and in the $\mathcal{F}(R)$ theory of gravity. It was found that the photon sphere radius r_{ph} is equal to the lower bound on radius of closest approach r_b of the radial LUA trajectory in-coming from past infinity while the shadow radius r_{sh} is equal to the inverse magnitude of the acceleration bound $|a|_b$ for the LUA trajectory to turn back to future infinity. Using the effective potential technique, it was further shown that the same relation is valid in any theory of gravity for static spherically symmetric black hole geometries.

2.5 Experimental Astrophysics and Instrumentation

The members of this group engage in research and developmental activities that augment the institute's overall research environment. These include devising and performing new experiments in the laboratory, characterising components of a new instrument, designing new instruments, laying the groundwork for plausible future projects, and developing novel data reduction software that not only mitigates the shortcomings of the data obtained with instruments but also act as a tool to analyze the data.

Calibration of VELC detectors onboard Aditya-L1 mission

Visible Emission Line Coronagraph (VELC) on board Aditya-L1 is an internally occulted coronagraph with four channels to image the solar corona at 5000 Å and to pursue spectroscopy at 5303 Å, 7892 Å and 10747 Å channels. In addition, the IR channel (10747 Å) is capable of carrying out the spectro-polarimetric observations. Therefore, VELC has three sCMOS detectors and one InGaAs detector.

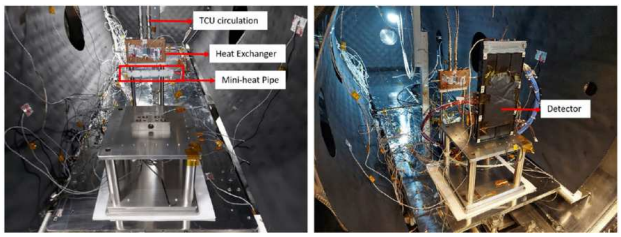

Figure 2.29: *Left: cooling plate interface calibration unit; Right: Detector Head Assembly after mounting in Thermo-Vac Chamber. Figure courtesy: Mishra et. al., Experimental Astronomy (2024) 57:7*

Thermo-vacuum calibration tests (Figure 2.29) of all the flight model detectors were carried out at IIA's CREST campus. Conversion gain, full-well capacity, and readout noise at different temperatures were measured and reported. Based on the results, it was thus concluded that it is essential to operate the sCMOS detectors and InGaAs detector at $-5°$ and $-17°$ C, respectively, at the spacecraft level.

Optics design trade-off for INSIST

INdian Spectroscopic and Imaging Space Telescope (INSIST) is the proposed next generation UV-optical space telescope. The INSIST optical design requirements, such as wide field-of-view, high spatial resolution, low background, high sensitivity, clean PSF and large field spectroscopy coupled with the given space envelope and optics constraints, demand an innovative design. A detailed trade-off study with a three mirror an-astigmatic design concluded that an off-axis eccentric pupil design will be the most suitable design. Figure 2.30 shows the INSIST optical layout including the focal volume instruments.

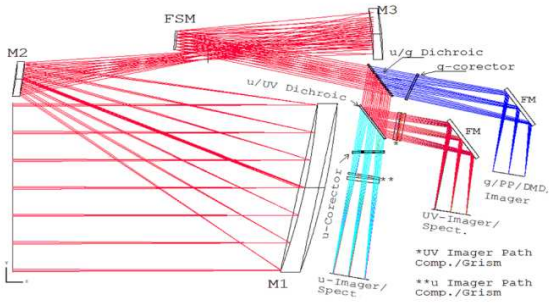

Figure 2.30: *INSIST optical layout shows the focal volume instruments. Figure Courtesy: S. Sriram et. al., JoAA, 2023, 44, 55*

Alignment device for PSMT

The Prototype Segmented Mirror Telescope (PSMT) is a 1.3 m aperture, seven segment telescope, being developed as a technology demonstrator for India's large optical-IR telescope project. A Shack Hartmann sensor based alignment device has been designed and developed for this instrument which not only precisely captures the segment misalignment but also measures the segment focus error with an accuracy of a few microns and hence helps in the tip-tilt correction and co-focusing of the mirror segments. The device will work primarily in (1) Shack–Hartmann mode and (2) imaging mode. The final image quality can be checked in the latter mode after alignment. Its design allowed it to conduct Keck kind of phasing experiment with one pair of mirror segments. To make the device cost effective, only off-the-shelf components are used. The optical design and opto-mechanical analysis of the device were carried out using Zemax and SolidWorks software. The device was realized (Figure 2.31) and its extensive testing was carried out in the laboratory.

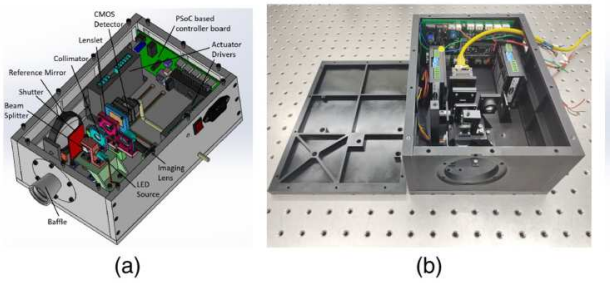

Figure 2.31: *3D mechanical model of (a) the segment alignment device and (b) the realized device. Figure Courtesy: Dharmadhikari, et. al, JATIS, 10, 1, 019002, 2024.*

3

Student Programmes and Training Activities

The Indian Institute of Astrophysics conducts various student training programmes, such as full-time research and short-term visiting programmes. The Board of Graduate Studies (BGS) oversees these programmes. The BGS is responsible for conducting courses and formulating and reviewing these programs' policies, guidelines, and regulations. Currently, IIA runs four Ph.D. programmes and one integrated M.Tech programme. IIA is affiliated to Academy of Scientific and Innovative Research (AcSIR) and is also a major partner in the Joint Astronomy Programme (JAP), organized by the Indian Institute of Science (IISc). The institute also trains students through short-term programs such as the Visiting Students Programme (VSP), the Summer School, and the Summer Project programme.

The four major Ph.D. programmes run by IIA (see Figure 3.1) are the IIA-Pondicherry University (IIA-PU) programme, IIA-Calcutta University (IIA-CU) Integrated M.Tech-Ph.D. Programme, AcSIR Ph.D at IIA (IIA-AcSIR), and IIA-IISc Ph.D. programme under the JAP.

The six-year IIA-CU integrated M. Tech Ph.D. program in instrumentation is unique in that it enables students to understand the principles and practices of science and technology and provides hands-on experience. The program also equips them for potential jobs in the industry.

Figure 3.1: *Various Ph.D. programs run by IIA.*

Admissions to the Ph.D. Programs

IIA admits full-time Junior Research Fellows (JRFs) for the IIA-PU and IIA-AcSIR Ph.D. programmes twice yearly for the January and August semesters. Applications for admission to the IIA-PU Ph.D programme and two externally funded project JRF positions and Integrated M.Tech.-Ph.D. programme were invited through IIA's online admission

portal on 1 May 2023 and closed on 21 May 2023. Admission notifications are published in the national editions of two national newspapers (Times of India in English and Rajasthan Patrika in Hindi). The notification was widely publicized through admission posters sent to various colleges, institutions, universities, and IIA's social media platforms.

In-person interviews were conducted to select students. Three students joined the Ph.D. program, two for the Project JRF positions, and one student joined the Int. M.Tech.-Ph.D. program. Following a similar procedure, applications for admission to the IIA-PU Ph.D. programme for the January semester were invited through IIA's online portal on 27 September 2023. In-person interviews were conducted from 20-21 November 2023. Four JRFs subsequently joined the programme.

One student joined IIA as JRF for the IIA-IISc Ph.D. under the JAP in December 2023.

Table 3.1: *IIA student strength as of 31 March 2024.*

Ph.D. Students	
Junior Research Fellows (JRFs)	32
Senior Research Fellows (SRFs)	40
Post-Doctoral Researchers (PDRs)	21
M.Tech. Students	
2022 (XV-batch)	1
2023 (XVI-batch)	1
Total student strength	**94**

3.1 Ph.D. Degrees Awarded

A total of 12 students were awarded their Ph.D. degrees from April 2023 to March 2024. Details are provided below.

Satabdwa Majumdar was awarded the Ph.D. degree (on 17 April 2023) for the thesis titled *"Kinematics of Coronal Mass Ejections in the Inner Corona and its Coupling with the Heliosphere"* submitted to the Pondicherry University on 27 July 2022. He carried out the above work under the supervision of Dipankar Banerjee.

Soumya Sengupta was awarded the Ph.D. degree (on 10 July 2023) for the thesis titled *"Characterization of the Atmosphere of Extra-Solar Planets"* submitted to the Pondicherry University on 20 May 2022. He carried out the above work under the supervision of Sujan Sengupta.

Suman Saha was awarded the Ph.D. degree (on 28 July 2023) for the thesis titled *"Precise Transit Photometric Studies of Exoplanets and Exomoons"* submitted to the Pondicherry University on 30 September 2022. He carried out the above work under the supervision of Sujan Sengupta.

Tanya Das was awarded the Ph.D. degree (on 6 October 2023) for the thesis titled *"High Precision Spectroscopy Using Stabilized Fabry-Perot Etalon"* to the University of Calcutta on 1 November 2021. She carried out the above work under the supervision of Ravinder K. Banyal.

Athira Unni was awarded the Ph.D. degree (on 13 October 2023) for the thesis titled *"Optical spectroscopy of exoplanets and hosts stars"* submitted to the Pondicherry University on 2 January 2023. She carried out the above work under the supervision of T. Sivarani.

Sahel Dey was awarded the Ph.D. degree (on 14 December 2023) for the thesis titled *"Insights into the Genesis and Dynamics of the Solar Spicule Forest: Aided by Laboratory Experiments"* submitted to the Indian Institute

of Science, Bengaluru on 31 July 2023. He carried out the above work under the supervision of Piyali Chatterjee and Tarun Deep Saini, IISc under the JAP, IISc., Bangalore.

Kshama S. Kurian was awarded the Ph.D. degree (on 22 December 2023) for the thesis titled *"Multiband studies of the AGN-starburst connection"* submitted to the Pondicherry University on 4 November 2022. She carried out the above work under the supervision of C. S. Stalin.

Sharmila Rani was awarded the Ph.D. degree (on 22 December 2023) for the thesis titled *"Investigating the ultra-violet bright stars in star clusters"* submitted to the Pondicherry University on 3 February 2023. She carried out the above work under the supervision of Gajendra Pandey.

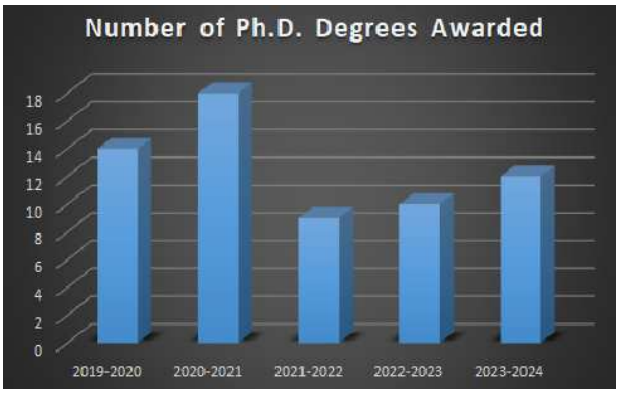

Figure 3.2: *Number of Ph.D degrees awarded year-wise.*

Anirban Dutta was awarded the Ph.D. degree (on 8 February 2024) for the thesis titled *"Unraveling The Nature of Explosion of Thermonuclear Supernovae"* submitted to the Pondicherry University on 31 May 2023. He carried out the above work under the supervision of G. C. Anupama.

Indrani Pal was awarded the Ph.D. degree (on 21 February 2024) for the thesis titled *"Accretion Disk – Corona connection in Active Galactic Nuclei"* submitted to the Pondicherry University on 24 June 2023. She carried out the above work under the supervision of C. S. Stalin.

Fazlu Rahman P. P. was awarded the Ph.D. degree (on 1 March 2024) for the thesis titled *"Investigations of statistical properties of Galactic foreground components and the CMB"* submitted to the Pondicherry University on 30 May 2023. He carried out the above work under the supervision of Pravabati Chingangbam.

Jyoti Yadav was awarded the Ph.D. degree (on 4 March 2024) for the thesis titled *"A UV and Optical Study Formation and AGN Activity using the UVIT and MUSE"* submitted to the Pondicherry University on 30 May 2023. She carried out the above work under the supervision of Mousumi Das.

3.2 Ph.D. Theses Submitted

A total of 10 students submitted their Ph.D. thesis between April 2023 to March 2024. Details are provided below.

Manika Singla submitted the thesis titled *"Characterization of the Atmospheres of Terrestrial Exoplanets"* to the Pondicherry University on 20 April 2023. The research was done under the supervision of Sujan K. Sengupta.

Fazlu Rahman P. P submitted the thesis titled *"Investigations of statistical properties of Galactic foreground components and the CMB"* to the Pondicherry University on 30 May 2023. The research was done under the supervision of Pravabati Chingangbam.

Jyoti Yadav submitted the thesis titled *"A UV and Optical Study Formation and AGN Activity using the UVIT and MUSE"* to the Pondicherry University on 30 May 2023. The research was done under the supervision of Mousumi Das.

Indrani Pal submitted the thesis titled *"Accretion Disk – Corona connection in Active Galactic Nuclei"* to the Pondicherry University on 24 June 2023. The research was done under the supervision of C. S. Stalin.

Deepthi S. Prabhu submitted the thesis titled *"Multi-wavelength study of Hot Stellar Populations in Galactic Globular Clusters"* to the Pondicherry University on 21 July 2023. The research was done under the supervision of Annapurni Subramaniam.

Sahel Dey submitted the thesis titled *"Insights into the Genesis and Dynamics of the Solar Spicule Forest: Aided by Laboratory Experiments"* to the Indian Institute of Science, Bengaluru on 31 July 2023. The research was done under the supervision of Piyali Chatterjee and Tarun Deep Saini, IISc under the Joint Astronomy Programme (JAP), IISc., Bangalore.

Manoj Varma S. V. submitted the thesis titled *"The Solar Ultra-Violet Imaging Telescope: Detector Characterization And On-Board Processing For Flare Studies"* to the University of Calcutta on 22 August 2023. The research was done under the supervision of Nagajaru K.

Ravi Kumar Sharma submitted the thesis titled *"Solving Cosmological Tensions with Neutrino Physics"* to the Pondicherry University on 11 November 2023. The research was done under the supervision of Subinoy Das.

Swastik Chowbay submitted the thesis titled *"Investigating star-planet properties of different exoplanet populations"* to the Pondicherry University on 28 March 2024. The research was done under the supervision of Ravinder K Banyal.

Sioree Ansar submitted the thesis titled *"Investigating the disk-halo connection in galaxies using numerical simulations"* to the Pondicherry University on 28 March 2024. The research was done under the supervision of Mousumi Das.

3.3 M.Tech. Degrees Awarded

One student from the 14th batch of the IIA-CU integrated M.Tech-Ph.D. programme received M.Tech. Degree.

Nitish Singh under the guidance of Bharat K. Yerra and S. Sriram submitted the M.Tech. Thesis titled *"Wide-field fiber-fed system for the multi-object spectroscopy with VBT"* to the University of Calcutta on July 2023.

3.4 Visiting Students Programme

The Visiting Student's Internship Programme is conducted by the IIA to promote scientific temper among college and university students. Students selected for this programme work on specific projects that form a part of the ongoing research at IIA. Based on the nature of the project, the students are asked to work either at the main campus of IIA in Bangalore or its field stations. Students pursuing their Ph.D. in universities and willing to visit IIA for collaborative research are also encouraged to apply for this programme. From April 2023 - March 2024, 121 students carried out projects under this

programme (details are provided in Table 3.2).

3.5 Kodaikanal Summer School

BGS conducts an introductory summer school in Astronomy and Astrophysics for students pursuing or recently completed their M.Sc./ M.Tech/ B.Tech degree in astronomy, physics, maths, or engineering, at Kodaikanal Solar Observatory every year. It is designed to introduce students to the fundamentals of astrophysics as well as recent developments in the field, and assumes familiarity with basic physics, but no previous astronomy knowledge. Due to the overwhelming response for the in-person school, a separate online school is also conducted to reach more students.

This year, the in-person school was conducted from 22-30 May 2023, and the online school was conducted from 31 May - 3 June 2023. 300 students attended the online program, and 40 attended the in-person program.

3.6 Awards and Recognitions

Annu Bura - *Best Poster Presentation award in the category of Solar and Planetary Sciences*, National Space Science Symposium (NSSS), Goa University (26 Feb-1 Mar 2024).
Poster title: *"Investigating the formation and dynamics of unresolved fine structure loops"*

Manjunath Bestha - *Early Career Researcher Award in the category of Exoplanets and Habitability*, International Conference on Planets, Exoplanets, and Habitability, Physical Research Laboratory, Ahmedabad (5-9 February 2024).
Poster title: *"Transmission Spectroscopy with 2m Himalayan Chandra Telescope"*

Parvathy M. - *Best Poster Award in the category of Sun, Solar System, Exoplanets, and Astrobiology*, 42nd annual meeting of the Astronomical Society of India, IISc, Bengaluru (31 January - 4 February 2024).
Poster title: *"Simulating the exo-ring spectra with solar system observations"*

Payel Nandi - *Astrosat Award for the Best Publication of the Year using Indian Space-Based Facilities*, 42nd annual meeting of the Astronomical Society of India, IISc, Bengaluru (31 January - 4 February 2024).
Article title: *"Star Formation in the Dwarf Seyfert Galaxy NGC 4395: Evidence for Both AGN and SN Feedback?"*

Rishabh Singh Teja - *Best Paper Presentation (Oral) Award in the category of Astronomy and Astrophysics*, National Space Science Symposium (NSSS), Goa University (26 February - 1 March 2024).
Paper title: *"Nearest supernova in decade 2023ixf: Rapid multi-wavelength follow-up & analysis using space & ground-based facilities"*

Shubham Ghatul - *Best poster award*, Modern Engineering Trends in Astronomy (META) Conference, RRI Bengaluru (1-4 November 2023).
Poster title: *"MaceBerryCam: Development of a Raspberry Pi based star camera for MACE telescope at Hanle"*

Table 3.2: *Details of the student training programmes for 2023-2024.*

#	**Programmes**	**Num**
Visiting Student Programme (VSP)		
1	Projects under GC-I, GC-II, and GC-III	96
2	Projects under the System Engineering Group	8
3	Projects under the Library (at Bangalore and KSO)	3
4	SERB-POWER Fellowship grant (of Annapurni Subramaniam)	2
5	SERB MATRICS grant (of Mousumi Das)	2
6	SRB project grant (of Vema Reddy)	2
7	Ramanujan Fellowship grant (of Santanu Mondal)	2
8	ITCC/TMT-India Project	2
9	DST-INSPIRE Fellowship	2
10	DST SERB project grant (of C. Muthumariappan)	1
11	DST Rajasthan Karya Scheme	1
12	KSO Winter School project	1
13	Indian Academy Sciences Fellowship	13
14	Pondicherry University M.Sc Projects at IIA	7
Kodaikanal Summer School		
1	In-person participation	40
2	Online participation	300
Total		**482**

Figure 3.3: *Kodaikanal Summer School 2024 participants.*

4

Observatories and Facilities

4.1 Observatories

IIA operates a number of observatories across India, the oldest being the Kodaikanal Solar Observatory followed by the Vainu Bappu Observatory, both in Tamil Nadu. IIA operates the Gauribidanur Radio Observatory in collaboration with Raman Research Institute. It also operates the Indian Astronomical Observatory in Hanle, Ladakh. The CREST campus in Hosakote hosts hosts HCT operations, India-TMT Optics Fabrication Facility, and the MGK Menon Lab for Space Sciences. In addition, IIA hosts the UVIT and VELC Payload Operation Centres.

4.1.1 Indian Astronomical Observatory (IAO)

The Indian Astronomical Observatory (IAO) Hanle, Ladakh, has four major telescopes along with a number of smaller telescopes and site-characterization instruments. In collaboration with other organizations in the country, many new facilities (e.g. NETRA, TeraHertz Telescope, Stereo MACE, TACTIC, SST 1m) are planned.

Himalayan Chandra Telescope (HCT)
The 2-m Himalayan Chandra Telescope (HCT) was opened for the astronomical community more than 20 years ago. The available instruments for imaging and low resolution spectroscopy in optical and near infrared (NIR) and high resolution spectroscopy in optical, provides the best combination of instrumental set-up which a 2-m class telescope can offer. The ease of switching between the mounted instruments during the observations, provides an opportunity of near-simultaneous observations in optical and NIR bands. Due to its unique capabilities and excellent sky condition at Hanle, the number of proposals requesting for observing time on HCT is increasing. For the cycles 2023-Cycle-02 (May-August 2023), 2023-Cycle-03 (September-December 2023), and 2024-Cycle-01 (January-April 2024), a total of 56, 57, and 63 proposals were received. The telescope time was over subscribed on an average by a factor 3, while the dark moon period was over subscribed by a factor ~ 3.5. Further, this has resulted in a good number of science publications coming out from this facility in reputed journals.

The Institute takes extreme care in maintaining this remotely located facility so that it is available to the astronomical community through out the year. IAO and CREST staff carry out monthly preventive maintenance around full moon, when the telescope and instruments are inspected, and telescope related calibrations and look-up tables are updated, with minimum downtime. A

comprehensive annual maintenance of the facility was carried out during 24 August - 8 September 2023. The telescope, dome, back-end instruments, and control computers were cleaned and thoroughly examined, the primary and secondary mirrors were cleaned with distilled water, and their alignment and surface uniformity were checked using the Shack-Hartmann test. All home switches, limit switches, and other safety provisions were tested, and the encoder tape heads were cleaned and signal strength was checked. A surge protection device was installed at the AC input power for HFOSC and the autoguider. The dewars were evacuated. After these maintenance activities, the performance of the telescope and back-end instruments were confirmed and the telescope was released for regular observations.

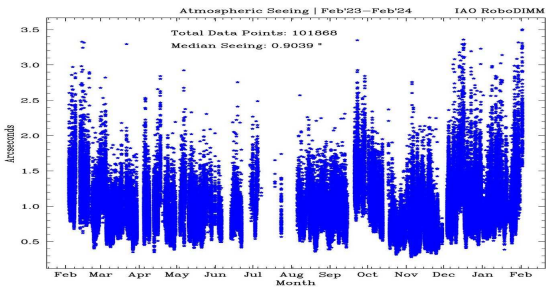

Figure 4.1: *Distribution of atmospheric seeing during Feb 2023-2024, IAO Hanle.*

50cm telescope

The 50cm equatorial telescope was refurbished in-house by the IAO engineering team. The Telescope Control Software (TCS) which controls the telescope and the Observatory Control System (OCS), responsible for controlling filter wheel, detector, dome, weather station and safety mechanisms were also developed and tested for trouble free operation. The telescope underwent rigorous testing during this period and some test observations were also performed. Since a telescope of this moderate size is most suitable for photometric monitoring of bright sources, at present observations for two key science programs, namely Young Stellar Objects (YSO's) and Active Galactic Nuclei (AGN's) are ongoing.

DIMM telescope

A portable fully automated Differential Image Motion Monitor (DIMM) seeing monitor was developed using a 12-inch Meade telescope, 52 fps LucidVision CMOS Camera, custom made wedge prism, and a DIMM mask. For the automated operation of the telescope, the required control software was written in-house. The objective is to use this as a portable seeing monitoring system at sites for potentially bigger telescopes. The first observation was carried out on 31 January 2023 and at present the system is working at Digpa Ratsa Ri. The result of the one year run is presented in Figures 4.1 & 4.2.

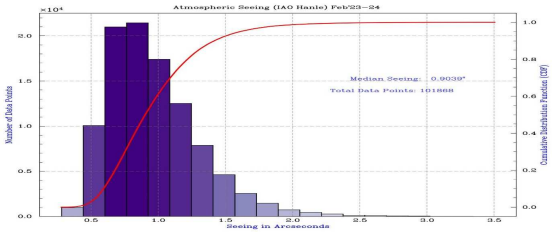

Figure 4.2: *Histogram of atmospheric seeing during Feb 2023-2024, at IAO Hanle.*

The control software for a 16-inch direct drive telescope is being developed at IAO. This telescope is planned to be used for measuring seeing as well as studying the vertical turbulence profile at the site. This complete setup is known as the Multi Aperture Scintillation Sensor (MASS) Differential Image Motion Monitor (DIMM). The control system of this telescope is developed using a Parker Automation multi-axis Controller (PAC320).

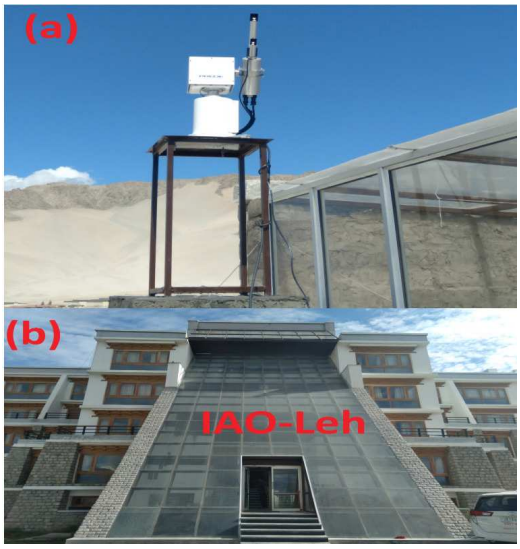

Figure 4.3: *Image of robotic Sun-sky radiometer installed at IAO, Leh*

The high-level telescope control software was written in C++ and Python.

Atmospheric earth science at Ladakh

IIA has its ongoing astronomical site characterization program on the studies of astro-climatological parameters over Hanle and Merak sites. Under this program, to study aerosol optical and radiative properties in multiwavelength solar spectrum, a Sun-sky radiometer (POM-01, Prede, Japan) was installed at Hanle and later moved to Merak. As a part of its atmospheric science efforts, IIA is collaborating in the following projects in Leh, Hanle, and Merak: (a) studies of aerosols, transported black carbon aerosols under Aerosol Radiative Forcing India (ARFI) network, with SPL (VSSC, Trivandum), (b) studies of greenhouse gases (CO2), kinematic and structural deformation inside the earth's crust using GPS network over the region, with 4PI Paradigm (Formerly CMMACS, Bangalore), (c) studies of multi-wavelength all-sky airglow emission over the Indian Himalayan region at Hanle, with IIT Roorkee, and (d) studies of atmospheric boundary layer dynamics, cloud characteristics, and various atmospheric process using Celiometer Lidar at Leh, with PRL, Ahmedabad.

Further, Hanle and Merak sites have been included in NASA's global network of aerosol measurement (SKYNET). Due to larger number of clear skies and other meteorological parameters, the region is becoming one of the potential sites to perform cross calibration network for the Sun photometer instruments, and sensitivity analysis of aerosol optical and radiative parameters. Hence, the Ministry of Earth Sciences (MoES, Govt. of India) encouraged aerosol measurement over the high-altitude climatic sensitive Ladakh region. Under the Ministry's financial support, a robotic Sun-sky radiometer (POM-01, Prede, Japan) was installed at IAO-Leh in July 2023 (shown in Figure 4.3).

4.1.2 Kodaikanal Solar Observatory (KSO)

Synoptic Observations

The Kodaikanal Solar Observatory (KSO) has more than a century long tradition of making solar photospheric and chromospheric observations. The daily photospheric and chromospheric sun observations are carried out with the White Light Active Region Monitor (WARM) and Hα telescopes at KSO (see Figure 4.4). There were 200 days of observations of the solar chromosphere using the Hα telescope between April 2023 and March 2024, whereas the WARM telescope observed G-band and Ca-K full disk images on 232 days. About 2967 filaments, 1601 prominences, and 41 flares were observed in this period. During this period, the WARM telescope observed 228 sunspot groups.

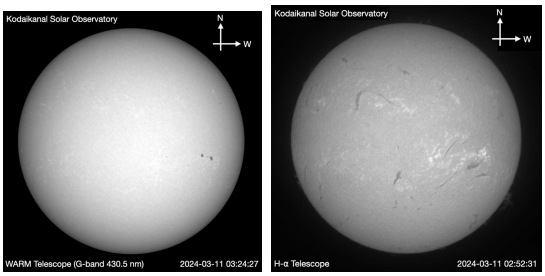

Figure 4.4: *Left: Solar photosphere in G-band from the WARM telescope, and right: Solar chromospheric image from the 20-cm telescope and Hα filter, taken on 11 March 2024.*

Digitization of Archival Data

At KSO. We have successfully digitized 30 years of solar data (1992-2022) using a high-resolution digital scanner (see Figure 4.5. This includes sun chart data, flare logs, spectroheliograms, log books of twin telescope observations, and spectrograms. The data is now stored in both high-resolution and low-resolution formats for accessibility.

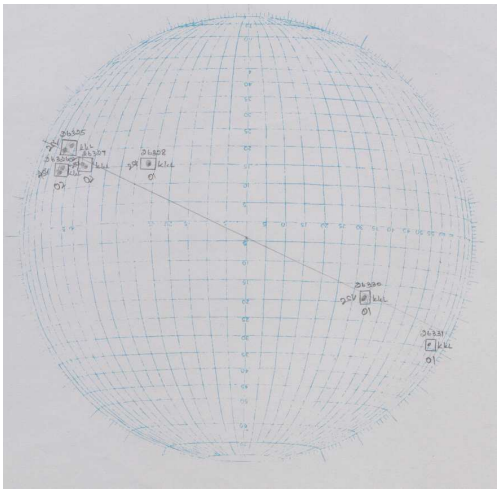

Figure 4.5: *Sunchart depicts sunspots traced from a photograph on 27 April 2022 at 8:42 AM. The sunspots are hand-marked.*

Kodaikanal Tower Tunnel Telescope

Measurements of seeing-induced cross-talk and magnetic fields using the Kodaikanal Tunnel Telescope (KTT) were undertaken using the newly installed tip-tilt system. It was concluded that the newly installed tip-tilt system can work for a long duration (minimum 1 hr) and helps mitigate the seeing-induced cross-talk by at least a factor of 2 (see Table 4.1).

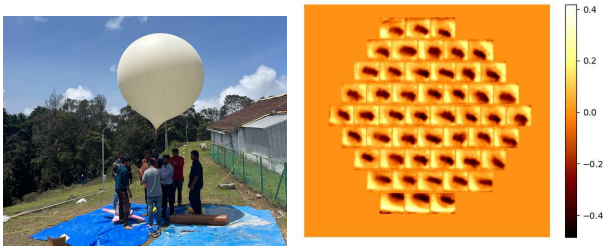

Figure 4.6: *Left: Balloon with seven temperature sensors being prepared for launch. Right: sunspot images formed by the micro-lenses (each being* $23'' \times 20''$*).*

Measurement of the turbulence strength profiles at Kodaikanal Observatory was undertaken through two distinct experiments. First, a set of seven PT-100 temperature sensors mounted on a horizontal rod with semi-redundant baselines was used to measure the temperature structure functions at various heights in steps of 10 m up to 350 m using a tethered balloon (see Figure 4.6). The turbulence strength profile up to 350 m was then estimated assuming Kolmogorov turbulence and using the relation between the temperature and the refractive index structure constants. In the other experiment popularly known as s-DIMM+, measurements were made of the covariance of two differential image motions of the solar scene.

These were observed with different sub-apertures at different field angles with a

Table 4.1: *Mean and rms cross-talk values of different terms of Hα and Ca II 8662 Å lines.*

Line	Term	Uncorrected mean	Corrected mean	Uncorrected rms	Corrected rms
Hα	I → Q	0.012	0.004	0.018	0.005
Hα	I → U	0.013	0.005	0.019	0.007
Hα	I → V	0.016	0.007	0.023	0.009
Ca II 8662 Å	I → Q	0.012	0.005	0.017	0.006
Ca II 8662 Å	I → U	0.007	0.004	0.011	0.005
Ca II 8662 Å	I → V	0.008	0.005	0.011	0.006

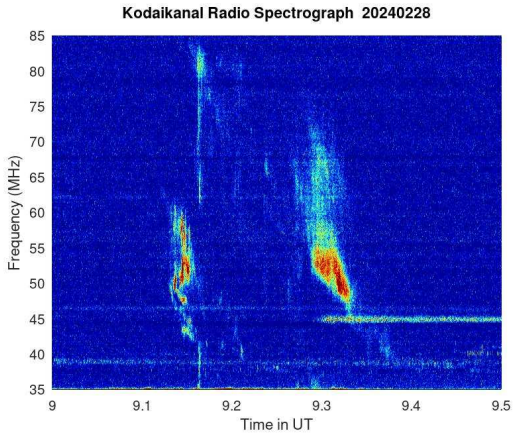

Figure 4.7: *A radio burst observed from KRS on 28 February 2024.*

row of eight micro-lenses placed at the re-imaged pupil plane of KTT. Turbulence strength profile up to 6 km were estimated by comparing the observed covariances with the theoretically computed covariances and a strong turbulence region at 3 km above the observatory was identified.

Kodaikanal Radio Spectrograph (KRS)

Measurement of coronal magnetic fields is an important area in observational solar astronomy. In the case of near-sun corona (heliocentric distance r∼1.1-3.0 $R_\odot$), observations of low frequency (<100 MHz) non-thermal radio bursts using the Kodaikanal Radio Spectrograph are the most promising tool at present to estimate the coronal magnetic field.

The KRS dynamic spectra are being uploaded regularly to the IIA web portal. The data can be combined with those obtained from the Gauribidanur Radio Observatory and Aditya-L1/VELC to study possible space-weather effects. During this year, KRS observed for a total of 339 days. The number of type-II and type-III events recorded are 20 and 428, respectively. A type-II burst observed on 28 February 2024 is highlighted in Figure 4.7 where one can see that a major fraction of its bandwidth is suppressed indicating the progress of severe turbulent processes in the low corona.

Kodaikanal Solar Observatory Museum

During the period covered in this report, KSO received nearly 53,700 visitors, with schools and colleges making up a significant portion (80 and 187 visits, respectively). School and college visits involve engaging talks and explanations led by the museum staff. KSO caters to a wide range of audiences, including students, teachers, dignitaries, tourists, and even industry visitors from colleges. On 28 February 2024, KSO celebrated National Science Day with an open house event, attracting over 1,000 visitors. Competitions like quizzes, drawing, elocution, essay writing, and science exhibits

Figure 4.8: *A picture of students from a school visited the KSO museum.*

were held for school students, with prizes awarded to the winners. On 10 November 2023, KSO celebrated World Science Day as well. KSO has also started operating its own social media accounts.

4.1.3 Vainu Bappu Observatory (VBO)

Scheduled observational programmes with major facilities of VBO, namely, the Vainu Bappu Telescope (VBT), J.C. Bhattacharyya Telescope (JCBT), and the 1-m Zeiss telescope, continued to be implemented during the 2023-24 period. The OMR and Echelle spectrographs were used at the VBT for low- and high-resolution spectroscopic observations. Imaging at the JCBT and low-resolution spectroscopy at the 1-m telescope were also carried out. The 30-inch telescope was under maintenance, the DIMM was rectified and regular observations are being carried out from 28 March 2024, and an automated weather station is also operational. VBO has a continuous record of weather data since 2008. A total of 33 proposals were received at the VBT, 21 proposals at the JCBT, and 14 proposals at the 1-m telescope.
The following programmes were carried out by using the OMR spectrograph at the VBT: Spectroscopic studies of abundances of Hydrogen poor ejecta in the Planetary Nebulae with WR Central stars, recurrent novae, core-collapse supernovae, novae in outburst, the orbital period of contact binary systems, a few short-period binary systems, a survey of Giant Planet Hosting Bright Stars, a few Beta Lyrae-type binaries, AGN feedback in the nearby active galaxies, late-decline and quiescent phase of novae, close binaries with the possibility of additional tertiary components/exoplanets, and investigating small scale wind structures in Wolf Rayet stars, Phase-resolved spectroscopy and polarimetry of Type-II Cepheids, Spectra (one slit) for an object near M104.

The following programmes were carried out by using a Fibre-fed Echelle Spectrograph at the VBT: The origin of Lithium enrichment in red giants, the study of emission-line stars in the transition phase from pre-main sequence to main sequence, the study of elemental abundances and isotopic ratios of stars with and without planets across the HR diagram, isotopic ratios in AGB stars of different metallicities, Helium enhancement in red giants of open clusters, high-resolution spectroscopy of UV bright stars in open clusters, high-resolution spectroscopic study of primary stars in white dwarf binary systems, high-resolution spectroscopy of bright metal-poor stars with [Fe/H] < 2.0, investigating small scale wind structures in Wolf Rayet stars, spectroscopic monitoring of the line variability in various mass ranges of Herbig Ae/Be stars, ground-based observations of the lunar surface boundary exosphere to explore its correlations with lunar surface elemental abundance observed by Chandrayaan-2.

The following programmes were carried out

at the JCBT: Stacking of bright nearby AGN for the host galaxy studies, imaging surveys of star-forming regions, observations of core-collapse supernovae, multi-band photometric follow-up of hot Jupiters around solar-type stars, search for variable stars in open stars clusters, the study of binary open clusters in the galaxy, the photometric study of a few overcontact binary systems, photometric reverberation mapping of the low luminosity AGNs, the study of period variation and unseen third body search in contact binaries, differential transit photometry of short-period exoplanets, investigating close-in extra-solar planetary systems through photometric follow-up of their transits, photometric observations of a few Beta Lyrae type binary systems, search for short-duration variability and transients, photometric monitoring of the BeXRB system - HD 54786, mapping the ionized gas outflows in Active Galaxies, observations of imminent impactors and risky NEOs.

Table 4.2: *Sky conditions at Vainu Bappu Observatory, Kavalur.*

Month	**Spec. hours**	**Phot. hours**
April 2023	118	04
May	12	00
June	15	02
July	03	00
August	06	00
September	06	00
October	34	00
November	12	00
December	27	00
January 2024	82	00
February	170	18
March	134	00
Total	619	24

The following programmes were carried out at the 1-m Zeiss telescope using the UAGS: Photo-polarimetric and spectroscopic variability of symbiotic stars, follow-up and monitoring of core-collapse supernovae and similar exotic transients, optical flux and polarization variability of Fermi blazars, multi-wavelength polarimetric observations of stars projected on MBM clouds and investigating the transient nature of classical Be stars using multi-epoch optical spectroscopy, spectroscopy of evolved stars, multi-band polarization measurements towards bright Tycho stars in Aquila region and study the dust grain properties, broadband polarimetric observations towards cloud cores, phase-resolved spectroscopy and polarimetry of Type-II cepheids.

Table 4.2 gives the summary of night sky conditions for the months of April 2023 to March 2024. The columns list the number of nights having 2 or more continuous hours and 4 or more continuous hours of nights classified as fit for spectroscopic or photometric studies. It is to be noted that for nights classified as "photometric" the sky has to be fully clear for the stated number of hours.

4.1.4 Gauribidanur Radio Observatory (GRO)

Solar Radio Spectro-Polarimeter (50-500 MHz)

A Cross-Polarized, Log-Periodic Dipole Antenna (CLPDA) has been designed and developed at the Observatory to estimate the magnetic field of the corona through polarisation measurements. The routinely used Zeeman effect is not available for the corona, and hence, the fact that almost all transient non-thermal radio emissions from

the corona are either partially or fully circularly polarized is used in this new instrument to estimate B as a function of heliocentric height.

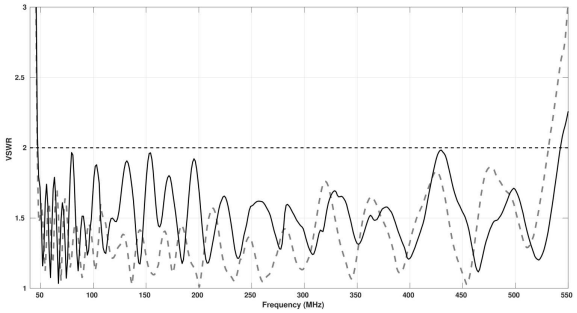

Figure 4.9: *Solid line: measured VSWR of the prototype CLPDA; dashed line: VSWR of 50-500 MHz prototype LPDA for comparison.*

The CLPDA was built as an integral part of a radio spectro-polarimeter, that works in the 50-500 MHz frequency range, which corresponds to a heliocentric height range $\sim$1.03<r<2.5 $R_{\odot}$, wherein the numerous coronal non-thermal transients associated with space-weather effects are observed to originate. The CLPDA is used to determine the strength and sense of polarization of the received radio signal. The uncertainty involved in the determination depends on the polarization-isolation (PI) between the two orthogonal components of a CLPDA. Recent advancements made in the antenna design concepts at high frequencies ($\sim$GHz) were adopted to reduce the PI at low frequencies (MHz). Throughout the above frequency range, the CLPDA has a gain, return loss and PI of $\sim$ 6.6 dBi, $\leq$ -10 dB (or VSWR $\leq$ 2.0, Figure 4.9) and $\leq$ -27 dB (Figure 4.10), respectively. The average PI of the CLPDA varies from -30 to -24 dB over an azimuthal angle range of 0° to 45° within which the observations are performed regularly.

The cross-talk at the reference position is about 10 dB lesser than the commercially available ones at the respective frequency. A significant reduction in the cross-polarized field was obtained by placing the two arms of each dipole (of an LPDA) with very minimum vertical displacement (1/100-th of the arm length) which ensured both arms in the same plane almost. The latter was achieved by the usage of rectangular bars (as transmission lines) in stead of the generally used square tubes to fabricate the LPDA / CLPDA.

Gauribidanur Pulsar System (GAPS)

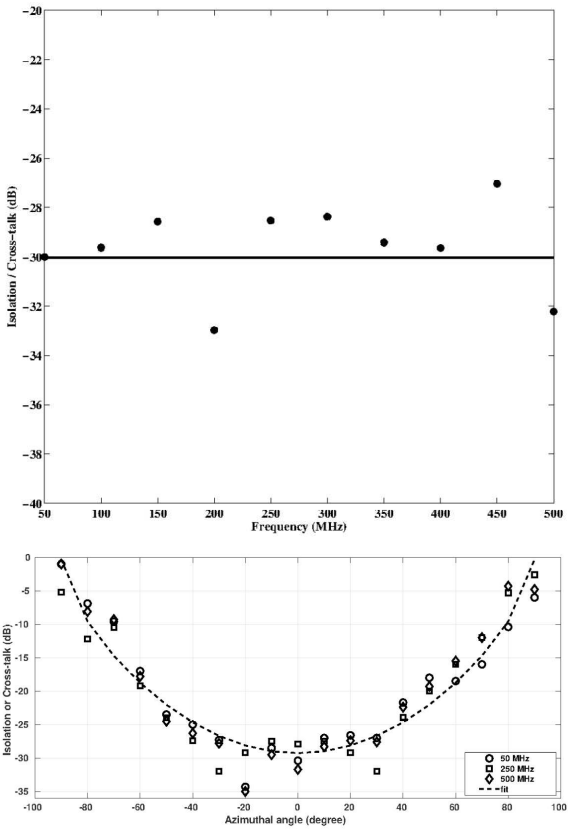

Figure 4.10: *Top: Isolation/cross-talk of the CLPDA at 0° azimuthal angle vs frequency. Bottom: polarization cross-talk vs azimuthal angle when the transmitter was horizontal.*

Initial results were obtained from multi-beam observations of pulsars and solar transient with the digital beam former for the Gauribidanur Pulsar System (GAPS).

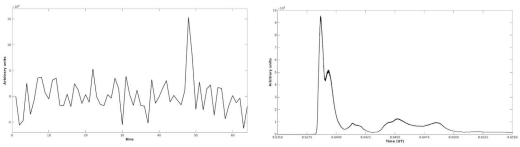

Figure 4.11: *Top: Pulsar B1919+21 observed with GAPS on 7 Dec 2022 over ∼62.5-65.0 MHz using the digital multi-beam technique. Bottom: The same but for a type-III radio solar burst.*

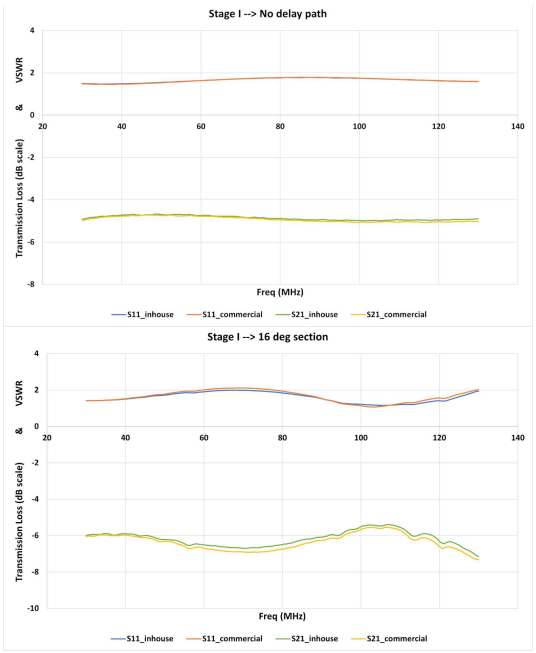

Figure 4.12: *Top: VSWR and transmission loss of Stage-I DCB vs frequency when the test signal was transmitted through the no-delay path. The response with inhouse and commercial inductors are overplotted. Bottom: Same but for the 16 degree section of the Stage-I board.*

A prototype for pulsar observations at low radio frequencies (< 100 MHz) using log-periodic dipole antennas (LPDAs) was commissioned at GRO. This is currently being augmented (i) to directly digitize the RF signals from the individual antennas and (ii) with a digital beamformer to simultaneously observe different regions of the sky present within the primary beam of the LPDA used in the array. Initial results indicate that co-temporal observations of a known pulsar (B1010+21) along with the Sun (see Figure 4.11) using two different beams could be used to calibrate the dynamic spectrum of the solar radio transients. This is important because the calibration of the latter in observations with the conventional solar radio spectrographs is difficult.

The GRAPH augmentation project

The GRAPH array has been augmented to obtain two dimensional images of the Sun both in Stokes-I and Stokes-V in the 30 – 120 MHz frequency range. During this period, the Declination Control Board (DCB) was mass-produced. A few boards were populated with electronic and RF components, tested for their transmission, reflection characteristics and pointing accuracy. During the prototyping, a few electronic components, viz., the inductors, were designed inhouse since their exact values were not known at the design stage. Once the values were determined by trial and error, their commercial equivalents were purchased and tested. It can be seen from Figure 4.12 that the commercial components respond almost identically with the inhouse designed components; the error between the corresponding values were less than 1% in the case of VSWR and less than 2% for the transmission loss, when the test signal was transmitted through the no-delay path of the board. Likewise the errors were less than 1% and 4%, when the test signal was transmitted via the 16° delay section. The

error in the delay for various sections were also determined at 30, 53, and 130 MHz and is shown in Figure 4.13. The maximum delay error measured was $\leq \pm 0.3$ ns with respect to the expected value which correspond to an antenna pointing error $\leq \pm 0.2°$ with respect to the reference position/pointing angle. Similar tests were conducted for Stage-II and Stage-III boards as well and found that the maximum error is of the same order as the aforementioned values.

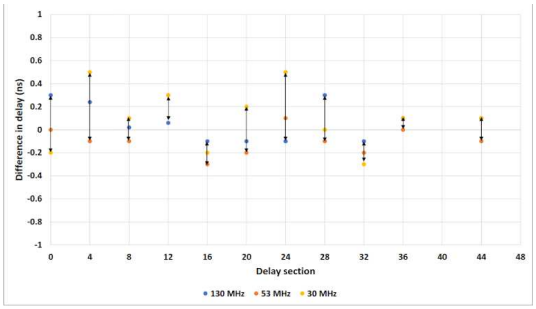

Figure 4.13: *Delay error (in ns) for various sections of a Stage-I DCB. The measurements were made at 30, 53, and 130 MHz.*

4.2 Visible Emission Line Coronograph (VELC) on Aditya-L1

Aditya-L1, the first Indian space solar mission of ISRO to observe the Sun and its outer atmosphere, was successfully launched on 2 September 2023 from Sriharikota. After multiple trajectory maneuvers, the spacecraft was placed in a halo orbit around the Lagrange point 1 (L1) of the Sun-Earth system on 6 January 2024. The L1 point is about 1.5 million km from the Earth. A satellite placed in the halo orbit around the L1 point has the advantage of continuously viewing the Sun. The spacecraft has seven payloads to observe the photosphere, chromosphere and the outermost layers of the Sun (the corona). Among them, the Visible Emission Line Coronagraph (VELC) payload for observations of the solar corona was designed and developed by IIA with help from different centers of ISRO. VELC has four different channels: 1) imaging observations of the continuum emission from the solar corona at 500 nm in the heliocentric distance range 1.05–3.0 $R_\odot$. Note that the VELC has got an occulting disk to block the bright light from the solar photosphere and near-Sun corona till 1.05 $R_\odot$; 2) spectroscopic observations in the spectral lines at 530.3 nm and 789.2 nm in the heliocentric range 1.05–1.5 $R_\odot$;

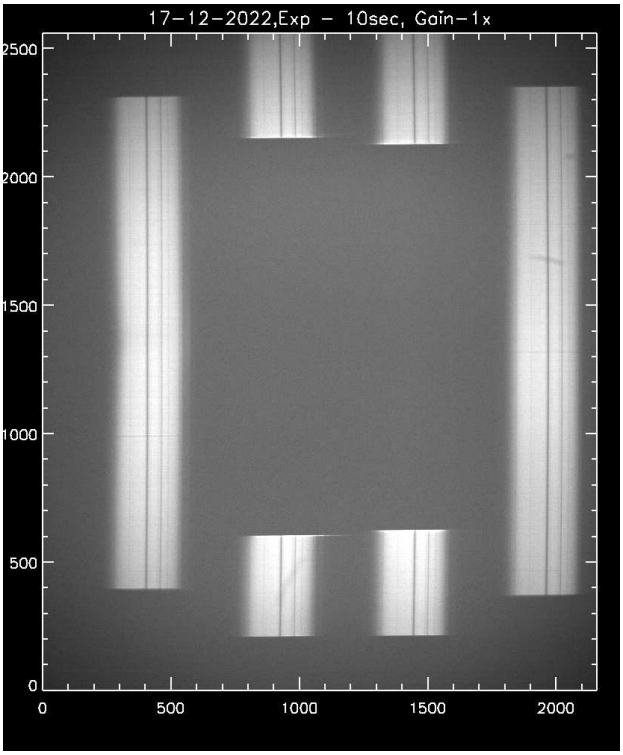

Figure 4.14: *Ground calibration observations at MGKM Lab at IIA/CREST using solar photospheric disk light in the 530.3 nm channel with four different slits.*

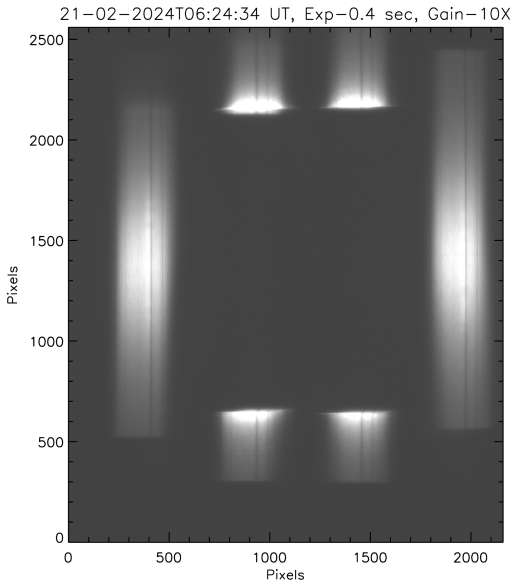

Figure 4.15: *Same as Figure 4.14, but observed in-orbit on 21 Feb 2024. The absorption lines as in the figure are due to scattered light from the solar disk.*

3) spectroscopic and spectro-polarimetric observations in the spectral line at 1074.7 nm in the heliocentric range 1.05–1.5 $R_\odot$. Different test observations are being carried out to check and calibrate the channels in VELC.

The 530.3 nm channel is now ready for routine observations. Figures 4.14 & 4.15 shows the ground and in-orbit observations with the above channel (see also Figure 4.16).

The detector size is 2160 × 2560 pixels. They cover a heliocentric distance range of -1.5 to +1.5 solar radii from the Sun's center. The vertical dark lines correspond to the different absorption lines in the solar spectrum. Each of the four slits can either scan or observe at a fixed location over 0.75 solar radii horizontal distance range from their home position. The home position for slit 1 (extreme left) is -1.125 $R_\odot$, slit 2 is -0.375 $R_\odot$, slit 3 is +0.375 $R_\odot$ and slit 4 is +1.125 $R_\odot$. In total they cover a distance range -1.5 to +1.5 $R_\odot$. The −ve & +ve sign indicate locations to the east and west of the Sun's center. The vertical extent of the slits cover a fixed heliocentric distance range of −1.5 to +1.5 $R_\odot$ irrespective of their position along the horizontal axis.

4.3 CREST campus

A new peripheral compound wall with a large span gate was inaugurated, with name board in three languages. The National Science Day 2024 celebration events, which included an evening event at CREST (including sky watch) and a day event at a Government High school, were conducted by CREST staff.

India-TMT Optics Fabrication Facility

De-ionised water plant

At the India-TMT Optics Fabrication Facility (ITOFF) at CREST campus, a de-ionised water plant was commissioned (see Figure 4.17). This is a purified EDI based de-ionized

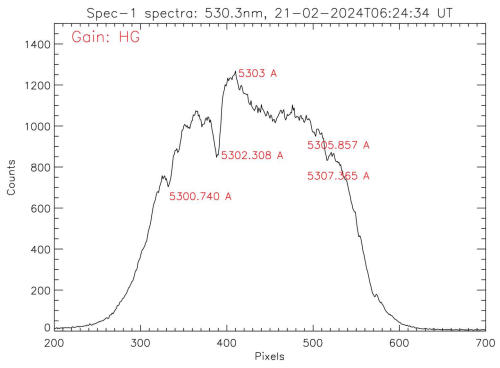

Figure 4.16: *Spectral profile ('row' profile) obtained using observations from the slit 1 in Figure 4.15. The emission at 530.3 nm which is solely due to the solar corona could be clearly noticed.*

water generation system, capable of dispensing de-ionized water at user points in the Lab for optical mirror polishing & mirror washing applications. This is fed by a continuous recirculation loop with 50 PSI pressure. The system has a resistance of $>$ 10 MOhm, a pH of $6.0 - 6.4$, a storage capacity of 2000 litres, and pumping system for continuous recirculation, with a loop designed to remove dead storage.

Figure 4.17: *De-ionised water plant at CREST.*

Electro deionization (EDI) is a continuous, chemical-free process of removing ionized and ionizable species from feed water. EDI is typically used to polish reverse osmosis (RO). Using electro deionization eliminates the need to store and handle the hazardous chemicals used for resin regeneration in mixed beds. Since electricity is EDI's only consumable, this method of permeate polishing does not produce a hazardous waste stream.

Compressed Gas System

A compressed gas generator and distribution system with 15 user points with flow and pressure control was created for mirror polishing process at ITOFF (see Figure 4.18). Compressed air system of rotary type, air cooled air compressors with motors, electrical switch gear and automatic control system, after cooler moisture separator, air drier, pressure regulator cum 0.5 micron filter, SS 304 piping circuit with necessary valves and fittings are part of the system.

Figure 4.18: *Left: Compressed gas generation & storage; Right: compressed gas distribution & controls at ITOFF.*

Hot water and soft water circuit

Soft and hot water generator, and distribution lines were installed at ITOFF for the mirror polishing process. The pressure at user points was 50 PSI with a TDS of ∼200 ppm, established by the pumping system. The loop is designed to remove the dead storage and the hot water generator capacity is 2 numbers of 200 litres each (see Figures 4.19 and 4.20).

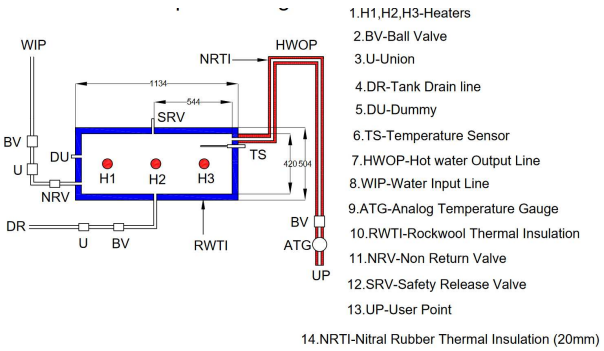

Figure 4.19: *Diagram of hot water tank and pipeline at ITOFF.*

4.4 Library

Collection Development & Management

The IIA Library continues to offer new information services that support the research community's research and learning needs with

Figure 4.20: *250 lt capacity hot water generator at ITOFF.*

a commitment to advancing research excellence, fostering an environment of continuous learning, and preserving knowledge for future generations. The library maintains an extensive collection of information resources, including e-journals, e-books, e-standards, CD-ROMs, online databases, research support tools, and printed materials related to astronomy and astrophysics. The holdings comprise 20,658 print books, 23,452 journal-bound volumes, and 14,865 e-books. Over the past year, the collection was enhanced by adding 48 print books and 337 conference proceedings (e-books). The library also renewed subscriptions for 21 print periodicals and 25 e-journals. Additionally, through the National Knowledge Resources Consortium, IIA users have access to 1,948 e-journals. The Bengaluru main campus library has taken a proactive role in monitoring and supporting all field station libraries. This includes ensuring seamless access to subscribed e-resources for all users, regardless of location.

Document Delivery Service

The document delivery service offers library patrons materials on demand, available in their original form or as copies, in both print and non-print formats. The IIA library has established partnerships with libraries funded by DST, CSIR, and others to facilitate cooperative resource sharing. The library successfully fulfilled 163 electronic document delivery requests from users. It also facilitated inter-library lending services, fulfilling 63 article requests from IIA faculty and students and 58 requests from libraries affiliated with our nationwide partners.

Bibliometric Analysis

Throughout the year, the IIA library monitors the trends in scientific research growth through continuous bibliometric and scientometric analysis of IIA's research productivity. This analysis plays a role in informing policy decisions and is presented in various regular reports. These encompass a wide range of metrics, including the cumulative impact factor of published journal articles, the publishing output of specific faculty members, and publications associated with projects and observatories.

Library Training and VSP Internship Program

The IIA library continues its commitment to supporting manpower development programs by providing training and internships to library science students. This year, four students were trained in library and archives management. Additionally, three students participated in the Visiting Student Internship Program. Furthermore, 15 students from Bharathidasan University, Tiruchirappalli, were trained at the Kodaikanal Solar Observatory Library, imparting valuable skills and experience to the next generation of library professionals.

Research Support Services

The library continued its subscription to iThenticate through the NKRC consortium. To significantly enhance its services, Grammarly was also subscribed to, through the same consortium this year. The library

conducted thorough plagiarism checks on 12 doctoral theses, 17 research papers, several PhD synopses, and numerous master's dissertations to maintain academic integrity. These checks are essential for upholding high standards and ensuring original, credible scholarly work. In addition, a needs analysis was conducted and a Overleaf license was purchased, which is a collaborative writing and publishing tool for LaTeX, and has been successfully launched across the institute.

Integrated Library Management Portal

The Integrated Library Management portal has evolved into the primary gateway for all information and learning resources of the IIA library user community, providing a seamless learning environment. Library staff diligently maintained the library website as well. New functionalities were implemented within the existing system, including installing security patches and resolving security-related issues. Regular backups were performed to maintain data integrity. Additionally, the upgrade process for the ILMS system to the new Koha version 23.11 was initiated. All potential issues with the upgrade were identified, tested, and resolved in a controlled test environment. Moreover, documentation for various internal processes in Koha was created, and comprehensive training sessions were conducted for all library staff, including trainees and interns, ensuring a smooth transition to the upgraded system.

Institutional Repository:

The IIA Institutional Repository collects and manages scholarly papers, emphasizing a diverse range of works, including research articles, theses, and technical reports. This year, the focus was on enhancing the collection of newspaper clippings, adding new content monthly to maintain relevance. The repository currently offers 8169 documents, a valuable resource for global researchers and scholars. Additionally, the Library have commenced testing on the new version of DSpace 7.6 for migration and customization, incorporating new features. This upgraded version is slated for launch in the upcoming year, complete with a refreshed appearance.

Collaborate@IIA Blog:

The Collaborate@IIA blogs have become an essential platform for sharing a wide range of information and updates from the IIA Library. This year, the blog has featured numerous library-related announcements, captivating archival stories, and highlights of significant events. Additionally, it has included posts from DOOT magazines to promote more online collaboration.

IIA Archives Online Finding Aids

Meticulously cataloging was done of archival descriptions for the records, following the ISAD standard, encompassing correspondence, maps, manuscripts, photographic slides, and photographs. The IIA Online Archives Finding Aid development is complete, with webpages and data successfully transitioned to a production environment, significantly enhancing access to IIA's valuable archival materials. Currently, a comprehensive security audit is underway to ensure that our Online Archives Finding Aids system meets CERT-In's guidelines for security and integrity. Once finalised, the finding aid will be publicly accessible, advancing the Library's mission to preserve and provide access to the rich historical records of the IIA.

Book Purchases

The library offers users the option to purchase books directly from sellers at fair rates. This year, the library has processed 26 requests

for individual and project book purchases, facilitating access to essential resources for its users.

Library and Archive Promotion Activities

The IIA Library and Archives played an integral role in the IIA Open Day, actively engaging with attendees by setting up an informative stall. The team showcased the library's diverse collection and services and the historical significance of the archives' materials. The exhibition highlighted the evolution of IIA from its inception as a private observatory under William Petrie in Madras to its current headquarters in Bangalore. Key figures such as John Evershed and Norman Pogson were featured, alongside exhibits of the photometer and transit circle. Notable items like the book by Johannes Kepler's "Astronomia Nova" (1609) and the handwritten "Annual Report of 1792" generated significant interest among visitors.

Figure 4.21: *Photos taken during IIA Open Day Library and Archives Exhibition.*

Article Processing Charges

The IIA library plays a crucial role in supporting researchers by facilitating the publication of their articles in prestigious journals, which includes processing article processing charges (APCs). In the last year, the library successfully processed payments for 30 articles, ensuring a seamless process for authors. This involved maintaining transparent communication channels with both authors and publishers, particularly with the American Astronomical Society (AAS), Astronomy & Astrophysics (A&A) and Monthly Notices of the Royal Astronomical Society (MNRAS) journals.

Reorganizing and preserving the Kodaikanal Solar Observatory Library

Over the past year, significant efforts to reorganize the extensive astronomical collection at the Kodaikanal Solar Observatory were undertaken. Utilizing the help of 15 library interns from Bharathidasan University and 3 VSP interns, the initiatives focused on implementing modern reorganization techniques, establishing an online catalogue, restoring items, and introducing preservation measures. Physical verification and reorganization of bound volumes, updating shelf numbers, and migrating to the ILMS (Koha) system were done. Regular cleaning was conducted, and documenting of bookshelf arrangements was done. Planing various preservation activities was undertaken and the implementation of pest control and varnishing will occur in the forthcoming year.

Figure 4.22: *Photos of the team in action rearranging KSO Library Collections.*

5

Upcoming Facilities & Projects

IIA is a part of the design, construction, and operation of a number of national and international astronomy facilities that are planned to be operational in the near future (e.g. Thirty Meter Telescope). IIA also continues to work on the design and planning of future observational facilities that it is leading (e.g. National Large Solar Telescope, Indian Spectroscopic and Imaging Space Telescope, and National Large Optical Telescope). Each of these projects is at different stages of their development and the progress made over the previous year is described here.

5.1 Thirty Meter Telescope (TMT)

India is participating in the construction of TMT as a Founder Member partner, with continued support from DST and DAE. The project is being developed by an international consortia of institutes and scientific organisations in Canada, China, India, Japan and the USA. India's participation in the project is spearheaded by IIA, Bangalore, IUCAA, Pune and ARIES, Nainital. The project is facing a delay of about 10 years and a cost escalation of about USD 2 B. During the year 2023-2024, the TMT project and National Science Foundation (NSF), USA made consistent efforts involving native Hawaiians to resolve the issues for ensuring access to the project site. A revised project schedule has been proposed subject to the decision of NSF/US Congress, to commence the project in late 2024 or early 2025 and complete the project by 2034/35. NSF is independently carrying out environment reviews, scientific and technical reviews, and technical readiness review of the TMT project. It has also released the first instalment of funds for the project's sustained continuation.

Though the civil construction on the desired site has been stalled, the technological advancement of the project has not been been deterred. Several major milestones in the production of TMT subsystems in the partner countries have been achieved (e.g. NAOJ, Japan and Ohara Inc. have already supplied 60% of quality-checked primary mirror blanks). During early 2024, the project celebrated a major milestone of polishing 109 mirror segments including India's and Japan's share. Several the subsystems too have completed their preliminary design and are currently in the final design phase. TMT's framework structure is also ready for production. Three first-light science instruments, viz., IRIS (Infrared Imaging Spectrograph) is ready for fabrication, WFOS (Wide-Field Optical Spectrograph) is in preliminary

Figure 5.1: *First TMT polished roundel churned out from ITOFF, IIA.*

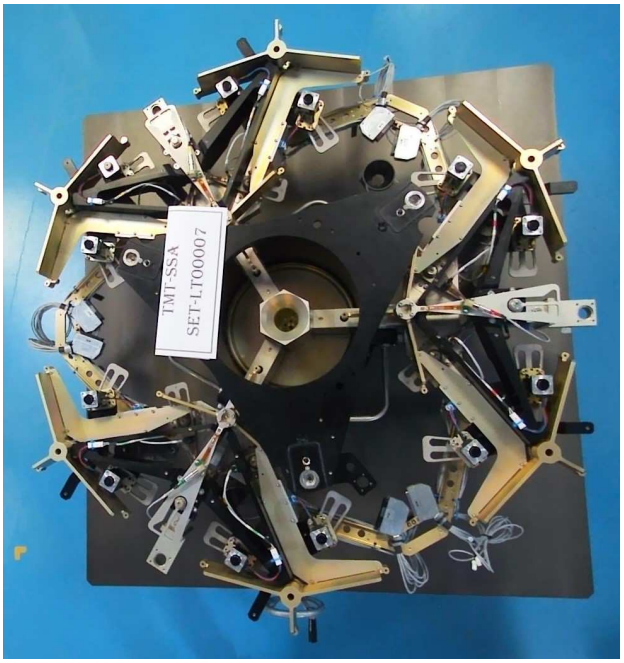

Figure 5.2: *7 sets of SSAs fabricated by L&T, Defence, Coimbatore and India-TMT.*

design phase, and MODHIS (Multi-Objective Diffraction-limited High-resolution Infrared Spectrograph) has successfully completed subsystem conceptual design.

In parallel, India-TMT has continued design, development and prototyping of several subsystems towards its in-kind commitments to the project and partnering with over 28 Indian industries. India's contributions include M1 control system fabrication, namely, Segment Support Assembly (SSA), Actuators, Edge Sensors, and Segment Polishing. Observatory Software (OSW) and Telescope Control Systems (TCS), Segment Coating, design and development of various subsystems of Science Instruments (WFOS & HROS) are also India's contributions.

The major developmental activities undertaken by TMT-India during the period covered in this report are described below. Further details can be found in Chapter 6.

M1 Segment Polishing

The installation of India-TMT Optics Fabrication Facility (ITOFF) was completed with all tests and calibrations. India-TMT also successfully completed the fabrication & metrology of the first mirror segment roundel at ITOFF, meeting all the engineering requirements (see Figure 5.1). ITOFF will continue to fabricate 84 out of 580 mirror segments required to build the 30 meter diameter aperture of the TMT. Three roundels, including a practice blank and two production blanks, have been successfully polished by India. This is an important milestone that has been achieved. With this milestone, India-TMT became the only facility in the country which can fabricate such high quality optical mirrors.

Segment Support Assembly

India will provide 574 Segment Support Assemblies (SSAs). The first assembly and testing of 7 sets of SSA modules was

completed successfully (see Figure 5.2), and the Indian industry (and thus India-TMT) has now become production-ready.

Central Diaphragm

The Central Diaphragm (CD) is a crucial interface between the SSA and mirror segment, and 580 CDs are required for the project. Till date, 10 CDs have been shipped to the TIO (see Figure 5.3). Four more have been successfully fabricated within this year. Rough machining, heat treatment and machining of thin sections have all been successfully achieved. 127 Primer coating qualification has been completed and is ready for coating in the actual CDs to be installed on SSAs.

Figure 5.3: *10 sets of Central Diaphragms fabricated and delivered to TIO.*

Warping Harness Cables

20 sets of Warping Harness Cables (WHC) were sent to the TMT Project Office, which were reviewed successfully after passing all cable qualifications.

Actuators

The technical and commercial evaluation of vendors for the P3 prototype actuator manufacturing phase has been completed. Two vendors were selected for the production of 20 actuators. All the component parts for these 20 actuators have been fabricated and 10 of them have been successfully assembled (see Figure 5.4). Of these, 8 have been shipped to TMT International Observatory (TIO) for performance testing and integration.

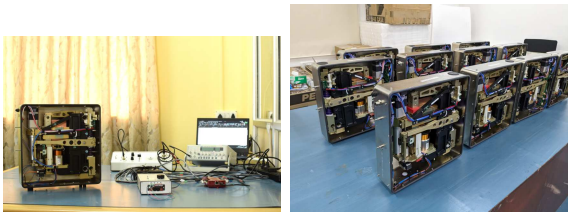

Figure 5.4: *10 sets of prototype P3 Actuators are fabricated and 8 have been delivered for performance testing and integration.*

Edge Sensors

Machining of Edge Sensor coupons and gold coating processes is continuing. 10 numbers of gold coated glass blanks of the total of 75 were successfully machined and developed (see Figure 6.3). Gold coating on edge sensor glass blocks using Physical Vapour Deposition (PVD) method and laser etching processes are ongoing.

Observatory Software

India-TMT plays a major role in producing more than 40% of the Observatory Software (OSW) for the project. ITCC is responsible for the software architecture support and the end-to-end observing software system. The Infrared Guide Star Catalogue (IRGSC) Phase-III WP signed in September 2019, which is completely being developed in-house, has now been completed.

Wide Field Optical Spectrograph

India-TMT continued work on prototyping the complete grating exchanger system including mechanical, electronics controls and electrical and software, for the Wide Field Optical Spectrograph (WFOS). Work on developing Instrument Control Software, optomechanical design of the calibration system, and FEA analysis of the structure of

WFOS is also continuing. Opto-mechanical design work of the High Resolution Optical Spectrograph (HROS) has been recently concluded with the optimization of Atmospheric Dispersion Corrector and K-mirror which are part of HROS pre-slit optics, beam compression using prisms, multiple collimator and combination design to reduce optical aberrations as in-house activities.

In addition to developmental activities, the project also resulted in one scientific and technical publication and 5 PhDs are ongoing.

5.2 Indian Spectroscopic and Imaging Space Telescope (INSIST)

The UltraViolet Imaging Telescope (UVIT) onboard India's first dedicated multi-wavelength space observatory, Astrosat, has completed nine years of successful operation. It is one of the few space facilities currently operational in ultraviolet wavelengths worldwide. Led by IIA, the UVIT was indigenously made, starting from design to fabrication, integration, test, and calibration, in collaboration with several institutions such at IUCAA in Pune, TIFR in Mumbai, several centres under ISRO, and the Canadian Space Agency (CSA). Through this project, Indian scientists and engineers have demonstrated their capability to develop and operate a space telescope. This project has enabled IIA to create state-of-the-art infrastructures and train human resources. It is, however, important to utilise this strength to create the next-generation UV-optical observatory class space telescopes for the next decade to fill the gap in the international scene.

The IIA team had originally presented a concept of a future mission capable of addressing several science questions, during the first UVIT science meeting in July 2017. Subsequently, responding to an Announcement of Opportunity (AO) for submitting proposals for future astronomy missions by ISRO, IIA submitted a proposal in partnership with IUCAA, TIFR, CHRIST (deemed to be a university), PRL, and ARIES. A possible international collaboration with the CSA and the Canadian mission, CASTOR (Cosmological Advanced Survey Telescope for Optical and Ultraviolet Research), was also explored. The INdian Spectroscopic and Imaging Space Telescope (INSIST; PI: Annapurni Subramaniam) was submitted to ISRO in April 2018. The ISRO set up a committee to review all the submitted proposals, and based on its recommendation, INSIST progressed to a seed-funded (30 Lakh) one-year pre-project phase in March 2019.

The INSIST was proposed as an observatory class facility, having high-resolution imaging ($\sim$0.2″) capability over a 0.25 square degree field using a 1-m primary mirror to achieve a detection limit of $\sim$26 mag in the UV and $\sim$29 mag in the optical, for an exposure time of 1 ksec. A moderate resolution multi-object spectrograph (MOS) (R$\approx$1000-2000), capable of obtaining spectra up to a limiting magnitude of 20 in UV, was also proposed for objects falling within a field of $\sim 3' \times 3'$. Details on the science objectives, instruments, and operation plans, were published in the Journal of Astrophysics and Astronomy.

During the pre-project phase, IIA initiated several feasibility studies of the optical, mechanical, and instrument designs and tests of some new technologies for the INSIST

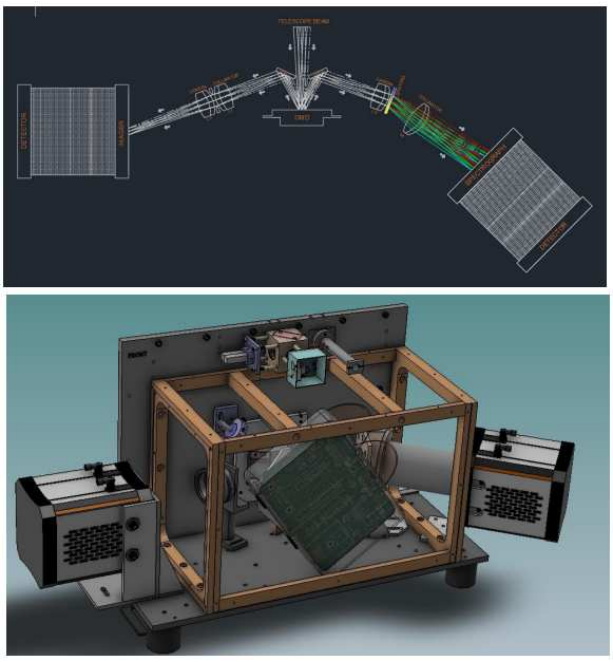

Figure 5.5: *DMD-Based spectrograph designed for the 1.3 m JCBT Telescope at VBO, Kavalur.*

mission. The MOS instrument uses a Digital Micro-Mirror Device (DMD) to select multiple science targets from the instrument's field-of-view. The INSIST team has developed a front-end GUI for interfacing the DMD with the chipset board, which was developed in collaboration with M/s Optimized Solutions, an Indian company that provides test, measurement, and automation solutions. Last year, a DMD-based spectrograph was designed and fabricated for IIA's 1.3-m JCBT facility at Kavalur as a prototype of the MOS instrument, but in the optical wavelength (Figure 5.5). Laboratory and on-telescope tests were carried out during this year. The main objective was to understand and characterizing the DMD performance for spectroscopic and Imaging observations. The INSIST science team developed Python-based packages and routines called Python Image Simulation and Testing Application (PISTA) to address various simulation requirements spanning different INSIST observing modes and facilitate various science teams in formulating science capabilities. The mechanical team has conducted several rounds of discussions with the ISRO teams to decide on the payload fairing size and interfaces.

The INSIST team submitted several documents capturing science requirements and the outcomes of various studies conducted during the pre-project seed funding phase to ISRO and is awaiting ISRO's future course of action. IIA also conducted a workshop titled "UV-Optical-IR Astronomy in India: Prospects of the next decade" as a part of the 42nd meeting of the Astronomical Society of India (ASI) on 31 January 2024. Over a hundred participants, including scientists, engineers, postdocs, and students from across the country, participated in the workshop and expressed an urgency for the next Indian UV space facility. With several UV missions in planning stages worldwide, moving ahead promptly with a mission like INSIST is crucial for the Indian astronomy community to become scientifically relevant in the coming decades and use already available infrastructure and skilled human resources effectively.

5.3 National Large Solar Telescope (NLST)

The Sun and Solar System group at the Indian Institute of Astrophysics (IIA) has proposed to build a large solar telescope. This cutting-edge instrument will enable high-resolution observations of the Sun, allowing us to delve deeper into the secrets of the magnetic fields within the Sun's active regions. Their research focuses on understanding both the static and dynamic

properties of these fields. Following a comprehensive site selection process, a location near Pangong Tso in Ladakh had emerged as the ideal candidate for hosting this telescope on Indian soil (see Figure 5.6). Currently, specialized instruments are continuously gathering crucial data on seasonal cloud cover, atmospheric seeing conditions, etc.

Figure 5.6: *A photo of the NLST with a signboard. The H-alpha telescope along with solar panels can be seen in the background.*

On 22 November 2023, the NLST team met the DST Secretary at Technology Bhawan, DST, New Delhi. The meeting, chaired by the Secretary, was attended by the Directors of IIA and ARIES, and representatives from the NLST project team including IIA, Udaipur Solar Observatory, IISER Kolkata, IIT BHU, and IIT Kanpur. The discussion centered on the progress of the NLST project and the proposed establishment of a 2-meter class telescope near Pangong Tso in Merak, Ladakh. Recognizing the project's significance as a mega-science initiative for India, the meeting highlighted the potential benefits of the NLST in understanding space weather and its impact on communication satellites, critical aspects for the global economy. Following the meeting, the NLST team resubmitted a revised Expenditure Finance Committee report (EFC) to the DST in January 2024.

The NLST team also requested an additional 5 acres of land for laboratory and office space, separate from the main telescope site. To discuss this request, the Ladakh State Wildlife Board (SBWL) convened a meeting on 24 November 2023, in Leh. Chaired by the Lieutenant Governor of Ladakh, the 9th SBWL meeting saw participation from Ravindra B. and Namgyal Dorjey representing IIA. Following the discussion, the chairperson and the Chief Wildlife Warden (CWLW) approved the allocation of 2.02 hectares of land for the NLST project. This designated area lies approximately 0.8 kilometers away from Pangong Tso Lake and Merak village. The IIA is now seeking funding to secure this land for the laboratory and office facilities.

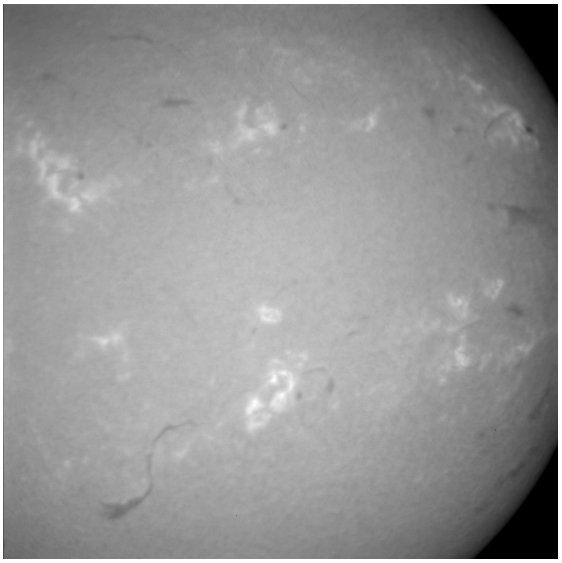

Figure 5.7: *The solar chromosphere on 24 June 2023 at 04:52 UTC, imaged by the Hα telescope at Merak.*

Observations of the Sun from Merak

At the incursion site of Pangong Tso, a 40 cm aperture DFM telescope and a 20 cm

aperture H-alpha telescope are operational. During the period covered in this report, the DFM telescope conducted 173 days of observations covering about 855 hours. The H-alpha telescope conducted 99 days of observations covering about 512 hours. Several sunspots, filaments, and flare observations were made during this period. A sample images are shown in Figures 5.7 and 5.8).

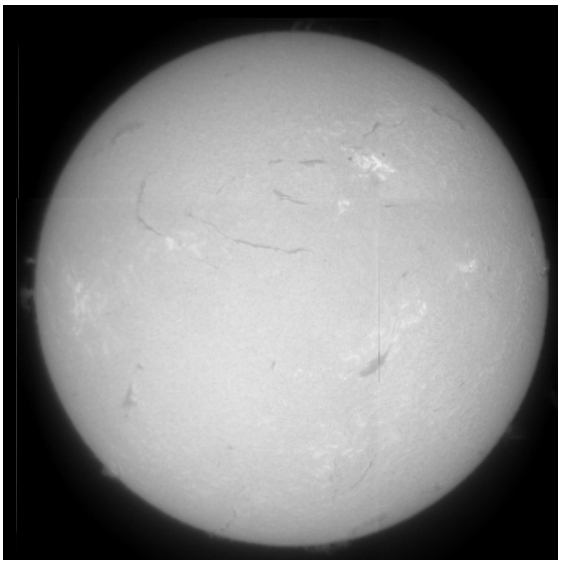

Figure 5.8: *A composite image of the solar chromosphere on 5 April 2023 using the Hα telescope at Merak, stitched together from several images.*

5.4 National Large Optical-Infrared Telescope (NLOT)

Large telescopes are pivotal in advancing astronomical research globally, and most countries have access to large telescopes of 8-10 m. Exclusive access by building an 8-10 m telescope within the country would enhance India's global standing in astronomy, further aiding the burgeoning space industry. The Indian astronomical community has actively pursued this through community workshops and proposals to the Department of Science & Technology (DST), notably a proposal in 2007 led by the Indian Institute of Astrophysics. With India's technical readiness, participation in the TMT project, and the recent TMT delay, it is essential to capitalize on this momentum to expedite the National Large Optical Telescope (NLOT) project. This effort aims to reboot the project by re-evaluating the evolving landscape of astronomy, considering the latest developments in gravitational waves, time-domain astronomy, and exoplanet studies. It also seeks to engage a broader academic community, including universities, Indian Institutes of Science Education and Research (IISERs), and Indian Institutes of Technology (IITs), to foster a more inclusive and comprehensive approach.

To advance the discussion and seek further community inputs on the nature and size of the NLOT, Director IIA contacted the directors of other national institutions and universities to form a national NLOT team. The main objective is to constitute an NLOT Science Team (NST) to identify key science cases that drive the technical requirements for the telescope and the back-end instrument designs. NST is tasked to coordinate to compile the inputs from the Indian scientific community by inviting white papers for the science cases and possible first-light instruments. Meanwhile, IIA's technical team is engaged in developing designs or prototyping various sub-systems that may be useful for the project's fulfillment. Some of the results are presented in section 6.1.

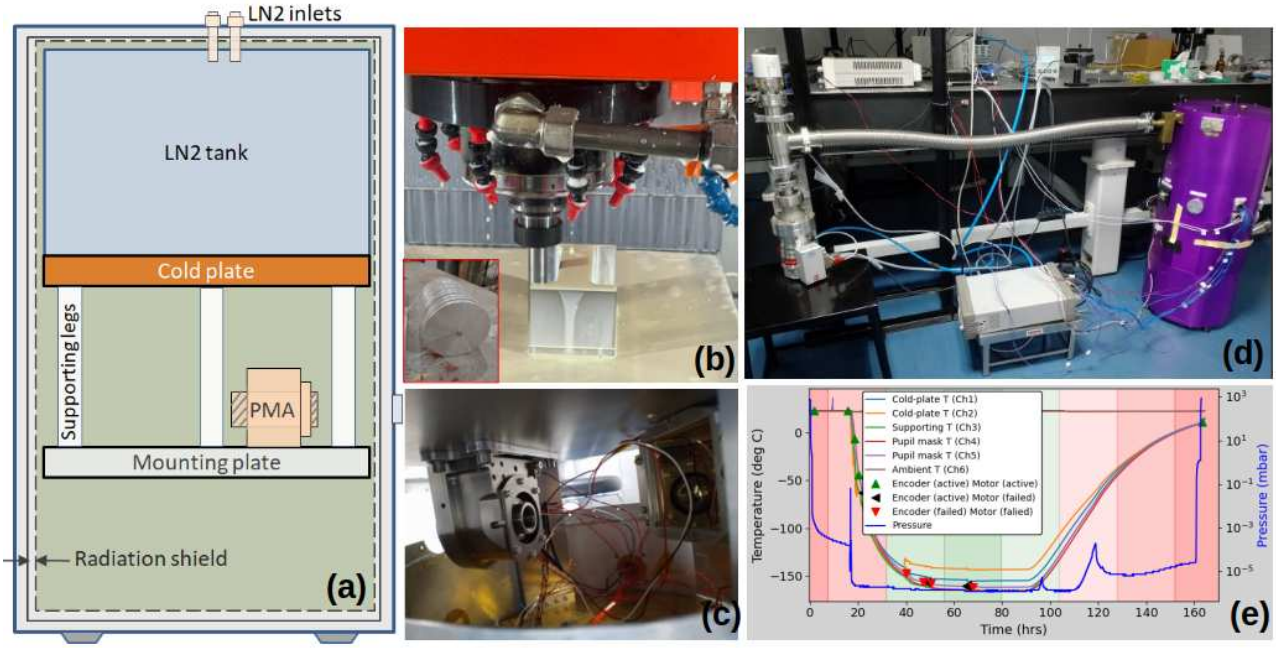

Figure 5.9: *(a) Schematics of cryogenic enclosure used for the cold testing (b) CNC machining of the filter wheel parts (c) Pupil mask assembly (d) lab setup for the cold-testing and (e) temperature and pressure readout.*

5.5 Slicer Combined with Array of Lenslet for Exoplanet Spectroscopy (SCALES)

SCALES is the next-generation thermal infrared instrument designed for exoplanet imaging and spectroscopy on the 10-meter Keck Telescope. It is being developed by a consortium that includes UC Santa Cruz, UC Irvine, UCLA, the Keck Observatory, Caltech (USA), and the Indian Institute of Astrophysics. Operating in the thermal infrared range (2-5 microns), SCALES will have the distinct ability to probe exoplanet parameters that remain out of reach for other instruments. It will offer improved sensitivity for imaging warm planets at close angular separations (≤1") and will examine planetary atmospheres with higher spectral resolution. Although the primary goal of SCALES is exoplanet science, it is also capable of addressing a diverse range of scientific problems, including the study of solar system objects, transient events, the dynamics of nearby active galactic nuclei, and the spatial and spectral characterization of protoplanetary disks and star-forming regions.

The SCALES instrument includes a low- and mid-resolution integral field spectrograph (IFS) and a high-contrast imaging channel. This year, SCALES entered the construction phase with IIA responsible for delivering key subsystems such as the Imaging Channel, TelSim Calibrator, IFS and imager filter wheels, and Pupil Mask Rotator. In addition to designing and fabricating the optomechanical hardware, IIA has set up lab experiments by integrating a vacuum system, temperature

Figure 5.10: *Clockwise from top left: Ring beams; ring beam columns footing level; reinforcement for ground floor slabcasting; and columns raised upto ground floor slab level.*

sensors, motion controllers, data loggers, and cryogenic chambers (see Figure 5.9). These subsystems are first warm tested at ambient temperature (22–23 °C) and then cold tested under vacuum ($\sim 10^{-6}$ mbar) down to liquid nitrogen temperatures of -196 °C. SCALES is expected to begin operations by late 2025, promising exciting scientific discoveries. See Section 6 for details on fabrication of mechanical components for SCALES.

5.6 COSMOS-Mysuru planetarium project

IIA is building the world's first commercial LED Dome planetarium in Mysuru under the COSMOS-Mysuru project. The planetarium is executed through an MoU between the IIA and the University of Mysore, is coordinated by the Office of the Principle Scientific Advisor to Govt. of India, and is funded by a number of central government agencies (DAE, DST, DoS) and the MPLADS funds of Hon'ble Finance Minister, Govt of India. The planetarium is being constructed on the grounds of University of Mysore at the base of Chamundi Hills (see Figures 5.10 to 5.13). The following activities were carried out in this period

[1] The layout of the building was finalised and all drawings were prepared by the Architect, M/s. Kothari Associates, Kolkota.

[2] A public tender was floated and the work order for the Civil Engineering work was awarded to M/s. RNR Constructions, Bangalore and construction work started in September 2023.

[3] A public tender was floated and the purchase order for the supply of the LED planetarium equipment was awarded to M/s. RSA Cosmos, France in May 2023.

[4] The inspection of the main frame of the LED planetarium equipment was scheduled to be conducted in France by a team of members from IIA followed by the inspection of the LED panels. The items of the LED planetarium equipment is expected to reach the site later in 2024.

[5] The selection of the shows for the inaugural programme is being decided by a duly formed committee. A ten minute introductory show detailing the cultural heritage of Mysuru, its landscape and its Astronomy heritage is also being planned.

Figure 5.11: *Left: A portion of main frame which will support LED panels; Right: A close-up of the same, assembled at vendor location in France.*

Figure 5.12: *Prototype of LED panels at RSA Cosmos, France.*

Figure 5.13: *Prototype of server rack at RSA Cosmos, France.*

6

System Engineering Group

The System Engineering Group (SEG) comprises of the institute's various engineering and technical divisions, including electronics, mechanical, Computing and IT, electrical, and civil engineering.

6.1 Electronics Division

INSIST

The development of the Indian Spectroscopic and Imaging Space Telescope (INSIST) DMD controller is in progress. The User Interface Controller (UIC) FPGA firmware and Chipset board (see Figure 6.1) hardware were designed and developed, and the DMD Chipset board fabrication and functional testing is complete. The integrated testing of the UIC and Chipset board is in progress. The design document, schematic, placement, routing, fabrication, and testing of the Dual FMC board was also completed.

Figure 6.1: *Fabricated DMD Chipset FPGA board with dual FMC interface board.*

Thirty Metre Telescope

Actuators

The P3 prototyping phase (or actuator final design qualification) is in progress, which includes manufacturing 20 P3 Actuators with two vendors in India. 12 sets of actuators have been successfully fabricated, assembled, and tested (see Figure 6.2), all of which fully conform to and meet 100% of the drawing requirements.

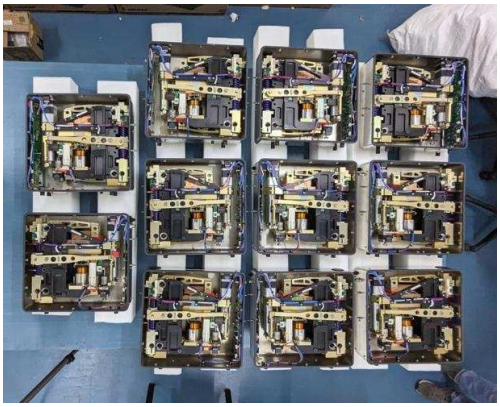

Figure 6.2: *First batch of P3 Prototype Actuators at ITCC.*

These actuators were received at the India-TMT Coordination Centre (ITCC) at IIA for further inspection and testing. Of these 12, 8 sets are shipped to the TMT International Observatory Project Office (TIOPO) for further life testing. During the period covered

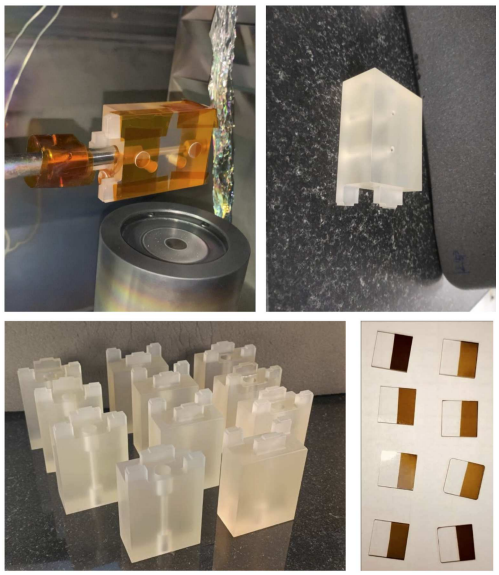

Figure 6.3: *Clockwise from top left: 8 coupons on TMT Edge Sensor block; Chromium coated coupons; ultrasonic machining at Optica; 15 machines blocks.*

in this report, various other tasks including parts fabrication, internals and third-part inspection, BOP procurement, EMS training and EIDP documentation, assembly procedure and training, functionality testing, etc, were undertaken.

Edge Sensors

The Edge Sensor Process Development and P3 Edge Sensor machining is under progress. Ultrasonic Machining of 75 blocks and PVD-based gold coating on 5 blocks is ongoing at Optica Bangalore and machining of 15 blocks is completed. Of these, 6 have had internal and third-party inspections, and reports were submitted to ITCC and TIOPO. Six rounds of coupon coating were done, and an optimized chrome coating thickness of 25nm to 60nm process was established (see Figure 6.3). Measuring this is not an easy task, and the ITCC team contributed to the process development for nanometric coating thickness measurement using the SURFCOM TOUCH roughness tester instrument. ITCC also conducted a technical feasibility study with Optica for machining and ARCI for laser etching. One canted block was fabricated and inspected to demonstrate the feasibility of this change. In addition, ITCC identified two major changes in Edge Sensor features, which are currently being discussed with TIOPO.

Segment Support Assembly

Segment Support Assembly (SSA) test controller development and testing has been ongoing at ITOFF. These include developing SSA functionality and performance test controllers and procedures, conducting tests of assembled SSAs at L&T, data interpretation, diagnosis of assembly issues and report preparation. India-TMT SSA Test Controller was also developed and was used successfully on the L&T SSA at ITOFF (see Figure 6.4).

Figure 6.4: *Left: SSA Test Controller developed at IIA; Right: Undergoing functionality testing at ITOFF.*

M1 Segments

The M1 Segment polishing team participated in Stretched Mirror Polishing (SMP) polishing and metrology equipment commissioning activities at ITOFF in May 2023 over two weeks. The tasks included maintenance of different equipment at ITOFF and diagnosis of issues related to 2DP equipment. The team also participated in 3 Axis Gantry system development activities for the Sub

Aperture Station (SAS) for Mirror Segment Metrology at ITOFF. This work involved a technical kick-off meeting with the vendor (Shri Venkateswara Hi-Tech Machineries Pvt. Ltd.), design review meetings, FEM analysis review meeting, technical meetings with subcontractors (Renishaw and Siemens), component identification, electrical design and placement, etc.

National Large Optical-IR Telescope

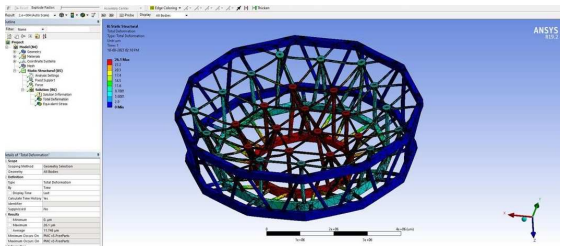

Figure 6.5: *NLOT mirror cell structure and static analysis.*

The NLOT working group contributed to telescope design, simulation and analysis aspects, which included the integrated modelling for a 6.2-m NLOT, the telescope structure concepts, mirror cell design and analysis, the new SSA design for NLOT M1CS testbed, etc (see Figures 6.5 & 6.6).

Support to Observatories

The Electronics Division supported the installation of Hanle Echelle SPectrograph (HESP) at IAO Hanle. A proposal for the upgradation of the HCT-Telescope Control System was also prepared and submitted to Director IIA.

Technical Developments

The electronics for CMOS image sensor-based readout was developed. A Liquid Crystal (LC) Retarder-based polarimeter was also developed. An LC Retarder was fabricated in collaboration with IIST Thiruvananthapuram. An IIA Data Logger (IDL) was developed for temperature, humidity and vibration logging for different applications, and this system has been installed at ITOFF, VBO Kavalur, CN2 Measurements and RRI Bengaluru.

Upgradation of telescopes at RV Mysore

Five telescopes had been installed at the Ramakrishna Vidyashram school in Mysuru, of which three are from Celestron and two are made by IIA. These telescopes have not been working since recently, and the 8-inch Celestron was brought to IIA for repair. Various problems were fixed and the telescope was successfully re-installed in the school premises.

Integration of HFOSC CCD with IDSAC

The Himalaya Faint Object Spectrograph (HFOSC) CCS at IAO Hanle had to replaced with the CCD controller (IDSAC) developed by IUCAA, Pune. The feasibility of interfacing the CCD with IDSAC (IUCAA Digital

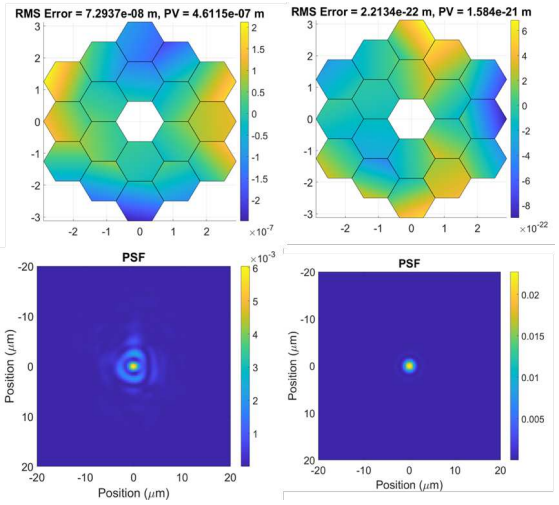

Figure 6.6: *NLOT integrated models (before and after correction).*

Sampling Array Controller) was examined. IDSAC is a Generic CCD controller that can handle various detectors. The HFOSC CCD, which is a Teledyne e2V 2048×4096 CCD44-82, has a pixel size of 15μ, with two amplifier outputs, three image clocks, five register clocks, 2 reset gates, two summing well gates, and a dump gate. All the clocks and gates operate on ± 20 V (bipolar) levels and transfer the data at a 1 MHz rate (max). The specifications of the IDSAC meet the requirements of the CCD and end-to-end electronics testing with the IUCAA engineering-grade CCD has been completed. The IDSAC controller will be shifted to IIA and tested in the clean room at CREST. At this point, the engineering grade CCD will be replaced with the actual scientific CCD and later integrated with the telescope IAO, Hanle (see Figure 6.7).

Figure 6.7: *HFOSC CCD for IAO Hanle*

Development of Liquid Crystal Retarder based Polarimeter

A polarimeter based on liquid crystal retarders (LCR) is under development in order to study the active regions of the sun (see Figure 6.8). The work undertaken so far includes the evaluation of several types of LCRs, the development of a Python-based simulation software including efficiency optimisation algorithms for various types and exploring different modulation schemes. A PID controller for maintaining the temperature of the polarimeter enclosure was developed, inside which the LCRs will be mounted, as well as a controller for driving the LCR. This polarimeter will be installed in the Kodaikanal Tunnel Telescope after lab characterisation.

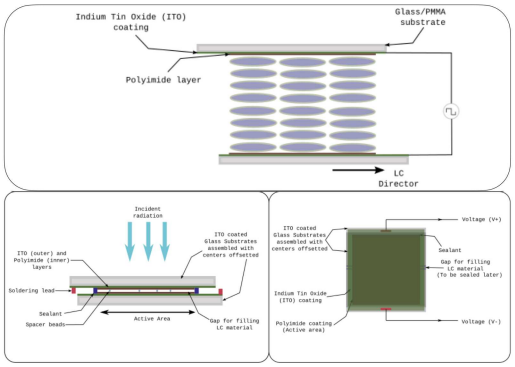

Figure 6.8: *Liquid Crystal Technology Description*

LCR Fabrication

An LCR is under fabrication in collaboration with the Center for Nano and Softmatter Sciences (CeNS), Christ (Deemed) University, Bangalore and IISER Thiruvananthapuram (see Figure 6.9). BK7 glass substrates of diameter 55 mm, with a surface roughness of $\lambda/4$ (RMS value) at λ = 550 nm have been procured and have been verified for the surface roughness at IIA. Thermal analysis of the substrate assembly was carried out using FEM simulation. Components such as E7 LC material, spacers, sealant etc have also been procured and other procurements are under progress. Using these, three sets of prototype LCRs have been fabricated at IISER-TVM, each set with a substantial improvement in the uniformity of retardance over the

previous one. These were characterized using the Full Stokes Polarimeter setup developed by IIA.

Figure 6.9: *Left: Cutting of ITO coated glass substrates; Right: Spin coating of Nylon on the substrates.*

Full Stroke Polarimeter for Characterization of Retarder

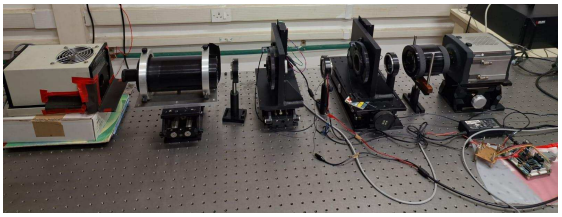

Figure 6.10: *Lab setup for full Stokes polarimeter for characterisation of retarder.*

A Full-Stokes Polarimeter was developed to characterise the LCRs (see Figure 6.10) and consists of two parts: Polarization State Generator (PSG), which generates a known State of Polarization (SoP) for illuminating the sample, and Polarization State Analyser (PSA), which analyses the output SoP from the sample. The design obviates the need to rotate the sample, and the surface can be imaged onto a camera, which is used for the characterisation of the retardance at various locations. Software was developed to interface with the camera, and an algorithm to provide the retardance map of the surface of the LCR was created, and the software has also been upgraded to accommodate scripting for automation. Mechanical mounts have been designed and fabricated, and following an optimisation effort using Zemax, and procurement of optical components is ongoing.

Development of Controller for Fiber Positioning System

The development of a controller for Fiber Positioning System (FPS) features a 3×3 fibre unit configuration mounted on robotic arms to enhance the Integral Field Spectrograph (IFS) capabilities with the Vainu Bappu Telescope. This helps to optimize observation time and maximize scientific output by linking the OMR spectrograph, Echelle spectrograph, and Integral Field Spectrograph (IFS) at the prime focus of VBT. The FPS integration facilitates efficient and synchronized operation of all three spectrographs, enabling seamless switching between instruments during observations. A controller for positioning the robotic arm of the FPS is also being developed.

6.2 Computer and IT infrastructure division

Migration of IT infrastructure and services to the new Data Center

Following the completion of the renovation of the Data Center (DC), it was required to migrate the entire IT infrastructure and services to it, which was a substantial amount of work performed by the Computer and IT infrastructure division. Some racks needed to be reused and other activities like PAC

installation needed to wait till its completion, all of which was to be done within 48 hrs.

Activities like restoring ISP connectivity and fibre connectivity between the different IIA blocks and the Data Center as well as patch panel cabling between server and network racks and iPDU installation in the different racks, are independent of each other and were carried out in parallel. However, many tasks were interdependent and needed to be prioritised. For example, precision ACs (PACs) installation had to follow all the racks being positioned in the DC, but some racks were already in use in the make-shift DC. Hence, a complete shutdown was done and one rack at a time was shifted to the new location. Likewise, inter-rack cabling between the patch panels of the different network and server racks cannot be achieved unless all the racks have been positioned and fixed. Once a priority list was made, the vendor was asked to provide an activity schedule with estimated time duration for each task as well.

Parallel and interleaving tasks including restoration of ISPs and LAN (Copper/Fiber) connections to different blocks of the institute, lifting and shifting of racks, servers, switches etc., unmounting and mounting of active IT components, patch panel cabling and testing, provisioning of connectivity from network rack patch panels to server rack patch panels, connection of active components to IIA network including labelling of patch panel ports etc were undertaken. The entire activity was carried out in such a way that the Computer and IT infrastructure division was able to resume all critical Data Center services within the stipulated downtime as announced to the end-users (see Figure 6.11).

Release of the new computational server (FORNAX)

A new server was released as a replacement for FORNAX with the latest hardware and upgraded specs with the same name to keep the perpetual IDL license server (v8.4.1) available for users. The server was configured to permanently retain the same MAC address on reboot as well. The server has been provisioned with an online account request form for users, and the server has been provided with a Linux modules (Lmod) feature as well (see Figure 6.12) so that the users can have the flexibility to change the environment settings on the fly.

The server has been configured with INTEL compiler suite (OneAPI) and other astronomy software as well. The /home directory on FORNAX has been provisioned on the XFS filesystem and XFS quota has been implemented. Hyper-threading feature has been disabled in BIOS to improve CPU performance. The firewall configuration was set up to avoid exposing any unused ports to the outside world. The two latest available versions of Python (3.9.16 and 3.11.4) were installed using miniconda setup and the python virtual environment was created and provisioned using module setup. The server has been provisioned with an in-house developed wrapper script "add-user" to automate the implementation of the HOME directory quota at the time of user creation itself. IDL license server application (lmgrd) was configured as a daemon on the new FORNAX server so that there is no need to start the license server application every time the server is restarted.

A mailing group for FORNAX users has also been created using Mailman to keep users informed by the server admin on the various

Figure 6.11: *Migration of IT infrastructure and services to the new Data Center.*

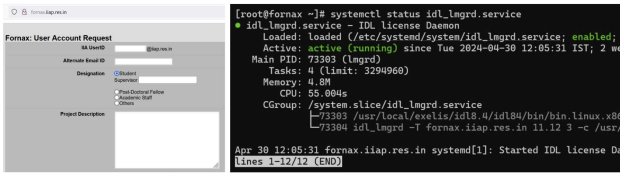

Figure 6.12: *Left: FORNAX account request form; Right: IDL LMGRD as daemon on FORNAX.*

activities related to the FORNAX server. The server comes with a single socket AMD EPYC 7302P (3.0 GHz, 16 cores, 128 GB L3 Cache), 512 GB DDR4 Memory and 5 TB of usable storage space.

Release of Visualization Node (VINO)

Visualization node with #1 NVIDIA A2 Card was configured with the latest version of NVIDIA drivers and CUDA Toolkit and was integrated with NOVA head node by writing and automating scripts to replicate the user profiles of NOVA head node on the Visualization node at regular intervals. The node was also provided with IDL software and INTEL compiler suite and provisioned with Linux module (Lmod) features which allows users to change the environment settings on the fly.

NCCC Project Phase-I

Phase-I of Nationwide Deployment of Honeypots Devices for Cyber Threat Intelligence (CTI) generation for National Cyber Coordination Center (NCCC) project by CERT-In and MietY has been completed at IIA. Honeypot devices have been deployed, installed and configured in our campus as per the agreed Rules of Engagement for Cyber Threat Intelligence (CTI) generation. The device was provided with 2 U rack space inside our DC and required power and cooling were provisioned for the device.

NCCC Project Phase-II

Phase-II implementation of (NCCC) by CERT-In and MietY is currently underway. The required information such as details of the ISP service providers, the routers and firewall details in the network, internet-facing servers and applications, their system soft-

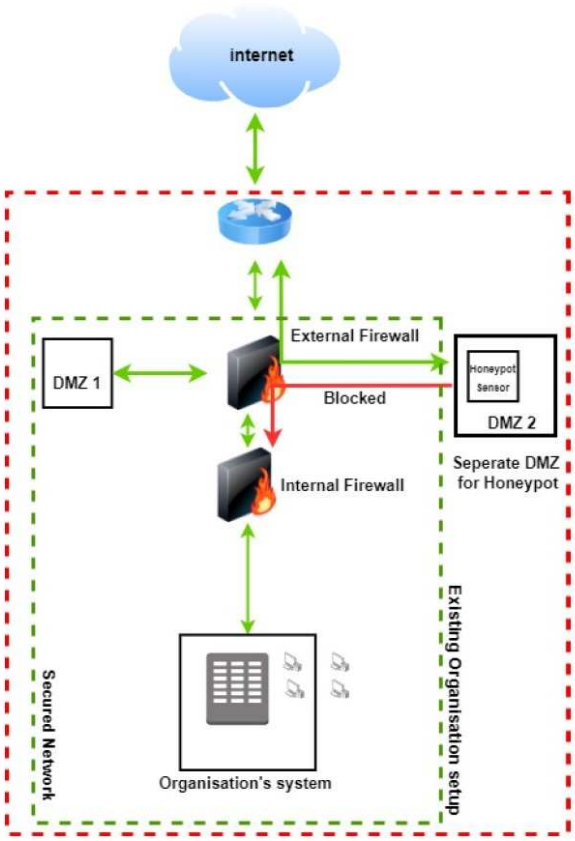

Figure 6.13: *Deployment Type II.*

ware and app server details, database details etc. have already been shared (see Figure 6.13).

Data Center Renovation

The Data center was renovated to TIER III standards to enhance efficiency, reduce operating costs, and minimize environmental impact. It is now equipped with state-of-the-art in-row cooling systems designed to provide efficient and precise temperature control while minimizing energy consumption. These cooling systems utilize modern techniques such as variable-speed fans and cold aisle containment to optimize airflow and reduce cooling-related energy costs. The system is modular, scalable and energy efficient, and redundancies in network, power, and cooling. It has remote system management, cold aisle design, iPDUs & iBMS, and an Aditya Smart Server.

The thermal control is equipped with FAS, VESDA, WLD, RRS, NOVEC, access & CCTV, jas in-row precision cooling system with focused cooling and efficient air flow management, inbuilt heater and humidifier, intelligent building management system, monitoring systems with critical alarm capability, fire detection, and fire suppression with NOVEC 1230.

The network system has the latest network cabling infrastructure, CAT6A and fibre ports for cross patching, enhanced server hosting capacity with additional racks, and monitoring of server power parameters through iPDUs. The electrical system has N+N redundancy in UPS and PDUs, grounding and signal reference grid for zero potential, zero N-E voltage isolation transformer, EMS and temp monitoring, dedicated breakers for each UPS, and DB for ADITYA server. The civil works include vinyl flooring, painting, furniture, walls, doors, partitions, access flooring (fire-rated), and pest control.

Aditya Servers with Smart Row Cooling

Intelligent Integrated Infrastructure with inbuilt hot and cold aisle containment with 2 racks with required redundancy in power and cooling for computing requirements of VELC/Aditya-L1 was created and housed in the renovated data center. Intelligent integrated infrastructure includes redundant or backup power supplies, environmental controls (precision air conditioning, fire suppression, smoke detection, water leak detection and humidity sensors), and security devices. Critical systems like UPS and precision air-conditioning systems have N+N topology respectively. Environmen-

tal monitoring is done with IP-based software.

The system includes in-row precision cooling (20KW), cooling redundancy N+N, in-built heater and humidifier, variable using digital scroll, fire alarm and detection, automatic novec1230-based fire suppression, water leak sensor, IP-based biometric access control, and rodent repellent system. The server and network components include R750 servers, R450 web server, NX3240 NAS, total power of 13 KW from servers, 24 port network switch, KVM extenders, and networking up to ADITYA/UVIT POC room.

6.3 Mechanical Division

KSO Tunnel Telescope

The refurbishment work of the secondary mirror RA & Dec axis drive assembly of the Kodaikanal Tunnel Telescope was undertaken at the Workshop. Both axes were exhibiting vibrations, leading to unstable images. The drive assembly consisting of AC motor, stepper motor coupled with electromagnetic clutch, along with a mounting base have now all been replaced (see Figure 6.14).

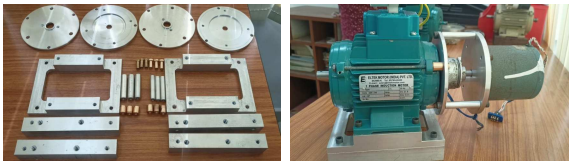

Figure 6.14: *RA & Dec refurbishment and the AC Stepper Motor for the KTT*

Hi-res solar imaging at VBO

To facilitate an experiment to perform high resolution imaging of the Sun using the 30-inch Telescope at VBO, a re-imaging unit was designed to magnify the image formed by the telescope by a factor of two, allowing diffraction-limited sampling with an S-CMOS detector. This unit was then manufactured at IIA's workshop (see Figure 6.15).

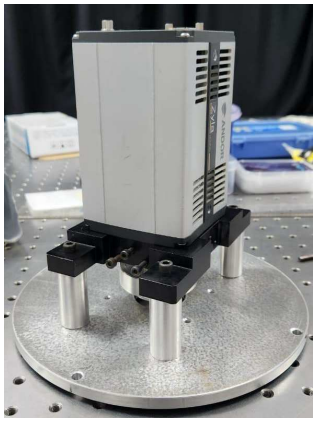

Figure 6.15: *The high resolution re-imaging unit*

VBT OMRS & Wide field corrector

A Wide-Field Corrector for the Vainu Bappu Telescope (VBT) prime focus, to enable wide-field imaging, was designed and developed (see Figure 6.16). In parallel, a setup that will enable the use of both the OMR Spectrograph and Echelle spectrographs on the same night is also being developed. Design, preparation of detailed engineering drawings and manufacturing of the WFC mount for the VBT prime focus is being carried out by the Division.

Figure 6.16: *Wide Field Corrector (WFC) for VBT Prime Focus.*

SCALES

Slicer Combined with Array of Lenslets for Exoplanet Spectroscopy (SCALES) is a

thermal infrared integral field spectrograph and high-contrast imager being jointly built by UCSC/UCO/UCI and IIA.

Cold Stop Rotator Subsystem

A cold-stop rotator is one of key subsystems for SCALES, and is designed and built by IIA. For its operation the instrument will be cooled to liquid nitrogen (LN2) temperature. The background thermal noise at these wavelength coming from the telescope structure can be significantly high and has to be minimized. The cold-stop rotator will hold a pupil-stop mask matched to image of M1. The precision manufacturing of cold-stop rotator sub-assembly has been carried out at the mechanical workshop following the thermal cycling process as specified by the project (see Figure 6.17).

Figure 6.17: *Cold Stop Rotator Subsystem*

IFS Filter Mount Subsystem

Some of the development and manufacturing work that has been carried out for the filter mount subsystem include machining of 18 sets of aluminum filter cells, filter clamping pads, cell covers, and gaskets for the filter wheel, teflon spacers with cover made from aluminium 6061, and gasket for holding spectrograph filters. Thermal cycling process operated in cryogenic temperature condition (−200°C), and outsourced wire cut operation to prevent high stress on optics were also performed. This has been tested in the Lab with the available sample filter, and the thermal cycling was carried out as per the procedure supplied by USC, USA, at the mechanical workshop.

Figure 6.18: *Aluminium filter cells, filter clamping pad, and gasket for IFS filter wheel.*

Thirty Meter Telescope

Two ITCC Mirror Handling Trolleys were fabricated as per required specifications to use as tool carts and vacuum lifter storage station for the TMT segment and polishing at ITOFF.

Support for outreach activities

Figure 6.19: *(left) Laser holder, (bottom) Nasmyth telescope concept, (right) Laser holder arch*

The mechanical structure for the optics adapter assembly for the demonstration of

optics principles for outreach activities using lasers was manufactured in the workshop (see Figure 6.19). A laser holder assembly with tip tilt arrangements was made in the workshop. A metallic arch to hold 11 lasers was also fabricated. The laser beams, reflected from a concave mirror, is being used to demonstrate the principles of optics. A mount for laser pointers was fabricated to demonstrate the principle of a Nasmyth telescope assembly. This is a three-mirror telescope prototype model, in which the lasers are mounted to the laser holder fabricated and the parallel beam follow the path of the rays in a Nasmyth focus in a telescope with segmented mirrors.

50 cm Dome Drive system for Hanle

The mechanical workshop manufactured the required spares for the 50-cm dome enclosure at Hanle, Ladakh, and procured items such as helical springs, bearings etc (see Figure 6.20). The spares include dome drive wheels, idler wheels, guide wheel shafts, drive and idler wheel axles, etc., which are worn out on regular use, and were manufactured.

Figure 6.20: *Drive system for 50-cm telescope.*

Coeleostat mirror assembly & X-Y Linear stage platform

The design and preparation of drawings of the complete first mirror assembly and X-l Linear stage, second mirror, and re-imaging lens mounts with pedestals were carried out at the Workshop for use at KSO (see Figure 6.21). The cell assembly was mounted and moved over the X-Y linear stage to point towards E-W and N-S and was fabricated using precision linear bearings and guide rods to achieve smooth linear movement to locate the sun's image during various seasons.

Kodaikanal Tunnel Telescope

A precision linear stage assembly was fabricated to mount three CCDs at the spectrograph plane at the Kodaikanal Tunnel Telescope, to make spectropolarimetric observation simultaneously in various spectral lines of interest. The linear stage assembly was then interfaced on to the KTT (see Figure 6.22) and was found to work satisfactorily.

Enclosure for Hα telescope, Merak

A sliding enclosure and its automation was designed and fabricated for the Hα telescope at Merak, Ladakh. The sliding enclosures at Kodaikanal and Merak are currently operated manually and now been motorized.

Spectro-Polarimeter enclosure

Fabrication of a spectropolarimeter enclosure

Figure 6.21: *Fabrication of Coelostat*

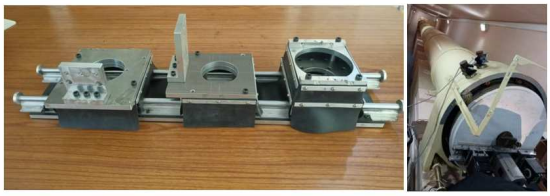

Figure 6.22: *Linear Stage Assembly.*

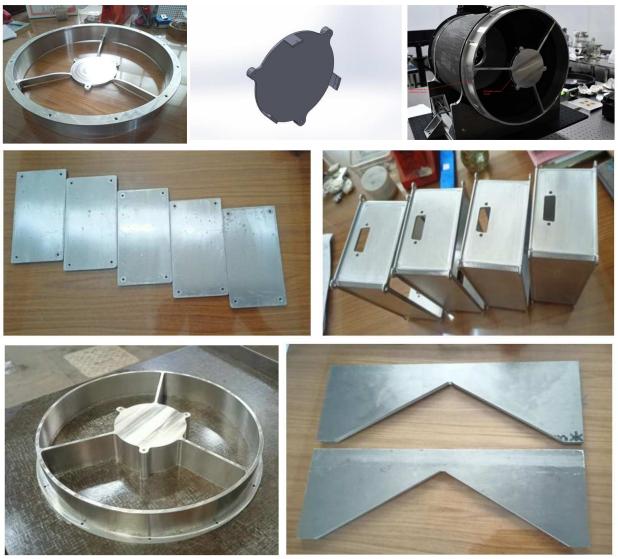

Figure 6.23: *Components for SING Payload*

assembly and aluminium tool post holders to hold the optical components, were fabricated at the workshop.

Sieve container for JCBT

Machining of CCD 4482 molecular sieve container was done for the 1.3-m JCB Telescope at VBO, Kavalur.

Spectroscopic Investigations of Nebular Gas Telescope

Spectroscopic Investigations of Nebular Gas (SING) is a Near UltraViolet (NUV) spectrograph, being designed at IIA. It is a compact spectrograph designed for operation in the 1400-2700 Åwavelength range, and is capable of obtaining multiple simultaneous spectra. SING was assembled, calibrated and tested at the MGK Menon Lab at IIA's CREST campus. The mechanical workshop developed the secondary mirror mount, spider mounts, V-blocks and other accessories and five aluminum plates were also machined to suit the connector boxes to use inside the payload (see Figure 6.23). The secondary mirror spider mount and aluminium sheet metal was manufactured using IIA's CNC vertical Machining centre.

Polarimeter experiment

Mirror mounts, housing and interface to rotation stage were made for the polarimeter experiment. The design, preparation of engineering 3D model, detail part drawings including assembly and fabrication of aluminum mirror mounts, housing and interface to the rotation stage for characterization of K-mirror arrangement of three mirrors, etc were all fabricated at the mechanical workshop.

Liquid Crystal Retarder

For the characterization of the Liquid Crystal Retarder, 55 post holders of different lengths were manufactured for holding optical components. A mounting base integrated with tube holding rings was also fabricated for the for polarimeter collimation (see Figure 6.24).

Figure 6.24: *Holders and mounting base for the Retarder*

6.4 Civil Division

IIA Bengaluru Campus

[1] Four office rooms needed civil works due to leaks and damaged flooring. Accordingly, new laminated wooden flooring, replaced false ceilings, new UPVC windows, replacing doors and partitions with

gypsum or wood, and waterproofing and painting were carried out.

[2] The toilets in the ground and first floor were renovated completely, including remodeling, replacing fixtures, installing new washbasins, changing tiles, adding exhaust fans, and painting. A changing area was added to the ladies toilets.

[3] All of the old and rusted steel windows in the Main Lab and Annexe Buildings were replaced with new UPVC windows due to issues with leaks and pigeons. This involved removing old windows, finishing the jam areas, and patch painting.

[4] The student area (Ramanujam Block) was extensively renovated, which involved installing sliding UPVC windows, adding a false ceiling, waterproofing the roof, replacing damaged roller blinds, and adding a stainless steel mesh to ventilators.

Figure 6.25: *Civil Work at IIA Koramangala Campus*

COSMOS-Mysuru construction

IIA had appointed M/s Kothari Associates, Kolkata, as the project architect for the construction of the planetarium building and allied blocks for the COSMOS-Mysuru project. Detailed planning and cost estimation have been finalized. To expedite contractor selection and avoid delays, contractors were shortlisted. Following a poor response to the initial tender document, a revised/modified pre-qualification tender was issued based on the recommendations of the Civil Works Committee (CWC), which recieved a good response. After due diligence by the CWC members along with the architects, and the completed evaluation process, the contract was awarded to M/s. R N R Construction Pvt. Ltd. Currently, the contractor has commenced work and completed the substructure. The construction of the superstructure is underway with the ground floor and first floor tie beams in place. Photographs of the construction phases can be found in Section 5.6.

CREST Campus, Hosakote

[1] Following the earlier construction of stone masonry compound walls on the west and north side, construction of the remaining boundary walls on the east and south sides were taken up. A total of 1020 metres of boundary wall was constructed. A grand entrance to the CREST campus was also built.

Figure 6.26: *Civil Work at CREST Campus, Hosakote*

[2] In compliance with government regulations for barrier-free environment for physically disabled individuals, guest rooms and toilets in the CREST campus were renovated, and a new 'Divyangjan toilet' was constructed at the Main Lab

building as well. The work included new floor and wall tiles, sanitary fixtures, doors, and sewage lines, and extensive painting was also undertaken. A ground floor toilet was modified for Divyangjan access, ladies' toilets were renovated and damaged wash basins and fixtures in guest rooms were replaced.

Vainu Bappu Observatory, Kavalur

[1] Many of the rooms in Lab B are old and needed major renovation. This was done, including the provision of a 'Divyangan toilet' in one of the rooms.

[2] To fix issues of leaks and damaged fixtures, a number of toilets in the buildings housing the VBT, the 40-inch telescope, 30-inch telescope, powerhouse, work shop, TV room, carpentry building, admin building, and security hut were renovated.

Figure 6.27: *Civil Work at VBO, Kavalur*

[3] A new toilet was constructed in the JCB Telescope building, since none existed.

[4] Six residential quarters, which were old and needed repair, were renovated extensively and made ready for inhabiting.

[5] Many of the existing pathways in the campus were damaged, and these were identified and renovated.

Kodaikanal Solar Observatory

Figure 6.28: *Civil Work at Kodaikanal Solar Observatory*

[1] The Mangalore-tile roofing in many buildings in the Observatory had developed leaks recently, and hence those in the auditorium, library, stores, VB hall, annexe, and power house buildings were all replaced.

[2] The existing retaining wall fell during the previous monsoon and needed to be reconstructed to avoid land slides. It was also necessary to install cow catchers at the existing staff quarters entrance to prevent entry of bisons. Both these works were completed during this period.

[3] In view of the 125th anniversary celebrations of the Observatory on 1 April 2024, various buildings were painted afresh.

[4] The I&M building needed major renovations since its inauguration in 2012, and civil works including crack filling, leakage arresting, painting, etc were undertaken.

[5] Various civil works were carried out in the administrative building to arrest leakage. The front portico was also extended for parking purposes.

Indian Astronomical Observatory, Hanle

[1] A block of design similar to that of the Hanle staff accommodation is being undertaken on the top of Digpa Ratsa Ri, with provision for three double-sharing rooms with essential sanitary facilities.

[2] The renovation of the Hanle House with upgraded structures is being planned, and the project has been awarded to a suitable external agency.

[3] IIA plans to install the National Large Solar Telescope (NLST) at Merak, Ladakh and the site has been allocated to the institute. The initial step involving soil investigation, crucial for designing the pier and other structures due to the proximity to a water body, is in progress.

Figure 6.29: *Civil Work at IAO, Hanle*

6.5 Electrical Engineering Division

Data center: electrical migration

The electrical work for the migration of the data centre was undertaken (see Figure 6.30).

Figure 6.30: *Data Center Migration*

200KVA Transformer

The electrical work for the 200KVA Transformer at Bhaskara complex was undertaken (see Figure 6.31).

Figure 6.31: *New Transformer Base*

Work at KSO

Telescope control system development for the Hα telescope at the Kodaikanal Solar Observatory was undertaken since the existing model is obsolete. A new motion controller (Omron CK3M), digital IO cards, guide CCD data acquisition card were procured. Modules were developed independently in-house and integrated with the telescope control system program and tested.

Periodic UPS maintenance was carried twice in the period at various locations in the Observatory and Hα telescope inverter card, IGBT, and charger cards were replaced.

6.6 Internships and training

[1] Internship of student Amulya K for the project "Development and Implementation Of Pincushion Distortion Correcting Algorithms" from March to May 2023.

[2] Internship of students Srinivas Prabhu and Upendra Ashwin Pai for the project "Design of Photodiode Readout Circuit for Sun as a Star Polarimeter" from June 2023 to August 2023.

[3] Internship of students Khushi Kedia and K. Shreya for the project "Development of Python-based Camera Interface Software" from June 2023 to August 2023.

[4] Internship of student Sinchana Jain for the project "Characterization of Polarization Rotators using Full Stokes Polarimeter" from September 2023 to March 2024.

[5] Internship of student Aditya Deshmukh for the project "Development of Controller for WFOS grating exchanger" from November 2023 to May 2024.

[6] Internship of student Tejesh Raj for the project "PID Temperature Control System".

7

Science Communication, Public Outreach, and Education

IIA Science Communication, Public Outreach, and Education (SCOPE) Section is responsible for the design, coordination, and implementation of the relevant activities for the institute. This chapter covers SCOPE activities, as well as the outreach activities undertaken by field stations in their locations.

7.1 Public engagement events

The SCOPE Section organized a number of events that were able to reach a large number of people. By nature, these are single events of short duration, but they serve the purpose of promoting awareness of astronomy and IIA to the public in one go. Organizing these events also necessarily involved the efforts of many people from the institute, especially the student community and the administration and support staff.

7.1.1 National Science Day 2024

National Science Day was celebrated as the IIA Open Day on 25 February 2024 at the Bengaluru campus, and more than 4000 visitors, which includes students and the general public, visited the campus throughout the day. The Open Day was organised to celebrate National Science Day by showcasing the work of IIA and engaging them in fun learning events. Several science organisations were invited to set up stalls, and various sections of IIA were instrumental in creating a large number of activities and interaction centres across the campus (see Figure 7.1). These are summarised below.

Demonstrations and experiments

[1] The Optics Division organised multiple experiments designed and fabricated in-house to demonstrate the principles of a telescope using lasers, live demos of light reflection using lasers, and a display of spectra, as well as the mirror grinding and polishing tools used in the lab.

[2] More than 25 posters on the basics of astronomy, IIA's observatories, ongoing and future projects undertaken by the institute, career guidance, etc, were displayed, and the students and staff were at hand to explain them.

[3] Many scaled models of telescopes operated by IIA as well as models of upcoming projects were displayed, and explained by the engineering staff including UVIT, VELC, VBT, TMT, NLST, etc.

Figure 7.1: *IIA Open Day on 25 February 2024, at IIA Bengaluru campus.*

[4] IIA Space Payload Group demonstrated a tethered Helium balloon equipped with a webcam, to explain the potential of balloon-based experiments in astronomy and atmospheric sciences.

[5] IIA Archives and Library section displayed many historic artefacts from the 230+ years of history of IIA and this was extremely popular with the visitors.

Public talks

Popular talks were organised in English and Kannada during the day, along with a public reading of a book of verses on astronomy by its author with the publisher invited to sell copies of the book. All of these were well attended and were live streamed as well. A special talk on scientific temper was organised on National Science Day.

Black Hole Shadow (in English)
Sanved Kolekar
Indian Institute of Astrophysics

Planetary Verses: a book reading (in English)
Biman Nath
Raman Research Institute

Have astronomers seen the first stars of the Universe? (in Kannada)
Udaya Shankar
Raman Research Institute

Science as a candle in the dark (in English)
Ajith Parameswaran
International Centre for Theoretical Sciences, ICTS-TIFR.

Activity corners

Stalls and specific areas were set up as activity corners to engage the visitors.

[1] Telescopes were set up by IIA as well as Bangalore Astronomical Society for the visitors to safely view the Sun both in projection and through filters.

[2] An interactive quiz was set up on a digital kiosk, with prizes given as well.

[3] The DOOT (e-magazine run by the students of IIA) team set up a stall with many games and puzzles on astronomy.

External invitees

Many astronomy, space science, and educational organisations were invited to set up stalls and exhibits as well. These included (1) a set of exhibits from ISRO, (2) astronomy models from Jawaharlal Nehru Planetarium (JNP), Bengaluru, (3) Association of Bangalore Amateur Astronomers, (4) Bangalore Astronomical Society, (5) Jantar Mantar models by a well-known science populariser, (6) a publishing company to sell titled on astronomy in Kannada.

Other activities

[1] An 'Ask an Astronomer' session was organised throughout the day with multiple faculty members of IIA on stage to answer questions from the visitors.

[2] The Section created astronomy-themed merchandise for the visitors to purchase, in the form of bookmarks, postcards, stickers, etc.

[3] The Section worked with FlippAR to create an Augmented Reality postcard on the Thirty Meter Telescope.

[4] Feedback was sought from visitors through multiple modes, including online forms, feedback books and cards, and video interviews, all conducted by the students of the institute.

7.1.2 Public Exhibitions

SCOPE Section organised stalls in many science exhibitions across the country, which were crewed by students and staff, with posters on IIA's science and engineering activities (see Figure 7.2). These exhibitions typically received a footfall of a few thousand people over a few days. These include:

[1] 42nd meeting of Astronomical Society of India, IISc, Bengaluru, 31 Jan-4 Feb 2024.

[2] India International Science Festival 2023, Faridabad, 17-21 January 2024.

[3] Bengaluru Tech Summit 2023, Bengaluru, 29 Nov - 1 Dec 2023.

[4] Government Achievements and Schemes Expo, Pragati Maidan, New Delhi, 21-23 July 2023.

[5] Ladakh Nomadic Festival, Hanle, Ladakh, 15-16 July 2023.

Figure 7.2: *IIA stalls at exhibitions.*

7.1.3 Individual public events

Zero Shadow Day

Zero Shadow for Bengaluru was celebrated on 25 April 2023 (Uttarayana) and 18 August 2023 (Dakshinayana) with public events for everyone to participate in. Special demonstrations were organised on both days by fabricating hands-on models in the workshop. These included a set-up with co-aligned holes on parallel plates that allow light to pass only at local noon, gnomons for visitors to measure shadow lengths, and other models as well (see Figure 7.3). The visitors were engaged in talks on the phenomenon and about the Sun, followed by hands-on experiments. They were also shown sunspots using a coelostat.

Figure 7.3: *Zero Shadow Day at IIA Bengaluru.*

Chandrayaan-3 precursor: Luney Tunes

As a precursor to the 14 July launch of Chandrayaan-3, a unique public event was organised on 4 July 2023, viz., "Luney Tunes". A talk on the payloads of Chandrayaan-3 was delivered by Dr. S. Seetha. This was followed by the audience being invited to share songs and stories from their culture related to the Moon, which they did in multiple languages. with participation from all ages (see Figure 7.4). A database of these songs and stories Moon is being collated for future use.

Figure 7.4: *Luney Tunes: science meets arts.*

International Asteroid Day

International Asteroid Day was marked on 30 June 2023 with a public event which saw participation from mainly school students. Following a public talk on asteroids, visitors were invited to throw pebbles into cornflour, and observe the formation of impact craters (see Figure 7.5). They measured the crater sizes and investigated their dependence on the height from which the pebble was thrown, the size of the pebble, etc, and made note of their measurements.

Figure 7.5: *Asteroid Day on 30 June 2023 at IIA Bengaluru.*

Chandrayaan-3 landing

A public event was organised to watch the live streaming of Chandrayaan-3's landing on the Moon on 23 August 2023, which was attended by more than 150 people. Following the presentations of moon-related videos, the attendees witnessed and celebrated the successful soft landing on the Moon during the emotion-filled evening (see Figure 7.6).

Figure 7.6: *Celebrating Chandrayaan-3 landing.*

IISF precursor event

An outreach program as a precursor to the India International Science Festival (IISF) was organised at IIA on 21 December 2023, and was attended by more than 150 college students. Following a talk by the Director IIA on the nature of cutting-edge technology used in astronomy, a talk on the history of astronomy as well as the slide deck sent by IISF on the events of the festival were presented by Niruj Mohan Ramanujam (see Figure 7.7). This was followed by a talk by Ravinder Banyal on 'Life in the Universe', a tour of the campus and a Q&A session on career opportunities for engineering students at IIA.

7.1.4 Launch of Aditya-L1

The launch of Aditya-L1 was a momentous occasion, especially as it carried the Visible Emission Line Coronagraph assembled and tested at IIA's CREST campus. An extensive campaign was organised by the SCOPE

Figure 7.7: *The IISF precursor outreach event at IIA Bengaluru.*

Section to (1) create public outreach material about VELC and Aditya-L1, (2) promote awareness of the launch of Aditya-L1 in the public domain, and (3) work with the media on a national publicity campaign. This included the creation of multi-lingual infographics, multi-lingual video interviews, a press conference at the institute, and liaising with a large number of media personnel. These are covered in detail in Section 7.5.

A public event was organised to watch the live streaming of the launch, which was supplemented by talks on the Aditya-L1 mission, and was attended by more than 100 participants (see Figure 7.8).

Figure 7.8: *Celebrating the launch of Aditya-L1.*

7.1.5 Night sky watch

The Section organised 5 night sky watch sessions through the year (see Figure 7.9). Some of these events also had volunteers from the Bangalore Astronomical Society (BAS) bringing their telescopes to show the public as well. These sessions included the following and reached more than 1000 people.

Figure 7.9: *Night sky programs at IIA Bengaluru.*

7.2 Conference on Astro-Tourism & Astro-Entrepreneurship

Motivated largely by Hanle Dark Sky Reserve, there has been an increasing awareness and interest in astro-tourism among amateur astronomy groups and state governments. Hence there was a need for a common platform to share experiences and mutual learnings, develop training modules, establish standardised practices, etc. In the recent past, many amateur astronomers in India have grown to be 'astro-entrepreneurs', and organise astronomy events for schools and for the public following a diversity of financial models, supplementing many decades of voluntary work by a large number of science communication groups.

Therefore, in order to bring various stakeholders together, the SCOPE Section organised a national conference on "Astro-Tourism and Astro-Entrepreneurship in India" from 11-12 March 2024, in a hybrid mode. Spread over two days, the conference was attended in person by about 70 people with 60 remote attendees (see Figure 7.10). This included sessions for budding astro-entrepreneurs and astro-tourism ventures, the Hanle Dark Sky Reserve project, government officials, etc. A network of participants was formed which continues to remain active.

Figure 7.10: *Conference on Astro-Tourism and Astro-Entrepreneurship in India*

7.3 External collaborations

Apart from the ongoing collaborations with the UT Ladakh and LAHDC Leh for the functioning of the Hanle Dark Sky Reserve, and the University of Mysore for the COSMOS-Mysuru planetarium outreach project (covered in later sections in this chapter), many new collaborations were also established in this period.

IAU OAE Centre India

Following an MoU signed between IIA and the International Astronomical Union (IAU) Office for Astronomy Education (OAE) Centre India, hosted at IUCAA, the institute participated in the latter's nationwide baseline survey on knowledge of astronomy in schools. The detailed survey of students and teachers, which included written tests and interviews, was conducted in an urban school in Bengaluru and, through COSMOS-Mysuru, in a rural school in the Mysuru district. The results were tabulated and sent to the Centre, which is now in press.

Karnataka Panchayat Raj Commission

The Panchayat Raj Commission of the Government of Karnataka runs around 6000 rural libraries, called Arivu Kendras or Gram Panchayat Libraries, across the state and IIA has been promoting astronomy in these centres through SCOPE and COSMOS-Mysuru through various ways.

Astronomy e-Library in Kannada

The section compiled an exhaustive database of resource material in Kannada that is freely available online, and annotated each item by theme, relevant age group, etc. These included articles, videos, audio podcasts, newspaper items, online quizzes, books, etc. These were made available to the Commission for incorporation into their software for the librarians of all Arivu Kendras.

Information on astronomy events

Basic information on naked eye celestial events as well as information on related live streams like that of the Chandrayaan-3 launch etc were made available in the form of posters and audio snippets in Kannada, for distribution to all Arivu Kendras and further propagation.

Other activities like recording popular talks in Kannada were also done. More substantial

in-person activities were conducted through the COSMOS-Mysuru project, which is described later in this chapter. The institute is planning to enter into an MoU with the commission to scale up the nature of this collaboration.

IT for Change

The Section is in collaboration with the NGO IT for Change, which works with the Karnataka Education Department, to use astronomy as a vehicle for physics education with online tools. In this context, IIA staff delivered three talks for the B.Sc./B.Ed. Physics students at the NMKRV College for Women, Bengaluru. These sessions included one on astronomy citizen science by Sudhanshu Barway, one on galaxies by Mousumi Das, and one on using online tools like Stellarium by Vikranth Pulamathi.

Others

In addition to the activities mentioned above, the section has been collaborating with the Tamilnadu Astronomy & Science Society (TASS) in their work to promote astronomy education in all Model Schools in the state as well as in teacher training. It also worked with an external film production company to develop a film on how AI/ML and Big Data are used by IIA astronomers for their research.

7.4 Student and teacher programs

Olympiad Exposure Camp

In collaboration with the Homi Bhabha Centre for Science Education (HBCSE-TIFR) and Swami Vivekananda Youth Movement (SVYM) Mysuru, an Astronomy Olympiad Exposure Training Camp was organised through the COSMOS-Mysuru project during 19-22 February 2024 at SVYM campus. Further details are mentioned in 7.8.

Research Experience for School Students

In order to cater to the lack of many programs that expose high school students to research, a unique program, viz., Research Experience for School Students (RESS), was started. The aim of the program was to provide an opportunity for the students to work on a hands-on project that taught them to calculate and estimate parameters for astronomy-themed problems, using their pre-existing knowledge and without relying on computers (see Figure 7.11). A total of 12 students from 11 and 12 grades were selected and spent a week during May 2023 at the institute working with their respective faculty mentors, following which, they presented their results at the auditorium. They were also taken to visit the Vainu Bappu Observatory. The program received positive response and feedback was collected.

A Day with an Astronomer: Job Shadowing

A new venture called 'A Day with an Astronomer' was started in order for school students to understand what the typical academic life of a scientist is like. This Job Shadowing program, which is relatively uncommon in the country, was conducted in May-June 2023 and 18 students from 8-10 grades were selected and paired with an IIA staff each (see Figure 7.11). They spent an entire day with these mentors, attended their group meetings, asked questions about their work, etc. The program received a positive response and feedback was collected.

Figure 7.11: *The RESS and JS programs.*

Campus visits

Visits by schools and colleges to the Bengaluru campus have been streamlined since last year, leading to a substantial increase in the numbers. A total of 11 schools and 9 colleges, which included almost 1200 students, visited the campus on various days. For each of these visits, the students were informed about IIA and its facilities and activities, followed by a visit to the UVIT Model and, for smaller groups, a visit to the Optics Labs. College students were also informed about career opportunities at IIA. Many of these institutions expressed interest in continued engagement and the Section is discussing the possibility of creating Astronomy Clubs for them. In addition, the Section visited four schools and colleges in Bengaluru upon invitation, to deliver talks, evaluate science contests, etc.

7.5 Resource material creation

The Section created resource material on astronomy aimed at the general public in many forms: video, infographics, posters, booklets, etc, all of which are available for free download online. Whenever possible, many of these resources have been translated into multiple Indian languages as well, and some of them are described below.

#SkySCOPE Campaign

A new campaign, termed #SkySCOPE, was launched in June 2023, which aims to create simple infographics on upcoming and ongoing celestial events, astronomy news and events, etc, for the general public. The objective of this campaign is to promote awareness of astronomy, inculcate scientific temper, and combat pseudo-science and fake news about popular astronomy events. A total of 21 #SkySCOPE posts were created during the period covered in this report (see Figure 7.13), and many more have been produced since. These are designed primarily for dissemination through social media like WhatsApp and Instagram and have become quite popular. They find their way into various miscellaneous social media groups and are also picked up by journalists at times. Some of the more important ones have also been translated into Kannada through the COSMOS-Mysuru project.

Infographics and posters

The Section continued to design and print large-sized posters on various aspects of IIA activities for display in exhibitions like IISF and ASI, and in public events (see Figure 7.12). These included posters on the research done at IIA, the engineering facilities that are on offer to academic and commercial organisations at CREST, and the science and technology behind VELC.

A set of posters were also designed and printed on the Hanle Dark Sky Reserve, both in English and Ladakhi, which were displayed at Hanle as well in other national and international conferences. In addition, a number of e-posters were created to spread

Figure 7.12: *Some infographics and posters.*

awareness about special events like eclipses, in English and Kannada. The entire set of ten science posters were also translated into Kannada with the help of the COSMOS-Mysuru project.

Outreach videos

To promote awareness of Aditya-L1 and VELC during the launch, the Section conducted interviews of the VELC team at IIA in multiple languages, viz., English, Kannada, Tamil, Telugu, Hindi, Marathi and Odia, and these videos were publicised among the media houses and science communication groups in the relevant states and uploaded on the institute's YouTube channel (see Figure 7.14).

A series of 9 videos of time-lapses and interviews were made in-house of the equipment commissioning activities at the India-TMT Optics Fabrication Facility at CREST, from the unloading to assembly and testing of each equipment. These were uploaded on the Institute's YouTube channel and also shared by the TMT International Observatory.

Short videos aimed at social media were made for many of the public events for publicity and public awareness, including for open day asteroid day, zero shadow day, etc. A set of 9 promotional videos were also made for International Dark Sky Week 2023 by various IAO and HDSR personnel.

In collaboration with IIA students and the Gender Amity Cell, a series of videos were made highlighting the women astronomers of IIA, including students, engineers and faculty. The series continues to grow and has 14 interviews to date.

Other communication material

The Section regularly creates flyers for the purpose of dissemination to visitors, funding agencies, media, etc. A detailed flyer was made for the Hanle Dark Sky Reserve which was also distributed at international conferences and another was made aimed at engineering students which talked about the cutting-edge technology developments at IIA and career opportunities. In addition, the Section also makes posters to support the activities of other departments of the institute, viz., Board of Graduate Studies, Internal Complaints Committee, etc.

7.6 Publicity and media

The Section coordinates the Institute's publicity and media interactions, as well as social media engagement.

In the fortnight leading up to, and during the launch of VELC, the Section coordinated press releases, more than 15 interviews of members of the VELC team, and more than 10 appearances on TV channels. It also organised a well-attended press conference on the day after the launch which led to substantial media coverage in many languages (see Figure 7.15), and helped coordinate the press conference at the BM Birla Planetarium in Chennai post the launch as well. This led to 37 media articles in English that mentioned

Figure 7.13: *The #SkySCOPE campaign posts.*

Figure 7.14: *Some videos made by SCOPE.*

the Institute and 17 television appearances by the VELC team members.

Figure 7.15: *Press conference for Aditya-L1 launch, on 1 September 2023*

The work done by SCOPE was also presented in various conferences.

SCOPE for Students: New Initiatives for Schools by IIA, A talk
Vikranth Pulamathi, SCOPE Section Associate, IIA
42nd annual meeting of Astronomical Society of India, IISc, Bengaluru, 4 February 2024.

9 press releases were issued directly to the media personnel (e.g. naming of an asteroid after Prof. Jayant Murthy, aurorae sighted at Hanle, TMT mirror segment polishing), and 12 press releases were issued by the DST through Press Information Bureau on research highlights from the Institute.

Press releases by DST through PIB

[1] *Tracking the solar source of the most intense geomagnetic storm last year*, 1 March 2024

[2] *Estimations of the heat-budget of Solar Coronal Mass Ejections can pave the way for space weather forecasting*, 10 Jan 2024

[3] *Tracking a solar burst with multiple telescopes gives clues about source region characteristics affecting space weather*, 18 December 2023

[4] *DST institutes key drivers in Aditya-L1 mission: Design primary payload, first automated algorithm to detect CMEs*, 31 August 2023

[5] *New methodology developed can give accurate analysis of the historic time series of images of Sun*, 25 August 2023

[6] *Unique star discovered that challenges previous understanding of star formation processes*, 14 August 2023

[7] *New technique developed to search for closely merging supermassive black holes*, 3 August 2023

[8] *Novel observations of the Solar Mean Magnetic Field (SMMF) establish a closer connection to the Interplanetary Magnetic Field* , 21 June 2023

[9] *New study reveals higher temperature enhancements during acoustic shocks in the solar chromosphere*, 15 June 2023

[10] *New metric can help quantify image quality of the Sun taken from ground-based telescopes*, 20 May 2023

[11] *Strange flip-flop behavior of black hole binary star system in Milky Way attributed to its changing mass accretion rate*, 19 May 2023

[12] *Marching towards identifying Earth's twin beyond the Solar System*, 12 May 2023

Press releases issued by IIA

[1] *Invitation to 125th anniversary celebrations of KSO*, 29 March 2023

[2] *An asteroid named after Prof. Jayant Murthy*, 22 March 2024

[3] *IIA Open Day celebration*, 25 Feb 2024

[4] *Invitation to IIA Open Day*, 22 Feb 2024

[5] *India International Science Festival*, 21 December 2023

[6] *Comet Pons-Brooks imaged using HCT/IAO*, 27 November 2023

[7] *Aurora at Hanle and Merak*, 5 Nov 2023

[8] *Hanle Dark Sky Reserve Star Party 2023*, 18 October 2023

[9] *TMT Mirror Segments Polishing & Metrology Equipment Commissioned*, 19 May 2023

Social media presence

The Institute has social media accounts on YouTube, Instagram, X/Twitter, Facebook, and LinkedIn, and runs many groups on WhatsApp and their engagement continues to increase (see Table 7.1).

Table 7.1: *Engagement on social media*

Media	Num
YouTube (no. of videos FY 23-24)	58
YouTube (total views)	63,200
Instagram (total reach)	42,700
X/Twitter (followers on 15/9/2024)	12,400
Facebook (total reach)	61,300
LinkedIn (total reached)	60,000
WhatsApp (groups operated)	20

7.7 Hanle Dark Sky Reserve

Hanle Dark Sky Reserve (HDSR) is being operated through a tripartite MoU between the Indian Institute of Astrophysics, UT Ladakh administration, and Ladakh Hill Development Council Leh, with the active involvement of the local villagers in Hanle. HDSR is a science-based sustainable socio-economic development project that rests on the two pillars of preserving the

darkness of the night sky (through the Light Management Plan) and astro-tourism that benefits the local communities. Members of the local villages have already been trained as astro-tourism guides (HDSR Astronomy Ambassadors) and have been loaned telescopes (funded by UT Ladakh) to conduct night sky sessions for visitors for a fee. These activities continue to flourish in the region and have attracted national and international attention. In addition, the following events were organised by the IAU staff and SCOPE Section together.

A HDSR Local Area Committee was formed in July 2023 for local coordination and streamlining operations, with representatives from the Observatory, heads of all villages, and Astro-Ambassadors.

HDSR Star Party 2023

In one of its kind events, the Institute organised the first official star party for experienced amateur astronomers and astrophotographers at Hanle Dark Sky Reserve from 12-15 October 2023, with partial funding from UT Ladakh. The HDSR Star Party 2023 was attended by more than 30 amateur astronomers from across India, enjoying the pristine dark skies and capturing faint objects through telescopes and cameras that they had brought with them. Special astronomical phenomena like the Zodiacal Light, Gegenschein, and the shadow cast by Venus are only observable from sites like HDSR, and many exceptional and unique photographs were captured by the participants which have since appeared in many websites and media stories (see Figure 7.16). The event was also a learning platform for local Astronomy Ambassadors.

More than 20 media stories covered the HDSR Star Party and many of the participants wrote about their experiences online as well. The Institute has decided to make this an annual event and the next one is scheduled for October 2024.

Figure 7.16: *HDSR Star Party 2023*

HDSR at Hanle Nomadic Festival 2023

A 2-day Ladakh Nomadic Festival was organised by the Ladakh government organisations at Hanle during 15-16 July 2023 and attracted 1000s of visitors from Ladakh and across India. The festival was organized in the common grounds in viewing distance of the Observatory. Hence, the institute decided to have a strong presence at the festival to promote awareness of the Observatory and HDSR among the visitors.

An IAO/HDSR tent was set up with posters about IAO and HDSR in English and Ladakhi, small telescopes to see sunspots in projection and nearby objects, and giveaways (see Figure 7.17), and was crewed by IAO and SCOPE staff.

HDSR awareness, promotion and publicity

HDSR is increasingly being seen nationally and internationally as a unique project that brings different stakeholders together for development using astronomy. HDSR has also been covered extensively in the media

Figure 7.17: *IAO stall at the Ladakh Nomadic Festival, Hanle*

over the last few years, as well as on social media by astronomy enthusiasts. A total of 62 media articles about HDSR appeared in national and international publications.

Many talks were delivered on HDSR at the "Astro-Tourism and Astro-Entrepreneurship Conference" organised by IIA. It was also covered in talks delivered by IIA staff at other national and international conferences (see Figure 7.18). More than 15 talks on HDSR were delivered at conferences, schools and colleges and some are listed below. Photographs taken at HDSR, by Dorje Angchuk and others, have been promoted at diverse venues and in media and have become quite popular. IAO staff created 9 videos about HDSR for International Dark Sky Week.

Figure 7.18: *HDSR at ASI 2024 (left) and IAUS 386 (right).*

Some of the Invited Talks delivered by Dorje Angchuk (IAO, IIA) are:

Lighting up the Himalayas
IAU Symposium 386, Addis Ababa, Ethiopia, 13-18 November 2023.

Himalayan night skies from Ladakh
Celebration of Astronomy, ASI 2024, J.N. Tata Auditorium, 31 Jan 2024.

Himalayan night skies from Ladakh
Celebration of Astronomy, ASI 2024, J.N. Planetarium, 4 Feb 2024.

Lighting up Himalayas with stars: an astrophotography journey
ICTS-TIFR, Bengaluru, 14 March 2024.

Illustrating the uniqueness of Hanle, and exemplifying the unusually high solar activity during the current maximum, aurorae were seen at Hanle on 10 May 2023 and 5 November 2023. The videos and photos were released to the media and garnered enormous attention. Exceptional photographs of the Perseids and Geminids meteor showers also became popular (see Figure 7.19).

Figure 7.19: *(left) Aurora in May; (right) Geminids Meteor Shower (credits: Dorje Angchuk)*

7.8 COSMOS Education and Outreach Project

IIA is building the world's first commercial LED Dome planetarium in Mysuru under the COSMOS-Mysuru project, and this is envisaged to also serve as a centre for training students in data analysis and astronomy. The planetarium is executed through an MoU between the IIA the University of Mysore. The project has an associated outreach and education program that has been functioning since April 2022, with full-time employees and interns, and conducts events throughout the district of Mysuru. The activities are coordinated through the COSMOS-Mysuru Education and Public Outreach Committee with support from SCOPE Section. In addition, it also runs a project on the history of astronomy in the region dating back to 8-9th century C.E., which is responsible for identifying, digitising, translating, and analysing old manuscripts.

Public astronomy events

The outreach team organised a number of public outreach events in collaboration with the University of Mysore and amateur astronomers in the city. These are attended by students and the general public and include the following. More than 600 people were reached in these programs.

[1] *Night sky watch programs*, on 23 May 2023, 18 December 2023, 4 March 2024, at Vijnana Bhavan (UoM) and on 14 March 2024 at SBRR Mahajana College.

[2] *Astronomy in a cafe*, 22 September 2023, a quiz and a talk in collaboration with Kutuhali (in Kannada).

[3] *International Asteroid Day*, 30 June 2023, invited talks and a visit to see meteorites at the Geology Dept. (UoM).

[4] *Zero Shadow Day Workshop*, 17 April 2023, talks followed by hands-on measurements and experiments.

Astronomy education in the University

IIA has been organising a number of academic talks on various topics at the Department of Physics, University of Mysore, for M.Sc. students from across the city. These include:

[1] *Why Quantum Mechanics - I & II*, 19 & 25 Jan 2024, by N. D. Hari Dass, (Retd., IMSc, Chennai).

[2] *Khagola Vijnana Andu Indu*, 11 April 2024, by B. S. Shylaja (JNP), at Kannada Dept. (UoM).

[3] *Big Bang and Beyond, Unraveling the Cosmos*, 5 & 19 Aug 2024, by Pravabati Chingangbam & Fazlu Rahman (IIA) for the M.Sc. course on General Relativity.

[4] *Laboraties in the Sky*, 7 July 2023, by B. S. Shylaja (JNP).

[5] *Science Communication - Why and How*, 23 June 2023, by K. Sharma (Kutuhali).

[6] *Formation and evolution of galaxies*, 21 April 2023, by Ramya Sethuram (IIA).

[7] *Astronomical Roots of Physics*, 11 April 2023, by B. S. Shylaja (JNP).

Astronomy in urban schools and colleges

A large part of the activities of the outreach team consists of visiting schools and colleges in the city as well as in rural areas. During these visits, the team delivers a talk on basic astronomy concepts, conducts sunspot viewing, and organises some hands-on activities.

During last year, such events were organised in 6 schools, 3 PU colleges, 2 undergraduate colleges, and 2 summer camps, reaching about 1,535 people in total.

The outreach team was one of the co-organises of the Astronomy Olympiad Exposure Camp for high school teachers, along with IIA SCOPE, HBCSE-TIFR, and SVYM, held at SVYM Mysore during 19-22 February 2024.

A video contest was announced for high school students to celebrate the Chandrayaan-3 launch, which received 29 entries.

Astronomy in rural communities

Astronomy events at local schools

An important component of the program is to promote astronomy in schools and communities in rural areas. Rural school visits were undertaken along with the Committee for Science Education in Schools (CSES) of UoM and with Kutuhali, a science communication project in Kannada, and 4 such schools were visited, reaching more than 1500 students (see Figure 7.20).

Along with educators invited from JNP, talks were delivered to primarily rural school students who were invited by the University for a special camp in Mysuru.

The Astronomy Baseline Survey of the IAU OAE Centre India was conducted at Govt. High School Madapura, to sample a rural school in the state, and the results were tabulated and submitted.

Astronomy events at rural libraries

As a part of the ongoing collaboration between IIA and the Karnataka Panchayat Raj Commission, which runs around 6000 rural libraries or Arivu Kendras, the COSMOS outreach team has been working with the rural libraries in the Mysuru district to promote astronomy. In particular, the libraries in Bilikere Panchayat and Saligrama Panchayat have been chosen for more substantial in-person engagement. The team organised an event at each location with talks, slideshows, and sunspot viewing, and has continued the interaction since.

The team was also invited to conduct hands-on training on basic astronomy for the librarians from all 250 Arivu Kendras in the district that was organised by the local government and Kutuhali.

Astronomy citizen science program

COSMOS-Mysuru facilitates regular training for the International Asteroid Search Campaign conducted by the International Astronomical Search Collaboration (IASC), in collaboration with Hands-on Universe, India (HoU-I). These are facilitated by the HoU-I mentor, Ilavenil, and are conducted online after a selection process. The 4th, 5th and 6th such campaigns were organised in this period, with some provisional discoveries being made so far.

Resource material in English & Kannada

Resource materials were created in English and Kannada in the form of posters, podcasts, articles, etc and made available online.

Radio Manasa and podcasts

IIA entered into an MoU with Radio Manasa 89.6 FM, the community radio station of the University of Mysore to produce Nakshatrasabha, which are regular radio programs on astronomy covering recent news, the

Figure 7.20: *Outreach activities at COSMOS Mysuru*

objects visible in the evening sky, etc. In addition, scientists who visit Mysuru are interviewed on the radio program by the team, and these recordings are also uploaded online on Spotify. In this period, 2 general radio programs and 10 interviews were recorded and broadcast, half of which were in Kannada.

Short audio clips were also created in Kannada for selected naked eye celestial events, which were distributed by the Panchayat Raj Commission to all 6000 rural librarians in Karnataka. The team members were also interviewed by AIR Mysuru and other radio channels multiple times.

Posters, infographics and articles

Some of the #SkySCOPE posters and info posters on events made by the SCOPE Section were translated into Kannada by the team and distributed online to students, teachers, and science communicators.

Popular articles in Kannada were written by the project associate on Indian observatories, viz., VBO and SARAS for Kutuhali, a popular science magazine in Kannada, and Aditya-L1 for Bala Vijnana of KRVP.

Promotion and publicity

The local media in Mysuru regularly covers COSMOS outreach events, and 17 stories appeared in the English newspapers with a similar number in Kannada ones, during this period. COSMOS also has social media accounts on YouTube, Instagram, X/Twitter, Facebook, Spotify, and Amazon Music, and runs multiple WhatsApp groups as well, through which it engages with the public.

Education and outreach activities of COSMOS-Mysuru have been presented in conferences as well and those delivered by N. Amoghavarsha, COSMOS outreach associate, are:

COSMOS Mysuru: A unique venture to build astronomy education in conjunction with an LED Dome planetarium
A talk at the 42nd annual meeting of the Astronomical Society of India, IISc, Bengaluru, 4 February 2024.

Stargazing to Star-teaching: Effective Approaches for Astronomy Education in Action
Online poster at 5th Shaw-IAU Workshops by the OAE, 29 November 2023.

Effective methods for astronomy educational programs in a multi-lingual region
Online talk at Global Hands-on Universe Conference, Japan, 24 August 2023.

History of Astronomy project

A unique project has been started under COSMOS, to identify, collate, digitize, and catalogue material on astronomy and related sciences over the last couple of centuries that have been written in, or sourced from the old Mysore province. This is one of the few attempts to do so in a language other than Sanskrit and the texts found so far are in a variety of languages (Old Kannada, Sanskrit, Prakrit) and also written in a variety of scripts (Old Kannada, a few types of Nagari, Pali, etc). These need to be carefully analyzed, transcribed, and then translated, in order to arrive at an authentic version of the astronomy content in them. This work has been done by a dedicated project assistant under COSMOS in collaboration with B. S. Shylaja of Jawaharlal Nehru Planetarium, with help from a few linguistics experts.

Over 20 manuscripts from Oriental Research Institute and Kuvempu Kannada Adhyayana Samsthe of UoM have been obtained, and of these, 5 have been transcribed and translated. Analysis of these manuscripts is ongoing, and these are Laghu Manasa Vyakhya, (see below), Graha Ganita Bhaskarah, Grahana Balabodhe, Chandra Suryamandala Vicharah, and a manuscript with 3 chapters on Romakasiddhantha, Vasista Siddhartha Goladhyaya and Soma Siddhanta.

The 17th century manuscript, titled Laghu Manasa Vyakhya and in Kannada/Telugu script, was obtained from ORI and was found to be a commentary on a 9th century manuscript showing how to calculate eclipses. This manuscript was translated and the calculations were analysed and compared with modern values. The results were published in the Journal of Astronomy and Astrophysics (JoAA) as well. A similar analysis of other works, including Grahaganita Bhaskara, is in progress. These are the first ever modern analyses of these manuscripts. Apart from this paper, the work was presented as below.

Laghu Manasa Vyakhya - a commentary in Kannada on the 10th-century manuscript
R. Punith, COSMOS-Mysuru, IIA
A poster at the 42nd annual meeting of ASI, IISc, Bengaluru, 31 Jan - 4 Feb 2024.

Laghu Manasa Vyakhya: a 17th-century commentary on eclipses in Kannada
B. S. Shylaja, JNP
IIA SCOPE Seminar Series, 11 January 2024.

The culture and tradition of astronomy in the South Indian State of Karnataka
R. Punith , COSMOS-Mysuru, IIA
Online talk at Global Hands-on Universe Conference, Japan, 24 August 2023.

7.9 Field station activities

IIA's field stations are mostly in remote areas but nevertheless attract a large and steady stream of visitors. Each field station also conducts other outreach activities, especially during celestial events, which are managed solely by the staff of the respective campuses and described below.

Vainu Bappu Observatory, Kavalur

Public events

National Science Day was celebrated at VBO

Table 7.2: *No. of visitors to field stations*

Campus	Students	General	Total
KSO	13,197	40,486	53,683
VBO	9,396	15,089	24,485
IAO	623	7,725	8,348
HQ	1,178	5,690	6,868
GRO	612	-	612
CREST	170	-	170

on 28 February 2024. 100 students from nine nearby government schools were invited, and a quiz and drawing contests were organised for them, followed by talks and a tour of the Observatory including the sun's image and spectrum (see Figure 7.21).

Founder's Day was celebrated on 10 August 2023 with contests and talks organised for college students in Tirupattur district, followed by a night sky watch program.

Figure 7.21: *Outreach activities at VBO*

Outreach infrastructure

To enhance the experience of the large number of visitors to the Observatory, many new outreach infrastructure and equipment were worked on during this period. The main structure is a coelostat being constructed on top of a tower which is used to project the Sun's image as well as a clear solar spectrum, which has been completed since. The Visitors Centre was renovated and new posters were made and displayed within. An Outreach Office was also established.

Public visits

The Observatory is well known in the region and beyond, and is open to all visitors every Saturday for an entry charge. In addition, special school and college trips are also permitted on occasion. Visitors are taken on a tour of the various telescopes at VBO, followed by a presentation at the VBT and night sky watch through smaller telescopes. In this period, 7191 students from 84 schools, 2205 students from 43 colleges, and 15089 members of general public, totally 24485 people, visited the Observatory.

Indian Astronomical Observatory, Hanle

The Indian Astronomical Observatory in Hanle is a popular destination for tourists to Ladakh, and 623 students and 7725 general public visited the Observatory in this period. They are given a tour of the HCT, with a presentation, and are allowed to visit MACE and HAGAR as well.

The substantial part of the outreach work done by the Observatory is to facilitate the Hanle Dark Sky Reserve in various ways, and this is described in detail in Section 7.7.

Kodaikanal Solar Observatory

The Astronomy Museum at the Observatory is a popular tourist attraction in Kodaikanal and about 53680 visitors including 87 school groups and 187 college groups visited during this period, most of whom visit on a chargeable basis. They are taken on tour of some of the telescopes as well.

Figure 7.22: *Outreach activities at KSO*

National Science Day was celebrated as Open Day with free entry. Contests like astronomy quizzes, drawing, elocution and essay writing were conducted for school students and over 1000 people visited on that day (see Figure 7.22). World Science Day was celebrated with a large group of students. A public event was organised to observe the lunar eclipse on 28 October 2023. The Observatory operates social media accounts on YouTube, Instagram, Facebook and X/Twitter. A state-level workshop was jointly organised with the Tamilnadu Astronomy & Science Society during 30 September - 2 October 2023 (see Figure 7.23).

Figure 7.23: *A workshop organized by KSO and TASS during 30 Sep - 2 Oct 2023.*

Gauribidanur Radio Observatory

The observatory is open to special school and college tours on prior approval. 18 different colleges visited the Observatory with a total of about 690 college students. They were taken on a tour of the telescopes and the control room, followed by an interaction with the engineers and scientists (see Figure 7.24).

Figure 7.24: *outreach activities at GRO*

CREST Campus, Hosakote

CREST staff visited a nearby government school to celebrate National Science Day with a talk and drawing and quiz contests (see Figure 7.25). A night sky watch was organized at the CREST campus for a large number of school students.

Figure 7.25: *National Science Day at CREST*

8

Special Lectures, Symposia, Colloquia, and Seminars

IIA organised special lectures throughout the year, viz., Founder's Day Lecture, Foundation Day Lecture, Vainu Bappu Memorial Lecture etc, as well as in-house symposia. The ones that were organised during the relevant period are covered in this chapter.

8.1 Founder's Day Lecture

Figure 8.1: *Founder's Day Lecture 2023 was delivered by Prof. Sujatha Ramdorai.*

Indian Institute of Astrophysics celebrates its Founder's Day on 10th August, which marks the birthday of its founder, Prof. Manali Kallat Vainu Bappu. An internationally renown astronomer, Vainu Bappu led the revival of optical astronomy in independent India and was responsible for inspiring and training an entire generation of optical astronomers in the country. His legacy of building telescope facilities, initiating new topics of research, and promoting quality science continues at the Indian Institute of Astrophysics, keeping India at the forefront of astronomical research.

10 August 2023
Vainu Bappu Telescope to James Webb Telescope: Role of Mathematics in Astronomy
Prof. Sujatha Ramdorai
Canada Research Chair at University of British Columbia, Vancouver, Canada.

The Founder's Day Lecture for 2023 was delivered by Prof. Sujatha Ramdorai of University of British Columbia, Canada, on 10 August 2023. The celebrations began with Prof. Ramdorai and the Director IIA, Prof. Annapurni Subramaniam, garlanding the portrait of Dr. Vainu Bappu in the library and his bust in the auditorium at the Bengaluru campus, followed by the lecture.

8.2 Prof. Peraiah Foundation Lecture

Prof. Peraiah Foundation Lecture has been instituted by Prof. Peraiah Foundation

with an aim to encourage scientific temper and excellence in research done in India. The non-profit Foundation is dedicated to promoting and encouraging astrophysics research in general and theoretical astrophysics in particular, within the country. The award-related matters are organised through an MoU between the Foundation and IIA. The Lecture Award is given at intervals of two years as a token of appreciation for the scientist's contribution to the field of theoretical astrophysics.

The Prof. Peraiah Foundation Lecture 2023 was awarded jointly to Prof. Archana Pai of IIT Bombay and Prof. Dibyendu Nandi of IISER Kolkata. The Foundation Lectures were delivered by the awardees on 5 January 2024 at the institute.

Figure 8.2: *Prof.s Archana Pai & Dibyendu Nandi delivered the Prof. Peraiah Foundation Lectures.*

5 January 2024
Intermediate Mass Black Holes in Gravitational Wave Astronomy
Prof. Archana Pai
Department of Physics, Indian Institute of Technology (IIT) Bombay, Mumbai.

5 January 2024
Living amongst Stars: Stellar Magnetism and Planetary Space Environments
Prof. Dibyendu Nandi
Department of Physical Sciences, and Head, Centre of Excellence in Space Sciences India (CESSI), Indian Institute of Science Education and Research (IISER) Kolkata, Mohanpur.

8.3 DAE C.V. Raman Lecture

IIA hosted the DAE C.V. Raman Lecture 2024 on behalf of the Indian Physics Association, and the lecture was delivered by Dr. Tessy Thomas, former Director General of Aeronautical Systems, DRDO, on 29 February 2024 at IIA Bengaluru.

Figure 8.3: *DAE C.V. Raman Lecture was delivered by Dr. Tessy Thomas.*

29 February 2024
Advances in Aerospace Technology, DAE C V Raman Lecture
Dr. Tessy Thomas
Distinguished Scientist & Former Director General of Aeronautical Systems, DRDO.

8.4 In-house Symposium

IIA organises an in-house symposium every year on 31 March and 1 April and this provides a forum for talks that update the institute on the status of telescope facilities, ongoing and upcoming projects, a few key divisions, and selected science talks. The Foundation Day Lecture is also held during this symposium. The lectures delivered during the symposium held during 31 March to 1 April 2023 are covered in this section. Apart from the talks listed below, selected students displayed their posters and gave brief summary talks as well.

(A) Research updates

- "Saturation mechanism of Fluctuation dynamos and insights from the morphology of structures in polarized synchrotron emission" by **Sharanya Sur**
- "Survival of Aromatically Fittest: Fullerenes near B type pre-main sequence stars" by **Arun Roy**
- "Rocket effect in molecular clouds near O-type stars" by **Maheswar Gopinathan**
- "Polarisation of Light- From Red Dwarf Stars to Blue Telluric Planets" by **Sujan Sengupta**
- "Emission from blazar jets: Challenges from new observations" by **C.S. Stalin**
- "Evolutionary connection of the H-poor central stars of Planetary Nebulae derived using IR study" by **C. Muthumariappan**
- "The search for planets around LkCa 15" by **Swastik Chowbay**
- "The stellar bar - dark matter halo connection in the TNG50 simulations" by **Sioree Ansar**
- "Type Ib Supernovae: A Tale of Binary Association of massive stars" by **Mridweeka Singh**
- "A comprehensive study of the galaxy group NGC 7733-34 using MUSE and HST" by **Saili Kumari Keshri**
- "Mining the GALAH data I: Study of five Super lithium-rich metal-poor giants." by **Susmita Rani Antony**
- "Spectroscopic study of classical Be stars using IIA optical telescope facilities" by **Gourav Banerjee**
- "Reconciling Meridional Circulation Measurements from SDO/HMI and GONG Observations" by **S. Paul Rajaguru**
- "Measurement of day-time turbulence profile at Kodaikanal Observatory" by **Kalyani Subramanian**
- "A study of Reconnection Flux during Solar Coronal Mass Ejection" by **Samriddhi Sankar Maity**
- "Probing the metal-rich gas reservoirs around galaxies over cosmic timeline" by **Ravi Joshi**
- "Unravelling the Dual Impact of Radiation and Jets: Insights into Feedback Mechanisms in Active Galactic Nuclei" by **Payel Nandi**
- "Exploring the Nexus: Powering Ultraluminous X-ray Sources with Intermediate Mass Black Holes" by **Santanu Mondal**

- "How does the presence of bar affects the fueling of supermassive black holes? IllustrisTNG100 perspective", **Vivek M.**
- "Star formation Rules in Galaxies from the Smallest Scales to Large Complexes" by **Mousumi Das**
- "Optical follow-up study of YY Hercules outburst" by **Sonith L.S.**

(B) Facilities updates

- "Kodaikanal Solar Observatory" by **B. Ravindra**
- "Vainu Bappu Observatory" by **P. Anbazhagan**
- "Gauribidanur Radio Observatory" by **C. Kathiravan**
- "50cm Robotic Telescope: Operation and Science highlights" by **Sonam Jorphail**
- "Visible Emission Line Coronagraph" by **V. Muthupriyal**
- "Development of a new robotic DIMM seeing monitor and atmospheric seeing at IAO Hanle" by **Tashi Thsering**
- "Indian Astronomical Observatory" by **D. K. Sahu**

(C) Ongoing and upcoming projects

- "IIA Inhouse CMOS Sensor Readout Electronics Development" by **Amit Kumar**
- "Optical Design Feasibility Study of 6.2m Multi-Observational Large Segmented Telescope" by **Totan Chand**
- "National Large Solar Telescope" by **Jayant Joshi**
- "codeSMT – An Integrated Modelling tool for Segmented Mirror Telescopes" by **Prasanna Deshmukh**
- "Proposal for the Development of Telescope Control System (TCS) for Himalayan Chandra Telescope" by **D. V. S. Phanindra**
- "My journey into the TMT project" by **Eswar Reddy**
- "National Large Optical-NIR Telescope" by **Maheswar Gopinathan**
- Slicer Combined with Array of Lenslets for Exoplanet Spectroscopy (SCALES)" by **Ravinder Banyal**
- "Experimental Validation and Qualification of India-TMT Buyoff Station" by **Alikhan Basheer**
- "Indian spectroscopic and imaging space telescope (INSIST)" by **Annapurni Subramaniam**
- "The impact of thermal variation on the sensitivity of a 2D Profilometer" by **Pramod Panchal**
- "Astronomy with small payloads: Science cases and opportunities" by **Rekhesh Mohan**
- "Development and testing of low noise photodiode readout circuit" by **Vishnu Madhu**
- "Data Centre" by **Anish Parwage**
- "Update on the new IIA website" by **Rekhesh Mohan**

8.5 Institute Colloquia

A total of 6 institute colloquia were organised by the Colloquium Committee during the period covered by this report.

7 March 2024
Cosmology without assuming a cosmology
Luca Amendola
University of Heidelberg, Germany.

5 March 2024 *Deciphering the physics of the early universe with gravitational waves*
L. Sriramkumar
Indian Institute of Technology Madras, Chennai India.

13 November 2023
Scientific Exploration to Benefit Humanity
Laurie Leshin
Jet Propulsion Laboratory, USA.

19 May 2023
The Galactic Warm Interstellar Medium
Shrinivas R. Kulkarni
California Institute of Technology, USA.

21 March 2023
Exoplanet Imaging with Current and Future Instruments
Andy Skemer
University of California Santa Cruz (UCSC), USA.

7 February 2023
Seismology of the Sun and Stars: What we have learned and what we need to learn
John Leibacher
Institut d'Astrophysique Spatiale, Université de Paris-Saclay, France Lunar and Planetary Laboratory University of Arizona

8.6 Institute Seminars

A total of 79 institute seminars were organised by the IIA Colloquium Committee.

15 February 2024
Supernovae interacting with circumstellar media
Takashi Moriya
National Astronomical Observatory of Japan, Tokyo, Japan.

13 February 2024
Quantum probes for quantum fields in curved spacetime
Hari K
IIT Madras

12 February 2024
Decoding electromagnetic wave signals from neutron star mergers
Masaomi Tanaka
Tohoku University, Sendai, Japan.

08 February 2024
Magnetic activity driven solar and stellar irradiance variability
Sowmya Krishnamurthy
Max Planck Institute for Solar System Research, Göttingen, Germany.

07 February 2024
The role of halo angular momentum distribution on bar formation, evolution and dynamical friction
Sandeep Kumar Kataria
SJTU, Shanghai.

30 January 2024
Machine Learning in the study of star clusters
Priya Hasan

MANUU, Hyderabad.

19 January 2024
Dark matter fraction across the galactic scales and cosmic time
Gauri Sharma
Observatory Astronomical De Strasbourg

11 January 2024
Observing radio transients - from counterparts of gravitational wave events to Fast Radio Bursts
Arvind Balasubramanian
Tata Institute of Fundamental Research, Mumbai.

09 January 2024
Distribution of atomic hydrogen in the TNG50 Fornax-like galaxy clusters
Avinash Chaturvedi
Leibnitz Institute for Astrophysics, Potsdam.

08 January 2024
Exoplanet atmospheres: A tale of evolution
Vigneshwaran Krishnamurthy
McGill University, Canada.

04 January 2024
Automatic Detection of Double-Nuclei Galaxies
Anwesh Bhattacharya
University of Illinois at Urbana-Champaign

28 December 2023
Tautenburg Solar Laboratory (TauSoL): a new full disk solar observational facility
Hemanth Pruthvi
Thüringer Landessternwarte Tautenburg, Germany.

21 December 2023
Probing interstellar Magnetic Fields with the Zeeman effect of Neutral Hydrogen
Ekta Sharma
NAOC, China

20 December 2023
Introduction to mid-infrared imaging for exoplanet detection and challenges
Prashant Pathak
IIT, Kanpur.

12 December 2023
New insights into magnetic processes that build the solar corona and drive the solar wind
Lakshmi Pradeep Chitta
Max Planck Institute for Solar System Research, Gottingen, Germany.

30 November 2023
The landscape of stellar and compact-object mergers through a time-domain lens
Viraj Karambelkar
California Institute of Technology (CalTech), USA.

29 November 2023
Extracting "new" binary black hole (BBH) mergers from the LIGO-Virgo O3b publicly released data
Ajit Kumar Mehta
University of California, Santa Barbara (UCSB), USA.

28 November 2023
Simulations of magnetized stellar atmospheres with MURaM
Tanayveer Bhatia
Max Planck Institute for Solar System Research, Gottingen, Germany.

09 November 2023
Galactic Chemical Evolution of rapid neutron capture elements and with short lived radioisotopes

Benjamin Wehmeyer
University of Wroclaw, Poland.

18 October 2023
Observational Signatures from the Shear dynamo simulations
Naveen Jingade
IIAP, Bangalore.

17 October 2023
Murmuring of the fabric of our Universe.
A. Gopakumar
TIFR, Mumbai.

12 October 2023
Monitoring of episodically accreting Young Stellar Objects.
Arpan Ghosh
ARIES, Nainital.

06 October 2023
RELATIVISTIC OBLIQUE SHOCKS: Transition from Regular to Mach Reflection
Prasanta Bera
The Open University of Israel

05 October 2023
Multiwavelength studies of Active Galactic Nuclei (AGN)

ARIES, Nainital

05 October 2023
Galactic evolution and chemical tagging with open clusters
Bala Sudhakar Reddy
IIA

04 October 2023
Probing the Universe's First Billion Years with Hydrogen 21-cm radiation.
Raghunath Ghara
IISER Kolkata

04 October 2023
On the origin of cosmic dust and the role of supernovae as dust producers in galaxies.
Arka Sarangi
University of Copenhagen

04 October 2023
Probing Solar Corona and Solar Wind Using Ground and Space-based Facilities.
Sasikumar Raja
IIA

03 October 2023
Exploring various aspects of accretion-ejection flows around black holes of all scales
Santanu Mondal
IIA

03 October 2023
Stellar spectroscopy as a tool to study fossils (stars) in the field of Galactic archaeology
Govind Nandakumar
Lund University, Sweden

03 October 2023
Transient Astronomy in the Survey Era
Subhash Bose
Ohio State University

03 October 2023
Stellar populations in nearby dwarf galaxies using multi-wavelength data
Samyaday Choudhury
University of Ahmedabad

29 September 2023
High-energy neutrino observations of the Universe
Ranjan Laha
Department of Physics, IISc, Bangalore.

29 September 2023

The origin for WNL stars: impact on ionizing photon budgets
Arpita Roy
Scuola Normale Superiore, Pisa, Italy.

27 September 2023
Multi-wavelength study of hot stellar population in dense stellar systems
Gaurav Singh
Indian Institute of Astrophysics, Bangalore.

14 September 2023
Resonant and Secular Evolution of Three Body Systems With Applications on Planetary Systems and Gravitational Wave Sources
Hareesh Gautham Bhaskar
Georgia Institute of Technology, USA.

12 September 2023
Gravitational Lensing with exotic image formations
Jasjeet Bagla
IISER, Mohali.

07 September 2023
Carbon Chemistry and Stellar Kinematics: Star Formation Processes near Hot Stars
Arun Roy
Indian Institute of Astrophysics, Bangalore.

05 September 2023
Untangling the morphological origin of bent jetted structures having "X"-shape
Gourab Giri
IIT Indore

24 August 2023
European and Indian PTA evidence for the nanohertz gravitational wave background
Golam Shaifullah
The University of Milano-Bicocca

09 August 2023
Reconstructing dark energy cosmology
Harvinder Kaur Jassal
IISER Mohali

04 August 2023
Heavy element nucleosynthesis & energetic neutrinos from highly magnetized outflows
Mukul Bhattacharya
The Pennsylvania State University, USA.

03 August 2023
Multi-wavelength View of Accreting Compact Objects with AstroSat
Gulab Chand Dewangan
Inter-University Centre for Astronomy and Astrophysics, Pune.

02 August 2023
Science Operations of 3.6m DOT Facility - recent highlights and upgradation plans
Brijesh Kumar
Aryabhatta Research Institute of Observational Sciences, Nainital.

18 July 2023
Vortical plasma motion in the solar atmosphere and their importance for energy transport.
Prof. Viktor Fedun
The University of Sheffield

17 July 2023
Plasma Motion in Sunspots
Debi Prasad Choudhury
California State University, Northridge.

28 June 2023
Star-forming dwarfs galaxies in the Local Neighbourhood
Samyaday Choudhury
Ahmedabad University

27 June 2023
Cosmological QUOKKAS - Cosmological Quasar Observations on the KVN from Korea to Australia (and Spain and South Africa)
Jeffrey H. Hodgson
Sejong University

26 May 2023
Randers Finsler metrics and Information Geometry of Black Holes.
Sumanto Chanda, Post-Doctoral fellow
IIA

18 May 2023
Dark Matter: A Particle Physics Perspective
Prof. Poulose
Department of Physics, IIT Guwahati.

27 April 2023
Studying gravitational physics using rotation-powered radio pulsars
Manjari Bagchi
The Institute of Mathematical Sciences (IMSc), Chennai.

20 April 2023
One Model to Rule Them All: towards unifying magnetic braking in binary and single star systems
Arnab Sarkar
Institute of Astronomy, University of Cambridge.

18 April 2023
Spectro-polarimetric and imaging technique for solar observation
Dr. Sajal Kumar Dhara
INPhocal, Netherlands.

18 April 2023
System Development and Integration for the Keck All sky Precision Adaptive Optics Tomography System
Dr. Avinash Surendran
W. M. Keck Observatory, USA.

18 April 2023
High-contrast imaging techniques and Challenges.
Dr. Prasanth Pathak
Space Sciences, Technologies & Astrophysics Research Institute, University of Liege, Belgium.

18 April 2023
Atmospheric mass-loss through UV spectroscopy of exoplanets and UV instrumentation advances to facilitate it in the future.
Dr. Sreejith A G
Laboratory for Atmospheric and Space Physics, University of Colorado, Boulder, USA.

13 April 2023
High resolution observations of Transient Sources using the
Dr. Mugundhan Vijayaraghavan
University of KwaZulu-Natal, Durban, South Africa.
Gauribidanur Radioheliograph (GRAPH)

13 April 2023
Ultraviolet instrumentation for the next decades and the technologies that enable them
Dr. Ambily Suresh
Laboratory for Atmospheric and Space Physics, Boulder, USA.

13 April 2023
Highly Multiplexed Spectroscopy in Optical and IR Wavelengths: From
Dr. Arun Surya
TIFR, Mumbai.
Instrument Design to Pipelines

11 April 2023
Implementation and prospects of India-

Uzbekistan joint research projects (with an excursion into the past and future of Uzbek Astronomy)
Alisher S. Hojaev
Ulugh Beg Astronomical Institute, Uzbekistan Academy of Sciences.

03 April 2023
PUNCH in the Polarimetry of Wideness
Ritesh Patel
Southwest Research Institute, Boulder, USA.

23 March 2023
Understanding Stellar feedback in our Galaxy through observations and unsupervised machine learning
Maitraiyee Tiwari
Max Planck Institute for Radio Astronomy, Germany.

14 March 2023
Testable galactic dynamo models
Luke Chamandy
National Institute of Science Education and Research, Bhubaneswar.

08 March 2023
Chemical characterisation of the inner Milky Way with IGRINS
Govind Nandakumar
Division of Astrophysics, Department of Physics, Lund University, Sweden.

24 February 2023
AI in the era of large galaxy surveys
Ofer Lahav
University College London

24 February 2023
Galactic bubbles and winds
Kartick Chandra Sarkar
Tel Aviv University, Israel

22 February 2023
The 21-cm cosmology
Rajesh Mondal
Tel Aviv University, Israel

14 February 2023
A simple approach to modeling CMEs at the inner heliosphere
Sanchita Pal
NASA Goddard/George Mason University, Greenbelt.

08 February 2023
Exploring the Origin of Solar Eruptive Events Using Magnetofrictional Simulations
Prantika Bhowmik
Department of Mathematical Sciences, Durham University, UK.

02 February 2023
Adaptive Optics and its Applications in Vision Research
Krishnakumar Venkateswaran
Tatvum LLC/ IMAI LLC, California.

25 January 2023
Star cluster formation in hub-filament systems.
M. S. Nandakumar
Instituto de Astrofísica e Ciências do Espaço, Porto, Portugal.

19 January 2023
Can spirals help the Milky Way 'breath'? - a quest with simulations & Gaia mission
Soumavo Ghosh
Max-Planck-Institut fur Astronomie (MPIA), Heidelberg, Germany

19 January 2023
Exploring the changing-states active galactic nuclei

Arghajit Jana
Institute of Astronomy, National Tsing Hua University, Hsinchu, Taiwan

17 January 2023
Protostellar Jet Launching and the Corresponding Changes in the Chemical Composition in the Disk.
Somnath Dutta
ASIAA, Taiwan.

06 January 2023
On the origin of a kiloparsec size superbubble in the JWST images of the "phantom galaxy" NGC628.
Divakara Mayya
National Institute of Astrophysics, Optics and Electronics (INAOE), Puebla, Mexico.

05 January 2023
Physics Training and Talent Search(PTTS) program: A novel initiative.
Prof. M. Sivakumar
University of Hyderabad.

05 January 2023
Are black-hole accretion states similar across the mass scale?
Abhijeet Borkar
Astronomical Institute of the Czech Academy of Sciences.

9

Other scientific activities

9.1 Talks at external meetings

This section lists the talks given by IIA staff at national or international conferences and workshops organised by external institutions.

9.1.1 Invited talks

Annapurni Subramaniam

- *Space astronomy from Indian missions*, 27 February 2024, National Space Science Symposium, Goa University.
- *Astronomy from ground and space: New technology and global perspective*, 1 December 2023, DST-NIAS training programme on "Science & Technology: Global Developments and Perspectives", NIAS, Bengaluru

Anusha L. S.

- *Radiative Transfer for (Magneto) Hydrodynamical Codes*, 12 July 2024, PLUTO workshop, IISc, Bangalore.
- *Radiative (magneto) hydrodynamical simulations of the solar atmosphere*, 14 July 2024, Conference on Plasma Simulations, Raman Science Centre, IAO, IIA, Leh.

Archana Soam

- *Magnetic fields in the ISM*, 29 November 2023, SAGI Astrophysical workshop on Dust polarimetry, ICISE, Quo Nhon, Vietnam.

Devendra Kumar Sahu

- *Type Iax supernovae*, 18 December 2023, India Japan collaboration meeting SN/transient boot camp, Kagoshima, Japan.
- *Supernovae studies at IIA*, 14 December 2023, Kagoshima University, Japan.

Niruj Mohan Ramanujam

- *Astro-tourism: a holistic approach and a balancing act: Lessons from Hanle Dark Sky Reserve*, 16 November 2023, IAU Symposium 386, "Dark Sky and Astronomical Heritage in Boosting Astro-Tourism around the Globe", Addis Ababa, Ethiopia.

Piyali Chatterjee

- *MHD simulations of Solar spicule forest*, 23 June 2023, Solarnet Gyula Summer School, Gyula, Hungary.

Pravabati Chingangbam

- *Statistical isotropy of the universe - an explicitly geometrical perspective*, 6 August 2023, A Dipolar Universe?, Aristotle University, Thessaloniki, Greece.

S. P. Rajaguru

- *Meridional Circulation in the Solar Convection Zone: Reconciling Helioseismic Measurements*, 21 August 2023, IAU Symposium 365 “Dynamics of Solar and Stellar Convection Zones and Atmospheres” at Yerevan, Armenia.
- *Helioseismology: current status and future prospects*, 7 November 2023, "Beyond Aditya-L1: Exploring the future of Indian solar physics from space", ARIES, Nainital.

Ravindra B.

- *Ground Based Solar Observational Facility: Present and the Future*, 3 April 2023, "Multiscale Phenomena on the Sun: Present Capabilities and Future Challenges", Udaipur Solar Observatory.
- *Science from NLST*, 7 November 2023, "Beyond Aditya-L1: Exploring the future of Indian Solar Physics from Space", ARIES, Nainital.

Santanu Mondal

- *Imprints of Accretion-ejection Flows around Black Holes*, 17 February 2024, "Exploring the Universe: From Near To Far", Indian Centre for Space Physics, Kolkata.

Sudhanshu Barway

- *Integrating small (<1 m diameter) and amateur telescopes of India in future transient program*, 31 January 2024, Workshop WS5: "Planning a more robust follow-up of transient astronomical sources from India", 42nd Annual ASI Meeting, IISc, Bengaluru.

M. Syed Ibrahim

- *Unveiling Mysteries of Space*, 6 October 2023, Swami Dayananda College of Arts and Science College, Manjagudi, Tamil Nadu.
- *Sun-Earth Connection*, 21 September 2023, National Workshop on Experimental Astronomy (NWEA 2023), Arul Anandar College, Tamil Nadu.
- *Flare initiation and CME-ICME propagation*, 17 June 2023, SRM College for Engineering and Technology, Madurai.

P. Vemareddy

- *Formation and eruption of magnetic flux ropes during the active region evolution*, 31 January 2024, 42nd Annual Meeting of ASI 2024, IISc, Bengaluru.

Wageesh Mishra

- *CMEs and their geoeffectiveness: Aditya-L1 perspective*, 11 April 2023, Science from in-situ measurements of Aditya-L1 Meeting, SPL-VSSC, Trivandrum.
- *Overview of the existing and upcoming coronagraphs/heliospheric Imagers to track solar eruptive phenomena*, 7 Nov 2023, Beyond Aditya-L1: Exploring the future of Indian Solar Physics from Space, ARIES, Nainital.

- *The behaviour of our daytime star in the last two decades*, 17 July 2023, Multi-disciplinary Approach to Understand the Mysteries of our Universe, NIT Rourkela.

9.1.2 Contributed Talks

Archana Soam

- *Magnetic fields in star formation*, 31 January 2024, Sub-mm Astronomy Workshop, 42nd Annual Meeting of ASI, IISc, Bengaluru.

Arun Roy

- *Herbig Be stars: Fullerene Factories for ISM*, 30 October 2023, Illuminating the Dusty Universe: A Tribute to the Work of Bruce Draine, Galileo Galilei Institute for Theoretical Physics, Florence, Italy.
- *Rocket Effect near Young Open Clusters*, 8 January 2024, Star Formation Studies in India, S.N.B.N.C.B.S., Kolkata.
- *Fullerene-Enriched YSOs: A Novel Class and Their Connection to Aromatic Evolution near B-type PMS Stars*, 31 January 2024, 42nd Meeting of ASI, IISc, Bengaluru.

Arun Surya

- *MOIS: A configurable slit multi-object infrared spectrograph and wide field imager*, 10 January 2024, Star Formation Studies in India Conference, S.N.B.N.C.B.S., Kolkata.
- *MOIS: A configurable slit multi-object infrared spectrograph and wide field imager*, 31 January 2024, NLOT workshop, 42nd Annual Meeting of ASI, IISc, Bengaluru.

Chrisphin Karthick

- *Facts to Equations & What!/Wow! to How?*, 29 November 2023, 5th Shaw-IAU Workshop on Astronomy for Education.

Devendra Kumar Sahu

- *Observing facility at IIA*, 31 January 2024, Workshop on Transients during the ASI meeting 2024 Category: Workshop

Hema B. P.

- *Detection and Measurement of Helium Enrichment in Giants*, 27 February 2024, National Space Science Symposium, Goa University, Goa.

Mousumi Das

- *Studies of Star Formation in Merging and Interacting Galaxies using the UVIT*, 25 October 2023, Network in UV Astronomy.
- *The Detection of a Large Sample of Dual AGN and what they reveal about Galaxy Evolution*, 13 October 2023, MASCA Meeting, Nice, France.

Niruj Mohan Ramanujam

- *Institutional Outreach A multi-pronged approach by IIA*, 23 August 2023, Global Hands-on Universe (GHoU) 2023.

Ravi Joshi

- *INSIST view of galaxy growth and impact of environment over cosmic timeline*, 12 April 2023, National Workshop on INSIST Engineering and Science Updates.

Ravinder K. Banyal

- *SCALES: An integral field spectrograph and imager for exoplanet studies with Keck*, 19 August 2023, Strange New Worlds: The Exploration of Exoplanets, IISER Pune.

- *Chemical and kinematic age proxies of planet-hosting stars from GAIA DR3*, 9 August 2023, APRIM, Japan.

Santanu Mondal

- *Intermediate-mass black holes and powering ultraluminous X-ray sources*, 2 February 2024, 42nd Annual Meeting of ASI, IISc, Bengaluru.

K. Sasikumar Raja

- *Spectral Analysis of Solar Radio Type III Bursts from 20 kHz to 410 MHz*, 31 January 2024, 42nd Annual Meeting of ASI, IISc, Bengaluru.

Suvedha Suresh Naik

- *Probing Primordial Features and the Epoch of Reionization: A Forecast from SKA*, 31 January 2024, 42nd Annual Meeting of ASI, IISc, Bengaluru.

- *Imprints of the Cosmic Inflation in the Redshifted 21 cm Signal*, 6 February 2024, Goa University.

M. Syed Ibrahim

- *Reason for radio quietness*, 12 April 2023, Science from in-situ measurements of Aditya-L1 (SIMA-01).

P. Vemareddy

- *Coronal magnetic helicity accumulation in the course of active region evolution: Formation of magnetic flux rope and its eruption*, 7 August 2023, APRIM, Japan.

Wageesh Mishra

- *Multipoint In Situ Observations of Coronal Mass Ejections Near 1 AU*, (poster)1 February 2024, 42nd meeting of ASI, IISc, Bengaluru.

9.2 Talks at IIA events

Talks at IIA conferences are listed here. The in-house symposium is in Section 8.4.

Archana Soam

- *Basics of magnetic fields in the ISM*, 1 June 2023, IIA Summer School.

- *Basics of star formation in the ISM*, 3 Jan 2024, Vainu Bappu Observatory, Kavalur, IIA.

Arun Mangalam

- *Hawking radiation, Penrose and B-Z processes*, 16 June 2023, Vainu Bappu Observatory, IIA, Kavalur.

Chrisphin Karthick

- *Basics of astronomy*, 30 September 2023, Workshop by KSO, IIA and Tamil Nadu Astronomy & Science Society.

Jayant Joshi

- *Lectures on introduction to solar physics*, 1-8 July 2023, IIA Summer School, Kodaikanal Solar Observatory, IIA.

Mousumi Das

- *Multiwavelength Astronomy and the UVIT*, 22 February 2024, Olympiad Exposure Camp, (organised by IIA, HBCSE-TIFR, and SVYM), SVYM, Mysore.

K. Nagaraju

- *Aditya-L1 mission*, 9 January 2024, Kodaikanal Winter School on Solar Physics, Kodaikanal Solar Observatory, IIA.

Naveen Jingade

- *Observational Signatures from the shear dynamo simulations*, 18 October 2023, IIA, Bengaluru.

Niruj Mohan Ramanujam

- *Lessons from HDSR, a Science Driven Development Program*, 1 January 2024, Astro-Tourism & Astro-Entrepreneurship in India Conference, IIA, Bengaluru.
- *Structure of Stars: What makes them tick?*, 19 February 2024, Olympiad Exposure Camp (organised by IIA, HBCSE-TIFR and SVYM), SVYM, Mysuru.

S. P. Rajaguru

- *Three Lectures* during 3-10 January 2024, Kodaikanal Winter School on Solar Physics, Kodaikanal Solar Observatory, IIA.

Ravindra B.

- *The Solar Telescope and Instrumentation*, 9 January 2024, IIA Winter School on Solar Physics, Kodaikanal Solar Observatory, IIA.

Sanved Kolekar

- *Celestial Mechanics*, 19 February 2024, Astronomy Olympiad Exposure Camp (organised by IIA and HBCSE), SVYM, Mysore.

M. Sampoorna

- *Resonance Line Polarization as a Diagnostic Tool for Stellar Atmospheres*, 14 July 2023, 3rd Conference on Plasma Simulation (CPS-2022), Raman Science Center, IIA, Leh.

Shantikumar Singh Ningombam

- *Atmospheric Physics: Astro-meteorological studies*, 6 January 2024, Kodaikanal Winter School on Solar Physics, Kodaikanal Solar Observatory, IIA.

Smitha Subramanian

- *Introduction to Extragalactic Astronomy*, 4 January 2024, for the PU MSc students, Vainu Bappu Observatory, Kavalur, IIA.

C. S. Stalin

- *Black holes: Theory and Observations*, 15 June 2023, Vainu Bappu Observatory, Kavalur, IIA.

M. Syed Ibrahim

- *Chandrayan-3 Moon mission*, 23 August 2023, Kodaikanal Solar Observatory, IIA.
- *Aditya-L1 payloads*, 2 September 2023, Kodaikanal Solar Observatory, IIA.

Tanmoy Samanta

- *Solar Atmosphere: Transition Region and Corona*, 23-28 January 2023, Kodaikanal Winter School on Solar Physics, Kodaikanal Solar Observatory, IIA.

P. Vemareddy

- *Flares and CMEs*, 6 January 2024, Kodaikanal Winter School, Kodaikanal Solar Observatory, IIA.

9.3 Talks at other institutions

Talks delivered on invitation by external institutions are listed here.

Annapurni Subramaniam

- *Highlights from two surveys of Galactic star clusters (UOCS and GlobULeS) using AstroSat*, 2 November 2023, ARI Heidelberg, Germany.
- *Highlights from two surveys of Galactic star clusters (UOCS and GlobULeS) using AstroSat*, 23 October 2023, University of Bonn, Germany.

Archana Soam

- *Magnetic field and dust grain alignment in the ISM: Current status and understanding*, 13 October 2023, Raman Research Institute, Bengaluru.
- *Magnetic field and dust grain alignment in the ISM: Current status and understanding*, 4 October 2023, Indian Institute of Science, Bengaluru
- *Magnetic field and dust grain alignment in the ISM: Current status and understanding*, 20 March 2024, Korea Astronomy & Space Science Institute, Korea.
- *Magnetic field and dust grain alignment in the ISM: Current status and understanding*, 21 September 2023, Stanford University, USA.

Arun Mangalam

- *Classical Mechanics*, August-December 2023, Jawaharlal Nehru Centre for Advanced Scientific Research, Bengaluru.

Arun Roy

- *Introduction of Astropy*, 1 March 2024, Workshop on Astronomical Data Processing, Newman College Thodupuzha.

Bharat Kumar Yerra

- *Lithium & Carbon Anomalies in Red Clump Stars*, January 2024, Weihai, China.

Jayant Joshi

- *AI and ML applications in Solar Physics*, 29 September 2023, Fifth Aditya-L1 Support Cell Workshop, IIT Kanpur.
- *Radiative Transfer and Inversions of Spectropolarimetric Data*, 19 December 2023, Winter school on concepts in solar physics, NIT Delhi.

Niruj Mohan Ramanujam

- *Introduction to Astronomy I and II*, 3 August 2023, ISRO Space Science and Technology AwaReness Training (STaRT) Training Program.
- *Astro-tourism and dark sky preservation*, 11 November 2023, Capacity Building Training of Dark Sky and Astro-Tourism, Addis Ababa, Ethiopia.

Gajendra Pandey

- *Stellar Spectroscopy I and II*, 14 October 2023, 100 Hours Certificate Course, M.P. Birla Institute for Fundamental Research, Bengaluru.

Piyali Chatterjee

- *The solar spicule forest and parallels with polymeric fluid jets excited in the laboratory*, 31 May 2023, HAO, Boulder, Colorado, USA.

- *Of spicules and coronal swirling conduits*, 1 June 2023, NSO, Boulder, CO, USA.
- *The nature of the solar spicule forest*, 18 June 2023, Nordita Dynamo seminar, Stockholm, Sweden.

Pravabati Chingangbam

- *Beyond the power spectrum - geometrical and topological statistics*, a series of 4 talks and tutorials, 14-16 December 2023, NISER, Bhubaneshwar.

Santanu Mondal

- *Observational Aspects of Accreting Black Holes*, 10 January 2024, Presidency University Kolkata.
- *Deciphering Imprints of Accretion-Ejection Around Black Holes: Theory, Observations and Simulation*, 14 February 2024, Raman Research Institute, Bengaluru
- *Accretion-ejection flows around black holes across mass scales*, 7 September 2023, Inter-University Centre for Astronomy and Astrophysics, Pune.

Sanved Kolekar

- *Asymptotic symmetries, charges and quantum memory*, 6 April 2023, IIT Madras.

Sridharan R.

- *Adaptive Optics*, 16 November 2023, SPASE, IIT Kanpur.

Subinoy Das

- *Hubble tension and neutrino physics*, September 2023, Stony Brooke University, USA.
- *Early dark energy beyond slow roll*, September 2023, University of Pennsylvania, USA.
- *Status of Hubble anomaly*, November 2023, IISER Kolakta.

Sudhanshu Barway

- *Galaxy Morphology Citizen Science programme & Analysing galaxy features*, 22 February 2024, Bharat Mata College, Cochin, Kerala.
- *Galaxy Morphology Citizen Science programme & Analysing galaxy features*, 21 February 2024, St. Thomas College, Thiruvalla, Kerala
- *Galaxy Morphology Citizen Science programme & Analysing galaxy features*, 20 February 2024, Farook College, Calicut, Kerala.
- *Galaxy Morphology Citizen Science programme & Analysing galaxy features*, 19 February 2024, Providence College, Calicut, Kerala.

Vivek M.

- *AGN outflows and its variability*, 11 October 2023, Indian Institute of Science, Bengaluru.

Wageesh Mishra

- *Evolution of CMEs and Space Weather*, 4 August 2023, DDU Gorakhpur University, Gorakhpur.
- *Our solar system and beyond*, 30 September 2023, MP Birla Institute of Fundamental Research, Bengaluru.
- *Heliospheric Evolution of Coronal Mass Ejections and their Space Weather Impacts*, 25 October 2023, Indian Institute of Science, Bengaluru.

9.4 Public Talks

This section lists talks given by IIA staff for the general public, either on invitation by an external institution or organised by IIA itself. Public talks organised by the SCOPE Section which feature external speakers are covered in Chapter 6.

Annapurni Subramaniam

- *Astronomy from Ground and Space*, 18 February 2024, Science at the Sabha, IMSc
- *A story to inspire more women to take up science*, 28 January 2024, Global Science Festival Kerala.
- *Why should we explore space?*, 20 January 2024, India Science Festival, IISER Pune.
- *Why, How and What of Chandrayaan-3 and Aditya-L1*, 12 October 2023, Chandigarh Science Congress, Punjab University.

Anusha L. S.

- *Importance of Radiation in Astrophysics*, 29 September 2023, Jawahar Navodaya Vidyalaya, Davanagere, Karnataka.
- *Importance of Radiation in Astrophysics*, 16 December 2023, : Jawahar Navodaya Vidyalaya, Balehonnur, Karnataka.

Archana Soam

- *Telescopes and role of observations in studying star formation*, 20 October 2023, Vainu Bappu Observatory, Kavalur, IIA.

Arun Mangalam

- *Applied Mechanics*, July 2023 - March 2024, Jawaharlal Nehru Plaetarium, Bengaluru.

Chrisphin Karthick

- *Astronomy Career Guidance*, 6 January 2024, CMR National PU College, HRBR Campus, Bengaluru.
- *Exposure to Astronomy and Astronomical Research career Guidance*, 15 May 2023, TESSERACT 2023, Pope John Paul II College of Education.
- *Moon and Lunar Science (in Tamil)*, 4 September 2023, Tamilnadu Astronomy and Science Society.
- *About the Moon (in Tamil)*, 13 September 2023, Kodaikanal FM 100.5 radio station, Kodaikanal.
- *Spectrum of Astronomy*, 16 May 2023, MVJ Engineering College, Bengaluru.

Devendra Kumar Sahu

- *Indian Astronomical Observatory*, 28 February 2024, Govt. High School, Hosakote.

Mousumi Das

- *Galaxies in our Universe*, 20 January 2024, National Hill View Public School.

Niruj Mohan Ramanujam

- *Astronomy outreach and public engagement at IIA*, 9 March 2024, YAM 2023, Christ University (Deemed), Bengaluru.
- *Space Rocks: the leftovers*, 30 June 2023, IIA, Bengaluru.
- *Zero Shadow Day*, 23 April 2023, University of Mysore.

- *Zero Shadow Day*, 24 April 2023, IIA, Bengaluru.
- *Aditya-L1, India's first space observatory to study the Sun*, 10 February 2024, SPACE India.

Piyali Chatterjee

- *Our dynamic Sun*, 4 October 2023, SRMIST, Bengaluru.
- *Aditya L1 Mission : Ask an Astronomer*, 16 September 2023, online.

Pravabati Chingangbam

- *Four lectures on Cosmology*, 5 and 19 August 2023, Physics Department, University of Mysore, Mysuru.

S.P. Rajaguru

- *Aditya-L1*, 3 September 2023, TamilNadu Science and Technology Centre (TNSTC), Chennai.

Ravinder K. Banyal

- *Search for life in the Universe*, 21 December 2023, IIA, Bengaluru.
- *Search for Life Outside Earth*, 12 August 2023, IIA, Bengaluru.
- *The Sun*, 17 April 2023, Vigyan Bhavan, University of Mysore, Mysuru.

Sanved Kolekar

- *Black hole Shadow*, 25 February 2024, NSD, IIA, Bengaluru.

Sharanya Sur

- *The Magnetic Universe - Deciphering the Invisible*, 15 July 2023, : Eliezer Joldan Memorial College, Leh.

Subinoy Das

- *Exploring unknown mystery of space and time*, 1 February 2024, IIT Delhi.

Vivek M.

- *Machine Learning Techniques in Astronomy*, 9 November 2023, Rajagiri College of Engineering & Technology, Kochi.
- *From Astronomical Data to Scientific Insights*, 9 November 2023, Bharatmatha College, Kalammasery, Kochi.
- *Active Galactic Nuclei: Energetic centers of galaxies*, 14 November 2023, Govt. Victoria College, Palakkad.

Wageesh Mishra

- *Aditya-L1 Mission from India*, 25 November 2023, Nijalingappa College, Bengaluru.
- *Our daytime star, celebrating Zero Shadow Day*, 25 April 2023, IIA, Bengaluru.

Apart from these public talks, many staff members of IIA also co-wrote chapters in the Astronomical Society of India - Vision Document.

9.5 Awards, Memberships, Grants, SOCs etc

Annapurni Subramaniam

- One of the "Top 100 Women achievers of India" by India Today, December 2023.
- Devi Award 2024, by The New Indian Express, January 2024.

- Future Female award 2024, by the CNBC-TV18 group, February 2024.
- Vanitha Ratna 2023 award from the Kerala Government in the field of Education, Science and Technology, March 2024.

Arun Roy

- SERB International Travel Grant for attending "Illuminating the Dusty Universe: A Tribute to the Work of Bruce Draine", Galileo Galilei Institute for Theoretical Physics, Florence, Italy.

Chrisphin Karthick

- Astronomy Lab and Orientation Program Member, the Hera Science Team, ESA.

B. Eswar Reddy

- Member of the Editorial board of the Journal of Astronomy and Astrophysics.

Gajendra Pandey

- Member of the Management Group for the Maunakea Spectroscopic Explorer Project).
- Member, SOC, Astronomical Society of India.

Mousumi Das

- "The Royal Society Yusuf Hamied International Exchange Award", for collaborators in the UK and India (P.I. Dimitra Rigopoulou, University of Oxford), "Understanding the properties and role of dual AGN in galaxy evolution", 31 March 2024 to 30 March 2026, Grant: £ 12,000.
- Member, SOC, IAU General Assembly Focus Meeting 9, Measures of Luminous and Dark Matter in Galaxies Across Time.

Niruj Mohan Ramanujam

- Member, SOC, IAU Communicating Astronomy to the Public (CAP) Conference.
- Member, SOC, IAU Symposium 386, 2024, Addis Ababa, Ethiopia.
- Member SOC, IAU Professional-Amateur Meeting 2023.
- Invited member on (1) ISRO Aditya-L1 Outreach Committee, (2) FAST India Working Group on Institutional Science Communication, (3) S20 Expert Committee: Gender, Equity, and Diversity Task Force, as a part of G20.

Pravabati Chingangbam

- Editor of Nuclear Physics B, Elsevier Publications, since November 2023.
- Member, SOC and Workshop Chair for Cosmology, 10th International Conference on Cosmology and Gravitation, IIT Guwahati, 6-9 December 2023.
- Member, SOC, School on Advanced 21-cm Cosmology, NISER, Bhubaneshwar, 11-16 December 2023.

S. P. Rajaguru

- Visiting Professor, Physics Department and Hansen Experimental Physics Lab, Stanford University, USA (July 2022 - July 2023).
- 2nd Term as Elected Member of IAU Commission E1 (Solar Radiation and Structure)

- SOC member for IAU FM-8 "Advances and Challenges in Understanding the Solar and Stellar Dynamos", IAU GA 2024

M. Sampoorna

- Member, SOC, 11th International Workshop on Solar Polarization (SPW11), Prague, Czech Republic, to be held on 8-12 September 2025.

Santanu Mondal

- Topic Editor in Frontiers in Astronomy and Space Sciences.

K. Sasikumar Raja

- Editorial member of Springer Journal Discover Space.

Subinoy Das

- A paper cited by IOP Publishing announced as a Top Cited Paper in India Award in Astronomy and Astrophysics.

Suvedha Suresh Naik

- Life membership of the Astronomical Society of India.

Tanmoy Samanta

- Received International Travel Support (ITS) grant from SERB for attending the Waves & Instabilities in the Solar Atmosphere meeting at the Northumbria University, UK, from 20-23 June 2023.
- Member, SOC, 5th Aditya-L1 Science Support Cell workshop, IIT Kanpur, 29 September - 1 October 2023.

Wageesh Mishra

- Associate of the Indian Academy of Sciences (IASc), Bengaluru, in 2023.

9.6 Externally Funded Projects

Project grants awarded to individual staff are listed here.

Annapurni Subramaniam

- SERB Power Fellowship SPF/2020/000009 from March 2021 to March 2024

Anusha L. S.

- Polarized radiative transfer in the solar atmosphere to understand the scattering polarization observations of Ca I 4227 A line, SERB CRG/2022/001522, 19 January 2023 to 2 July 2026.

Arun Mangalam

- Propagation of MHD waves in twisted magnetic flux tubes, Royal Society International Exchange Award funded by The Yusuf and Farida Hamied Foundation, August 2021 to 2023.
- Magnetic, Relativistic and Dynamical Astrophysics, SERB CRG/2021/005174/PHY, 2022-25.

Gajendra Pandey

- Measuring helium abundances in cool stars, SERB CRG/2021/000108, 11 March 2022 to 10 March 2025.

Mousumi Das

- "The Royal Society Yusuf Hamied International Exchange Award", (P.I. Prof. Dimitra Rigopoulou, University of Oxford), Title "Understanding the properties and role of dual AGN in galaxy evolution", 31 March 2024 to 30 March 2026.

- Understanding the distribution of accreting supermassive black holes pairs in our nearby universe and their effect on galaxy environments using optical, UV and radio observations, SERB CRG/2022/004531, with Barway, 3 years from February 2023.

C. Muthumariappan

- Photo-ionization structures of PNe, DST-SERB CRG/2020/000755, 3 years ending in February 2024.
- HI/CO gas interaction and non thermal emission in Galaxy cluster (Co-Proposer), Indo French Centre for Promotion of Advanced Research (CEFIPRA), 3 years ending Feb 2025.

S. P. Rajaguru

- Connecting Solar Interior Dynamics to Variable Solar Activity and Space Weather, SERB/DST CRG CRG/2019/003786, 28 February - 27 August 2023.

M. Sampoorna

- DST-SERB grant WEA/2020/000012, Solution of the Polarized Line Radiative Transfer Equation in Relativistic Flows with Applications in Astrophysics, 10 September 2020 - 9 September 2023.

Santanu Mondal

- Accretion Processes in Astrophysics, SERB/ANRF Govt. of India, RJF/2020/000113, 1 February 2021 to 31 March 2026.

Shantikumar Singh Ningombam

- Studies of aerosol optical properties and associated radiative forcing at Leh, in the climate sensitive Hindu Kush Himalayan region; Ministry of Earth Sciences (MoES), GoI, Grant number: MoES/16/02/2021-RDESS, 20 September 2022 to 20 September 2025.

Smitha Subramanian

- DST SERB grant SPG/2021/002672, Effect of tidal interactions on the evolution of low mass galaxies, 28 July 2022 - 27 July 2025.

Subinoy Das

- Can dark matter clump in early universe and form primordial Black hole, DST-DAAD Indo-German project DST/INT/DAAD/P-07/2023 with Heidelberg University.
- Shedding light on dark matter interactions through CMB, supernovae and global 21 cm (EDGES) experiments data, DST core research grant: CRG/2019/006147, ended March 2024.

Suvedha Suresh Naik

- National Post-Doctoral Fellowship.

Vivek M.

- Probing the disk-jet connection in AGN using multi-wavelength observations, SERB CRG/2020/007887, July 2023 to July 2026.
- Probing quasar outflows using broad absorption line variability, December 2020 to July 2024.

9.7 Teaching and Guidance for external students

This section lists staff members who have guided external students for carrying out their academic projects.

Anusha L.S.

- *Optimization of the feature tracking code to analyze solar quiet Sun data*, Kamil F. Nadaf, M.Sc., NIT Jamshedpur.

Archana Soam

- Taught Astrophysical Concepts course to ARIES and IIA MTech-PhD students in August 2023.

Arun Roy

- *Identifying Neon Forbidden Lines near Herbig Ae/Be stars using Spitzer*, Akhila D., Christ University, Bengaluru.
- *Estimating HI 12.37 Micron Line Luminosity in Herbig Ae/Be Stars using Spitzer SH spectra*, Krishnanjana S. & Kavya J, St Xavier's College for Women, Aluva.

Bharat Kumar Yerra

- *Investigation of Weak G-band Stars in the Milky Way*, Sunayana Maben, National Astronomical Observatories, Beijing, China.

Firoza Sutaria

- *MESA+SNEC Simulations of Type II-P Supernova Light Curves*, Riddhiman Sharma, IISER Bhopal.
- *A spectroscopic study of the type-IIP supernovae SN2017eaw and SN2017gmr*, Vasudha Choudhary, Central University of Haryana.

Hema B.P.

- *Identification of spectral lines*, Yogeesh N.& Koothodil Abhijith Augustine, Sant Longowal Institute of Engineering and Technology, Punjab.
- *Measurement of radial velocity in the spectrum of Arcturus*, Veera Vaishnavi, IISER Mohali.
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- *Study on low-mass star formation*, Hiba Paliyil, M.Sc. thesis, Pondicherry Univ.
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- *Dependence of spicule properties on magnetic field*, Kartav Kesri, IISER Bhopal.

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- *Incorporating parallel transport in the calculation of the contour Minkowski tensor and application to observed data*, Nidharssan S, MS Thesis, IISER Trivandrum.

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Ravi Joshi

- *Probing the nature of absorption selected galaxies*, Malavika Raja, St. Xavier's College, Mumbai.
- *X-shaped radio galaxies harboring binary black holes*, Prasoon Ashok Singh, Pondicherry University.
- *Gas galaxy connection over cosmic timescale*, P.V. Sruthi, Amrita Vishwa Vidyapeetham, Kerala.
- *Mechanical design of a robotic fiber positioner*, Harshith Reddy Kaila, IIEST, Shibpur, Kolkata

Ravinder K. Banyal

- *Analysis of TESS light curves of stars hosting RV detected planets*, Arkaprova Dutta, IISER Kolkata.
- *Study of Brown Dwarf and their Stellar Companion*, Satyam Soni, NIT Rourkela, Odisha.
- *The 10 pc Stellar Neighbourhood of Known Habitable Zone Exoplanet Hosting Stars*, Tisyagupta Pyne, Visva-Bharati University, Calcutta.

Santanu Mondal

- *Spectral and Temporal study of NGC 4395 X-1*, Athira Nandakumar, Christ University, Bengaluru.
- *Studying the Properties of Iron line in Active Galactic Nuclei using NuSTAR data*, Amrutha B.R., St. Josephs College, Bengaluru.

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- *Detector Response along a Rindler-Rindler trajectory*, Jaswanth Varma Uppalapati, BS thesis, IISc, Bengaluru.
- *Black hole Shadows*, A. Murali & Aswin P., M.Sc. thesis, Pondicherry Univ.
- *The Theory of General Relativity*, Sarah Jacob & Kabir Saha, M.Sc. thesis, St. Joseph's College, Bengaluru.
- *Applications of Semi-classical gravity*, Ashique T., M.Sc. thesis, IISER-K.
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- *UVIT study of an interacting pair of dwarf galaxies in the Virgo Cluster*, Ananthu Sanal, M.Sc. thesis, Pondicherry University.
- *Investigating the hierarchical nature of young star forming clumps*, Nimya T., M.Sc. thesis, Calicut University.
- *Comparison of bars of low and high surface brightness galaxies*, Agnus Antony, M.Sc. thesis, Calicut University.

R. Sridharan

- *Astronomical Adaptive Optics*, Shabbir Baig, Archana A.S., Moulya Y.J. & Suresha, Government First Grade College, Bengaluru North University, Kolar.

M. Syed Ibrahim

- *Multi-Parameter Analysis of Earth-Directed Coronal Mass Ejections during Solar Cycle 24*, Akshaya & Deepika, II M.Sc., Mother Theresa university, Kodaikanal, Tamilnadu.
- *Data collection - different types of observed stars*, Nisha, III B.Sc., Arul Anandar College, Madurai, Tamil Nadu.
- *HALO CMEs and their various parameter links with geo-effectiveness*, Allwin Rex, II B.Sc., St. Joseph College, Trichy, Tamil Nadu.

Tanmoy Samanta

- *Investigating Temperature Variations of the Solar Corona During CMEs*, V. Dheeraj Shenoy, M.Sc. thesis, Jain University, Bengaluru.

P. Vemareddy

- *In situ observations during Earth directed solar eruptions*, Arron Augustine D'Awarave, St. Albertis College, Ernakulam.
- *Magnetic origins of the CMEs in the source regions of the Sun2*, Gismol Saji, Amrutha Viswa Vidya Peetam.

Vivek M.

- *Detection and Analysis of Quasar Spectroscopic Anomalies*, Arihant Tiwari, IISER Bhopal.
- *Quasars with extreme spectral index variations*, Sherine Martina & Majal Shiny, CHRIST University, Bengaluru.
- *Nitrogen rich quasars from the SDSS*, Vasundhara K. Krishnan, Pondicherry University.
- *Testing the JCBT data reduction pipeline*, Gowri Sudarsan, Aswani T., Harikrishnan K.S., Zen Thomas, Mohammad Sinan, Bharatmatha College, Kochi.

9.8 Memoranda of Understanding (MoU)

[1] MoU signed on 15th June 2023 for collaboration between International Astronomical Union (IAU) - Office of Astronomy for Education (OAE) Center India and Science Communication, Public Outreach and Education Section (SCOPE), IIA

[2] Memorandum of Agreement (MoA) signed on 11th August 2023 with the Academy of Scientific & Innovative Research (AcSIR) to establish academic connectivity and synergy of academic complementation and collaboration to build capacity in identified areas/faculties of research and development. The scope of the agreement includes AcSIR to collaborate and recognize IIA as its Associate Academic Center where AcSIR would accept students from IIA for its PhD program. The scope may be widened to include additional academic programs/activities that may be taken up jointly by AcSIR and IIA, at a later date.

[3] MoU signed on 17th August 2023 with the Aryabhatta Research Institute of Observational Sciences (ARIES) in connection with the development of a 2-m class, state-of-the-art National Large Solar Telescope (NLST) Project in Merak on the shores of the Pangong Lake in Ladakh (UT).

[4] MoU signed on 11th September 2023 with Altair Infrasec Pvt. Ltd. (AIPL) for design & deployment of prototype for ACNS (Navigational system)

[5] MoU signed with the University of Mysore, Mysuru on 17th November, 2023 to strengthen content delivery and development by engaging in cooperation with the Radio Manasa 89.6 FM, Community Radio Station, University of Mysore, Mysuru

[6] MoU signed with M/s PixxelSpace India Private Limited on 19th February 2024 for usage of MGKML facility for Pixxel requirements

9.9 Workshops, Conferences, Schools, Other Events

This section lists workshops, schools, and other events that have been organised at IIA.

[1] National Conference on REcent Trends on Compact Objects: Theory and Observation (RETCO-V), held at Kodaikanal Observatory between 3-5 April 2023.

[2] INSIST Workshop on Updates on Project Status and Expected Science, IIA Bengaluru, 12 April 2023.

[3] Black holes: Theory and Observations Workshop, Vainu Bappu Observatory, IIA, Kavalur, 15-17 June 2023.

[4] 3rd National Conference on Plasma Simulations, Indian Astronomical Observatory, IIA, Leh, 13-15 July 2023.

[5] Hanle Dark Sky Reserve Star Party 2023, Indian Astronomical Observatory, IIA, Hanle, 12-15 October 2023.

[6] Modern Engineering Trends in Astronomy (META-2023), co-organised with RRI, NCRA, ARIES, IUCAA, and PRL, Raman Research Institute, Bengaluru, 1-4 November 2023.

[7] Kodaikanal Winter School on Solar Physics, Kodaikanal Solar Observatory, IIA, 3-10 January 2024.

[8] Prof. Peraiah Foundation Lecture Program 2023, IIA Bengaluru, 5 January 2024.

[9] Workshop 6 - UV-Optical-IR Astronomy in India: Prospects of the next decade (co-organiser), 42nd Annual Meeting of Astronomical Society of India, IISc, Bengaluru, 31 January 2024.

[10] Astronomy Olympiad Exposure Camp (with HBCSE-TIFR, SVYM), SYVM Mysuru, 19-22 February 2024.

[11] Astro-Tourism & Astro-Entrepreneurship in India, IIA Bengaluru, 11-12 March 2024.

[12] IIA In-house Synposium, IIA Bengaluru, 26–28 March 2024

10

Publications

10.1 In refereed journals

[1] Adithya H. N., Kariyappa R., Kusano K., Masuda S., Imada S., Zender J., Damé L., et al.,2023, Solar Physics, 298,99 *Solar Soft X-Ray Irradiance Variability, II: Temperature Variations of Coronal X-Ray Features*

[2] Aditya K.,2023, Monthly Notices of the Royal Astronomical Society, 522,2543 *Stability of galaxies across morphological sequence*

[3] Aditya K., Banerjee A., Kamphuis P., Mosenkov A., Makarov D., Borisov S.,2023, Monthly Notices of the Royal Astronomical Society, 526,29 *H I 21cm observations and dynamical modelling of the thinnest galaxy: FGC 2366*

[4] Andersson B.-G., Karoly J., Bastien P., Soam A., Coudé S., Tahani M., Gordon M. S., Fox-Middleton S.,2024, The Astrophysical Journal, 963,76 *Submillimeter-wavelength Polarimetry of IRC+10216*

[5] Ansar S., Kataria S. K., Das M.,2023, Monthly Notices of the Royal Astronomical Society, 522,2967 *Modelling dark matter halo spin using observations and simulations: application to UGC 5288*

[6] Anusha L. S.,2023, The Astrophysical Journal, 949,84 *Hanle Effect with Angle-dependent Partial Frequency Redistribution in Three-dimensional Media*

[7] Arellano Ferro A., Bustos Fierro I., Muneer S., Giridhar S.,2023, Revista Mexicana de Astronomia y Astrofisica, 59,3 *RR Lyrae Stars in the Globular Cluster Palomar 2*

[8] Arun K., Sivaram C.,2023, Indian Journal of Physics, 98,407 *Gammaless gamma-ray bursts?*

[9] Arun R., Mathew B., Manoj P., Maheswar G., Shridharan B., Kartha S. S., Narang M.,2023, Monthly Notices of the Royal Astronomical Society, 523,1601 *Fullerenes in the circumstellar medium of Herbig Ae/Be stars: insights from the Spitzer mid-infrared spectral catalog*

[10] Bandyopadhyay R., Das R., Parthasarathy M., Kar S.,2023, Monthly Notices of the Royal Astronomical Society, 524,1547 *Morpho-kinematic and photoionization models of the multipolar structures in planetary nebula NGC 6572*

[11] Bane K. S., Barve I. V., Gireesh G. V. S., Kathiravan C., Ramesh R.,2023, Journal of Astronomical Telescopes, Instruments, and Systems, 10,1.4001 *Initial results from multi-beam observations of*

pulsars and solar transient with the digital beamformer for the Gauribidanur pulsar system

[12] Bane K. S., Barve I. V., Gireesh G. V. S., Kathiravan C., Ramesh R.,2024, Journal of Astronomical Telescopes, Instruments, and Systems, 10,014001 *Initial results from multi-beam observations of pulsars and solar transient with the digital beamformer for the Gauribidanur pulsar system*

[13] Banerjee A., Negi V., Joshi R., Kumar N., Wiita P. J., Chand H., Rawat N., et al.,2023, Monthly Notices of the Royal Astronomical Society, 526,5172 *Probable low-frequency quasi-periodic oscillations in blazars from the ZTF survey*

[14] Banerjee A., Das S., Maharana A., Nadler E. O., Sharma R. K.,2023, Physical Review D, 108,043518 *Nonthermal warm dark matter limits from small-scale structure*

[15] Bhargava Y., Dewangan G. C., Anupama G. C., Kamath U. S., Sonith L. S., Singh K. P., Drake J. J., et al.,2024, Monthly Notices of the Royal Astronomical Society, 528,28 *Soft X-ray and FUV observations of Nova Her 2021 (V1674 Her) with AstroSat*

[16] Bhattacharya A., Nehal C. P., Das M., Paswan A., Saha S., Combes F.,2023, Monthly Notices of the Royal Astronomical Society, 524,4482 *Automated detection of double nuclei galaxies using GOTHIC and the discovery of a large sample of dual AGN*

[17] Bonne L., Andersson B.-G., Minchin R., Soam A., Yaldaei J., Kulas K., Karoly J., et al.,2023, The Astronomical Journal, 165,243 *High-resolution Observations of H I in the IC 63 Reflection Nebula*

[18] Brilenkov M., Fornazier K. S. F., Hergt L. T., Hoerning G. A., Marins A., Murokoshi T., Rahman F., et al.,2023, Astronomy and Astrophysics, 675, A4 *BEYONDPLANCK. IV. Simulations and validation*

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[21] Chanda S., Wada T.,2024, International Journal of Geometric Methods in Modern Physics, 21,2450098-10 *Mechanics of geodesics in information geometry and black hole thermodynamics*

[22] Chung E. J., Lee C. W., Kwon W., Tafalla M., Kim S., Soam A., Cho J.,2023, The Astrophysical Journal, 951,68 *Magnetic Fields and Fragmentation of Filaments in the Hub of California-X*

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[28] Dhanush S. R., Subramaniam A., Nayak P. K., Subramanian S.,2024, Monthly Notices of the Royal Astronomical Society, 528,2274 *Spatiotemporal map of star clusters in the Magellanic Clouds using Gaia: synchronized peaks and radial shrinkage of cluster formation*

[29] Dharmadhikari R., Parihar P., Jacob A.,2023, Experimental Astronomy, 56,569 *Building a large affordable optical-NIR telescope (I): an alternate way to handle segmented primary mirror*

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[31] Divakar D. K., Saraf P., Sivarani T., Doddamani V. H.,2024, Journal of Astrophysics and Astronomy, 45,5 *Possibilities of identifying members from Milky Way satellite galaxies using unsupervised machine learning algorithms*

[32] Eskilt J. R., Lee K., Watts D. J., Anshul V., Aurlien R., Basyrov A., Bersanelli M., et al.,2023, Astronomy and Astrophysics, 678,A169 *COSMOGLOBE: Towards end-to-end CMB cosmological parameter estimation without likelihood approximations*

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[34] Gandhi H., Patel R., Pant V., Majumdar S., Pal S., Banerjee D., Morgan H.,2024, Space Weather, 22,e2023SW003805 *Correcting Projection Effects in CMEs Using GCS-Based Large Statistics of Multi-Viewpoint Observations*

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[42] Gulati S., Bhattacharya D., Ramadevi M. C., Stalin C. S., Sreekumar P.,2023, Monthly Notices of the Royal Astronomical Society, 521,2704 *Multiwavelength study of radio galaxy Pictor A: detection of western hotspot in far-UV and possible origin of high energy emissions*

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[46] Jadhav V. V., Subramaniam A., Sagar R.,2023, Astronomy and Astrophysics, 676,A47 *UOCS. X. Rich collection of post-mass-transfer systems in NGC 6791*

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[51] Kapoor R. C., Orchiston W.,2023, Journal of Astronomical History and Heritage, 26,113 *Colonial astronomy as an element of Empire in British India*

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[55] Karoly J., Ward-Thompson D., Pattle K., Berry D., Whitworth A., Kirk J., Bastien P., et al.,2023, The Astrophysical Journal, 952,29 *The JCMT BISTRO Survey: Studying the Complex Magnetic Field of L43*

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[63] Kumar R., Pradhan A. C., Sahu S., Subramaniam A., Piridi S., Cassisi S., Ojha D. K.,2023, Monthly Notices of the Royal Astronomical Society, 522,847 *Globular Cluster UVIT Legacy Survey (GlobULeS) - II. Evolutionary status of hot stars in M3 and M13*

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Table 10.1: *Number of publications over the past seven years.*

Year	Published in Journals	Published in Proceedings	Total
2017-18	129	3	132
2018-19	123	36	159
2019-20	135	35	170
2020-21	132	13	145
2021-22	194	7	201
2022-23	179	11	190
2023-24	176	14	190
Total	**1068**	**119**	**1187**

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[172] Xu F.-W., Wang K., Liu T., Goldsmith P. F., Zhang Q., Juvela M., Liu H.-L., et al.,2023, Monthly Notices of the Royal Astronomical Society, 520,3259 *ATOMS: ALMA Three-millimeter Observations of Massive Star-forming regions - XV. Steady accretion from global collapse to core feeding in massive hub-filament system SDC335*

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10.2 Conference Proceedings

[1] Banerjee D., Jha B. K., Mandal S., Chatterjee S., Hegde M., KoSO Digitization Team,2023,IAUS, 372,84 *Long-term Evolution of Magnetic Field Proxies as Deduced from Archival Data*

[2] Beri A., Shastri P., Banyal R., Chatterjee D., Chatterjee R., Jassal H., Kanekar N., et al.,2023,AIPC, 3040,060003 *Towards gender equity in Indian astronomy*

[3] Bestha M., Hasan A., Divakar D., Surya A., Sriram S., Sivarani T., Prakash A., et al.,2023,SPIE, 12677,126770Q *Atmospheric dispersion corrector for a multi-object spectroscopic mode of HROS-TMT*

[4] Das M.,2023,IAUS, 373,114 *A UVIT Look at Star Formation in Nearby Interacting/Merging Galaxies*

[5] Desai A., Sallum S. E., Banyal R., Batalha N., Batalha N., Blake G., Brandt T., et al.,2023,SPIE, 12680,1268023 *Simulating medium-spectral-resolution exoplanet characterization with SCALES angular/reference differential imaging*

[6] Dharmadhikari R., Jacob A., Parihar P.,2023,SPIE, 12638,1263807 *Optical design of FOSC and wide field aberration corrector for the prototype segmented mirror telescope*

[7] Khan R., Nagaraju K., Phanindra D.,2023,SPIE, 12679,126790T *Design concepts of EUV polarimeter*

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[12] Shrivastav A. K., Pant V.,2023,IAUS, 372,119 *Study of the Impact of Coronal Rain on Kink Oscillations of Coronal Loops*

[13] Subramanian S. K., Rengaswamy S.,2023,SPIE, 12638,1263812 *Forward modelling of turbulence strength profile estimation using S-DIMM+*

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10.3 Technical reports, Monographs, Circulars, Telegrams

[1] Bacci P., Maestripieri M., Grazia M. D., Prosperi E., Prosperi S., Jaeger M., Foglia S., et al.,2023,MPEC, 2023-O51 *Comet P/2023 m4 (atlas)*

[2] Basu J., Barway S., Anupama G. C., Teja R. S., Dutta A.,2023,ATel, 16064,1 *Search for the progenitor of SN 2023ixf in archival AstroSat UVIT images*

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[5] Basu J., Barway S., Anupama G. C., Chamoli S., Kumar S. P.,2023,ATel, 16364,1 *HCT detection of the 2023 eruption of M31N 2008-12a*

[6] Basu J., Barway S., Anupama G. C., Chamoli S., Kumar S. P.,2023,ATel, 16367,1 *Spectroscopic confirmation of the 2023 outburst of M31N 2008-12a*

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[8] Panwar N., Jose J., Rishi C.,2023, Journal of Astrophysics and Astronomy, 44,42 *Survey of Hα emission-line stars in the star-forming region IC 5070*

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11

Other Institutional Activities

11.1 Official Language Implementation (OLI)

Correspondence

[1] The prescribed target of 55% in respect of "Originating Correspondence in Hindi (including E-mail, Fax etc.)" was achieved.

[2] OL Rule-5 - "Letters received in Hindi to be answered in Hindi" was strictly adhered to during every quarter and a prescribed target of 100% was achieved.

[3] The prescribed target of 30% in respect of "Noting in Hindi" was achieved.

OLIC Meeting
Four meetings were conducted in the Institute on 21 July, 25 September, & 20 December 2023 and 14 March 2024, and the reports were sent to DST, New Delhi and the Member Secretary, TOLIC, Bengaluru.

Hindi Workshop
In order to implement the Official Language in the Institute and to improve the official work in Hindi by the staff members, four Hindi Workshops were conducted on 28 June, 27 September, & 20 November 2023, and 14 March 2024, for the employees.

Hindi Day/Fortnight Celebration
The institute celebrated Hindi Fortnight from 14-30 September 2023. During the occasion, seven different competitions were conducted in the institute viz. "Hindi Gaan", "Hindi Antakshari", "Hindi Sulekh", "Hindi Shrutlekh", "Hindi Vachan", "Smaran Shakthi", and "Hindi Scientific/Technical Article" contests. The winners of Hindi competitions were awarded prizes.

Official Language Training
One employee successfully completed their Hindi typing training course conducted by Central Hindi Training Sub Institute (CHTSI), Bengaluru.

Incentive Rewards
Under this scheme, five employees were awarded incentive amounts for implementing Official Language in their day-to-day official work.

11.2 Welfare of SC/ST Staff and Physically Challenged Staff

A senior officer of the Institute has been functioning as the liaison officer to support the

welfare of the SC/ST staff members. Special consideration as per norms during recruitment and regular assessment has been provided to these categories of employees. As of the end of the year (31 March 2024), members belonging to the SC, ST, OBC, and Physically Challenged categories constitute 8%, 14%, 21% and 1% respectively of the total strength. In addition, reservations continue to be extended to SC, ST, OBCs, and physically disabled persons. Proactive efforts are continuously made towards their welfare. Facilities and mechanisms have been provided for special administrative as well as technical training of staff from the historically disadvantaged categories.

11.3 Internal Complaints Committee

IIA is committed to providing a working environment that is free of sexual harassment and gender-based discrimination. In accordance with the guidelines of the Supreme Court of India, and the Central Civil Services (Conduct) rules of the Government of India, IIA's Internal Complaints Committee (ICC) is in place to receive and respond to complaints from employees related to harassment and the workplace if any, with compliance to the rules and procedures laid down by the institute. Awareness activity related to the Sexual Harassment of Women at Workplace (Prevention, Prohibition, and Redressal) Act, 2013 was conducted in December 2023. The workshop was conducted by the Lawyers from Alternative Law Forum, Bengaluru, and was led by Adv. Poorna Ravishankar (see Figure 11.1). Another special session was conducted by ICC members and BGS specifically for visiting students at IIA in Feb 2024 to spread awareness about the prevention of sexual harassment, where the members of the ICC were also introduced.

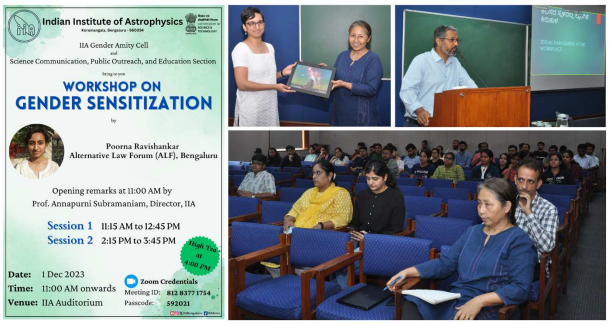

Figure 11.1: *ICC awareness event led by Adv. Poorna.*

To commemorate the ninth anniversary of the notification of the above Act, informative material aimed at spreading awareness of gender-related issues, including a poster, documentary video and various materials available on the IIA website, was shared with all members of IIA (see Figure 11.2). The material covered topics such as what is sexual harassment, the functioning of the ICC, the procedure for complaints, inquiry into the complaints, the timeline between receipt of the complaint and completion of the inquiry process, and so on. They also covered elements of handling and prevention of unacceptable behaviour, the various duties of the employer/employee to curb harassment, and how to make the workplace safe and secure not only for women but for everyone.

11.4 Gender Amity Cell

In addition to the Internal Complaints Committee, IIA has constituted the Gender Amity Committee (GAC) whose mandate is to carry out activities aimed at promoting

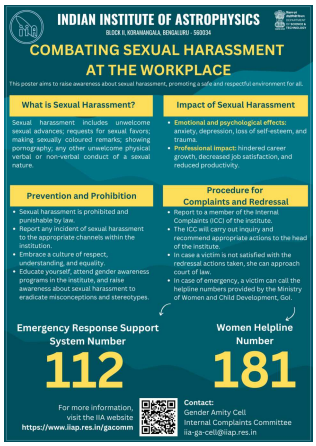

Figure 11.2: *A poster on "Combating Sexual Harassment at the Workplace"*

awareness of gender-related issues and work towards creating a congenial atmosphere. To mark International Women's Day on 8 March 2024, the GAC along with the SCOPE Section organised a talk by independent science journalist and writer Ms Nandita Jayaraj on "The Gender Gap in Indian STEM and the Questions that Remain" (see Figure 11.3). It also started a new series of videos, with SCOPE, highlighting women astronomers of IIA, which are uploaded on the institute's YouTube channel.

Figure 11.3: *International Women's Day celebrations.*

11.5 Creche on IIA campus

A new Child Care Facility was made available in the IIA Bengaluru campus, which was inaugurated on 18 October 2023 (see Figure 11.4). This is a daycare facility for children aged between 6 months to 5 years. Currently, only employees of IIA are allowed to use this facility and it is not open to the public. The facility has one teacher and a caretaker to look after the children from 8:30 AM to 5:30 PM. The facility is equipped with four CCTV cameras for the safety of the children as well.

Figure 11.4: *The new Creche facility at IIA*

11.6 DOOT e-magazine

DOOT is a completely student-led initiative that aims to bring out contributions to popularize Astronomy and Astrophysics from IIA to a larger community. Since the release of the 1st issue of DOOT in August 2020, 8 more issues with over 125 articles in total, are now available online. The articles include interviews with eminent scientists, research-based review articles, simplified explanations of scientific concepts, experiences shared by the IIA fraternity, anecdotes from alumni, astrophotography and so on.

The latest issue of DOOT was released in September 2023 at IIA by the Dean IIA. A new DOOT logo was also unveiled. Posters and flyers publicising the e-magazine were displayed at various public events for the benefit of masters and research students. The stall set up by DOOT at the IIA Open Day 2024 was extremely popular with the general public (see Figure 11.5). The stall featured games, puzzles, quizzes etc, aimed mainly at school students. DOOT also maintains an active online social media presence.

Figure 11.5: *Activities by DOOT*

The tenure of Rishabh Singh Rawat as Chief Editor concluded in Jan 2024, following which, Neeraj Singh Rawat and Sipra Hota were elected as Chief Editor and Co-Chief Editor, respectively. The DOOT team, now with 24 members, is currently engaged in transforming the online magazine into a full-fledged website.

11.7 Other activities

In addition to those listed above, the institute regularly organised celebrations and events to mark important occasions, viz., flag hoisting during Independence Day and flag unfurling during Republic Day in all its campuses, Vigilance Pledge, Yoga Day, fire safety demonstrations, etc, and some of these are featured in Figure 11.6.

Figure 11.6: *Other activities at IIA*

12

IIA Staff

In this chapter, we list all the IIA staff as on 31 March 2023.

Director: Annapurni Subramaniam

(A) Academic & Scientific members

Senior Professor: B. Eswar Reddy, Arun Mangalam, R. Ramesh, S.K. Sengupta

Professor: P. S. Parihar, D.K. Sahu, Gajendra Pandey, S. Paul Kaspar Rajaguru, Muthu Mariappan, Sivarani Thirupathi, C. S. Stalin, S. Muneer, Mousumi Das, Pravabati Chingangbam, B. Ravindra, Maheswar Gopinathan

Associate Professor: Umanath S. Kamath, M. Sampoorna, C. Kathiravan, Firoza K Sutaria, Subinoy Das, Ravinder Kumar Banyal, Sharanya Sur, Sudhanshu Barway, Nagaraju K., Piyali Chatterjee, Smitha Subramanian

Assistant Professor: P. Vemareddy, Vivek M., Wageesh Mishra, Ravi Joshi, Bharat Kumar Yerra, Jayant Joshi, Kolekar Sanved Vinod, Tanmoy Samanta, Archana Soam, Anusha L. S., K. Sasi Kumar Raja, Bala Sudhakara Reddy

Scientist E: Niruj Mohan Ramanujam, R. Sridharan, Shanthikumar Singh N.

Scientist D: Rekesh Mohan, Arun Surya

Scientist C: M. Chrisphin Karthick

Scientist B: Namgyal Dorjey

Honorary Visiting Professor: Shyam N. Tandon

Honorary Professor: P. Sreekumar, Jayant Murthy, K. P. Raju, B. Raghavendra Prasad

Adjunct Professor: A. N. Ramaprakash

Consultant: Jagdev Singh, C.H. Basavaraju, Poornima U. B., P. K. Mahesh

NASI Sr. Scientist: Ram Sagar

INSA Senior Scientist: G. C. Anupama

Woman Scientist: B. P. Hema

Visiting Scientist: Manjunath Hegde

Ramanujan Fellow: Santanu Mondal

DST Inspire Faculty Fellow: Nayana A. J.

Post Doctoral Fellows: Sarang Shashikant Shah, Syed Ibrahim M., Mridweeka Singh, Susmitha Rani Antony, Sumanto Chanda, Naveen Jingade, Arun Roy, K. Aditya, Neeraj Kumari, Anwesh Kumar Mishra

Post-Doctoral Researchers

IIA: Subhashree Swain, Dhrimadri Khata, Alik Panja, Sagarika Tripathy, Suvedha Suresh Naik, Gourav Banerjee

IIA-PU: Sharmila Rani, Soumya Sengupta, Suman Saha, Meenakshi P., Ankit Kumar, Athira Unni, Manika Singla, Anirban Dutta, Indrani Pal, Deepthi S. Prabhu, Fazlu Rahman P. P., Jyoti, Ravi Kumar Sharma, Sioree Ansar, Swastik Chowbay

Senior Research Fellow:
IIA-PU: Sonith L. S., Pallavi Saraf, Anohita Mallick, Rishabh Singh Teja, Aratrika Dey, Dhanush, Sipra Hota, Amrutha S., Neeraj Singh Rawat, Soumyaranjan Khuntia, Judhajeet Basu, Amalam Chakraborty, Saili Kumari Keshri, Renu Devi, Saikhom Pravash Singh, Kajol Vaijanath Paithankar, Nitesh Kumar Dubey, Rupesh Behera, Chandan, Ameya Uday Nagdeo, Shivani Gupta

Externally funded projects: Sambit Ratha, Anisha Sen, Sushant Kumar

IIA-CU: Harsh Mathur, Kshitij Bane T., Bharat Chandra P., Vishnu Madhu, Raveena Khan, Radhika harmadhikari, Saraswathi Kalyani, Shaik Sayuf, Shubham, Jankiram Ghatul, B. Manjunath

IIA-JAP: Sahel Dey, Samriddhi Sankar Maity, Payel Nandi

Junior Research Fellow:
IIA-PU: Abinaya Ondivillu Omkumar, Sriram Krishna, Masroor Bashir, Sankalp Srivastava, Shashank Gairola, Shatakshi Chamoli, Ayushi Chippa, Annu, Lupamudra Sarmah, Puja Porel, Sunit Sundar Pradhan, Anjali Agarwal, Reena Chaudhary, Kanan Vijay Virkar, Saurabh Tripathi, Yuvasri G., Sujit Das, Amrit Dutt, Kanika Sharma

Externally funded projects: Swagata Mukhopadhyay, Rakshit Chauhan, Abishek Balakrishnan, Ajay Kumar Saini, Shubham Kumar Jha, Arav B. J., Devang Agnihotri, Hrishav Das

IIA-CU: Akhil Jaini, Parvarthy M, Shubhangi Jain, Nitish Singh

IIA-JAP: Rachana

IIA-CU M.Tech.: Gurwinder Singh, Savitha M. S.

(B) Engineering & Technical staff

Engineer F: S. Nagabhushana, S. Sriram, P. Madan Mohan Kemkar, M. V. Ramaswamy

Engineer E: V. Arumugam, Amit Kumar, S. Kathiravan, P. Anbazhagan, B. Ravikumar Reddy, Sanjiv Gorka, Dorje Angchuk, Tsewang Dorjai

Engineer D: K. Anupama, Anish Parwage, D. V. S. Phanindra, S. Ramamoorthy, R. Vellai Selvi, A. Ramachandran, Venkata Satya Gireesh Gantyada, Sonam Jorphail, Tashi Thsering Mahay

Engineer C: Deshmukh Prasanna G., C. Mallappa, Chinchu Mohanan K., Totan Chand, M. Rajalingam, Indrajit Vittal Barve, Tsewang Gyalson

Engineer B: Srinivasa K. V., P. R. Sreeramulu Nayaka, Ali Khan Basheer, Vinay Kumar Gond

Technical Officer: J. Manoharan, K. Sagayanathan, P. Kumaravel, S. Venkateshwara Rao

Librarian: Arumugam Pitchai

Asst. Librarian C: P. Prabahar, B. S. Mohan

Tech. Associate B: N. Thimmaiah

Research Associate B: V. Moorthy

Senior Associate: C. Velu

Sr. Research Assistant B: A. K. Venkataramana

System Administrator: S. Fayaz

Technical Assistant C: Anwar Saheb

Sr. Technical Assistant B: Phuntsok Dorjay

(C) Administrative staff

Administrative Officer: Shripathi K.

Accounts Officer: S. B. Ramesh

Sr. Stores & Purchase Officer: K. P. Vishnu Vardhan

Section Officer (SG): N. Sathyabhama, Diskit Dolker

Senior Section Officer: P. Selvakumar, Srinivasa Rao Vuyyuru

Section Officer: S. Dhananjaya, K. Bhaskaran, Manish Soni, Man Singh

Hindi Officer: S. Rajanatesan

INDIAN INSTITUTE OF ASTROPHYSICS
BENGALURU - 560034

AUDITED STATEMENT OF ACCOUNTS
FINANCIAL YEAR 2023-24

INDIAN INSTITUTE OF ASTROPHYSICS
BENGALURU - 560034

Audited Statement of Accounts 2023-24

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E-mail : cagvassociates@gmail.com / gireeshatl@yahoo.com

Ref.

Date....31.07.2024.....

Independent Auditor's Report

To

The Members of the INDIAN INSTITUTE OF ASTROPHYSICS,

Report on the Financial Statements

Opinion

We have audited the accompanying financial statements of **INDIAN INSTITUTE OFASTROPHYSICS** which comprises the Balance Sheet as at March 31, 2024, the Statement of Income & Expenditure Account and Statement of Receipts and Payments Account for the year then ended, and Notes to the Financial Statements, including a summary of significant accounting policies and other explanatory information.

Responsibility of Management for the Standalone Financial Statements

The Management is responsible for the preparation of these financial statements that give a true and fair view of the financial position and financial performance in accordance with the accounting principles generally accepted in India. This responsibility also includes maintenance of adequate accounting records and safeguarding of the assets of the Institute and for preventing and detecting frauds and other irregularities; selection and application of appropriate implementation and maintenance of accounting policies; making judgments and estimates that are reasonable and prudent; and design, implementation and maintenance of adequate internal financial controls, that were operating effectively for ensuring the accuracy and completeness of the accounting records, relevant to the preparation and presentation of the financial statement that give a true and fair view and are free from material misstatement, whether due to fraud or error.

Auditor's Responsibility for the Audit of the Financial Statements

Our objectives are to obtain reasonable assurance about whether the financial statements as a whole are free from material misstatement, whether due to fraud or error, and to issue an auditor's report that includes our opinion. Reasonable assurance is a high level of assurance, but is not a guarantee that an audit conducted in accordance with Standards on Auditing will always detect a material misstatement when it exists. Misstatements can arise from fraud or error and are considered material if, individually or in the aggregate, they could reasonably be expected to influence the economic decisions of users taken on the basis of these financial statements.

Gireesha Vijayan & Associates FRN 014117S Chartered Accountants

Opinion,

In our opinion, and to the best of our information and according to the explanations given to us, the aforesaid financial statements give the information required and give a true and fair view in conformity with the accounting principles generally accepted in India.

a. In case of Balance Sheet of the state of affairs of the Institute as at 31st March 2024;

b. In case of statement of Income & expenditure Account, Excess of Expenditure Over Income for the year ended on that date;

c. In case of Receipts and Payments Account for the year ended on that date;

We further report that,

a. We have sought and obtained all the information and explanations which to the best of our knowledge and belief were necessary for the purpose of our Audit.

b. In our opinion, proper books of account as required by law have been kept by the Institute so far as it appears from our examination of those books.

c. The Balance Sheet, the Statement of Income & Expenditure Account and the Receipts and Payments Account dealt with by this Report are in agreement with the books of account.

For GIREESHA VIJAYAN & ASSOCIATES
Chartered Accountants
FRN: 014117S

CA. GIREESHA T.L., B.Com, FCA, DISA.
Partner
M.No. 230674
UDIN: 24230764BKCRKA8644

Gireesha Vijayan & Associates FRN 014117S Chartered Accountants

Place: BENGALURU
Date: 31/07/2024

INDIAN INSTITUTE OF ASTROPHYSICS, BENGALURU
BALANCE SHEET AS AT 31ST MARCH 2024

(Amt. in Rupees)

	Sch	Current Year	Previous Year
LIABILITIES			
Capital Fund	1	1,01,49,95,882	1,02,52,78,697
Reserves & Surplus	2	-	-
Earmarked External Projects Fund	3	36,02,66,968	38,43,68,666
Secured Loans & Borrowings	4	-	-
Unsecured Loans & Borrowings	5	-	-
Deferred Credit Liabilities	6	-	-
Current Liabilities & Provisions	7	3,08,80,402	1,99,98,146
TOTAL		1,40,61,43,252	**1,42,96,45,510**
ASSETS			
Fixed Assets	8	94,81,32,271	85,61,38,669
Investments- from earmarked & endowment funds	9	-	-
Investments-Others	10	-	-
Current Assets, Loans & Advances	11	45,80,10,981	57,35,06,841
TOTAL		1,40,61,43,252	**1,42,96,45,510**
SIGNIFICANT ACCOUNTING POLICIES	24		
CONTINGENT LIABILITIES & NOTES ON ACCOUNTS	25		

S.B.RAMESH
ACCOUNTS OFFICER

SHRIPATHI.K
ADMINISTRATIVE OFFICER

ANNAPURNI SUBRAMANIAM
DIRECTOR

As per our report of even date
For GIREESHA VIJAYAN & ASSOCIATES
Chartered Accountants
FRN 014117S

CA. GIREESHA T.L., B.Com, FCA, DISA.
Partner
M.No.230674
UDIN:24230764BKCRKA8644

Gireesha Vijayan & Associates FRN 014117S Chartered Accountants

Date: 31.07.2024
Place :BENGALURU

INDIAN INSTITUTE OF ASTROPHYSICS, BENGALURU

INCOME AND EXPENDITURE ACCOUNT FOR THE YEAR ENDED 31ST MARCH 2024

(Amt. in Rupees)

	Sch	Current Year	Previous Year
INCOME			
Income from Sales/Services	12	-	-
Grants/Subsidies	13	92,16,00,000	72,78,00,000
Fee/Subscriptions /Guest House/Canteen/CMS etc.	14	1,06,37,328	-
Income from Investments (earmarked/endowment funds)	15	-	-
Income from Royalty, Publication / Guest House, Canteen etc.	16	-	-
Interest Earned	17	55,15,754	1,42,55,700
Other Income	18	82,07,250	71,84,530
Increase/Decrease in stock of finished goods	19	-	-
TOTAL (A)		**94,59,60,332**	**74,92,40,230**
EXPENDITURE			
Establishment Expenses	20	65,99,98,541	62,67,38,417
Other Administrative Expenses	21	22,98,56,475	20,55,36,758
Expendtiture on Grants/Subsidies etc.	22	-	-
Grant in Aid and Interest Returned to Govt	23	3,21,12,487	13,45,38,407
Depreciation (Net Total at the year end as per Schedule 8)		10,42,75,644	7,84,95,181
TOTAL (B)		**1,02,62,43,148**	**1,04,53,08,763**
Balance being Surplus/(Defecit) Carried to Corpus/Capital Fund		**(8,02,82,816)**	**(29,60,68,534)**
SIGNIFICANT ACCOUNTING POLICIES	24		
CONTINGENT LIABILITIES & NOTES ON ACCOUNTS	25		

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UDIN:24230764BKCRKA8644

Date: 31.07.2024
Place :BENGALURU

INDIAN INSTITUTE OF ASTROPHYSICS, BENGALURU
RECEIPTS AND PAYMENTS ACCOUNT FOR THE YEAR ENDED MARCH 31, 2024

(Amt. in Rupees)

Receipts	Current Year	Previous Year	Payments	Current Year	Previous Year
1) Opening Balances			1) Expenses		
a) Cash in hand	1,19,969	95,016	a) Establishment Expenses (Sch.20)	65,99,98,541	62,67,38,417
b) Bank Balances			b) Admin Expenses (Sch. 21)	22,98,56,475	19,81,10,562
i) Current Accounts	2,07,180	21,58,217			
ii) Deposit Accounts			2) Payments made against projects	98,22,17,350	1,27,66,97,147
iii) Savings Accounts	55,30,06,047	1,21,79,53,666	3) Investments made	-	-
Tax Deducted at Source			a) Out of Earmarked/EndowmentFunds	-	-
2) Grants Received			b) Out of own funds	-	-
a) From Govt. of India					-
i) Capital Grants	7,00,00,000	-	4) Pmt of Group Insurance	-	-
ii) Recurring Grants	92,16,00,000	72,78,00,000		-	-
b) From State Govt.			5) Capital Expenditure (Sch. 8)	-	-
c) From other sources			a) Purchase of Fixed Assets (Sch.8)	19,40,58,387	14,04,76,903
3) Project Receipts	95,81,15,651	96,09,24,844	b) Expenditure on Work-in-Progress	22,10,859	66,40,914
4) Interest Received			c) Any other receipts/payments	-	7,81,068
a) On Savings Bank Account	43,41,112	1,36,37,486	d) Interest returned to Funding Agency	-	1,35,16,799
b) on Loans, Advances etc.	9,61,723	6,18,214	6) Pmt of EMD, Caution, Security Dep etc	1,06,99,760	63,00,945
5) Sundry Creditors, Curr Liabilities	89,66,069	-	7) Grant in Aid returned to DST	3,21,12,487	12,10,21,608
6) EMD, Caution, Security Dep. Recd	1,77,23,874	23,94,573	8) Advances to Staff members etc	54,98,501	1,05,54,799
7) Refund of Adv. from Staff, Deposits	63,25,756	1,52,86,385	9) Sundry Creditors, Curr Liabilities	68,94,754	-
8) Receipts of Margin LC	1,11,89,767	1,44,87,000	10) Payments on Margin LC	36,30,000	81,35,767
9) Salary Recoveries	8,22,85,276	8,62,38,810	11) Salary Recoveries	8,21,51,328	8,63,22,687
10) Any other receipts	91,31,651	79,65,598	12) Consumable Stock & Provisions	10,74,720	9,28,994
11) Guest House & Canteen, CMS	1,06,37,328	-			
12) Service benefits received	16,52,880	-	13) Closing Balances:		
			a) Cash in hand	2,35,387	1,19,969
			b) Bank Balances	-	-
			i) Current Accounts	2,99,184	2,07,180
			ii) Savings Accounts	44,53,26,551	55,30,06,047
TOTAL	**2,65,62,64,283**	**3,04,95,59,807**	**TOTAL**	**2,65,62,64,283**	**3,04,95,59,807**

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Date: 31.07.2024
Place :BENGALURU

INDIAN INSTITUTE OF ASTROPHYSICS, BENGALURU

SCHEDULES FORMING PART OF BALANCE SHEET AS AT 31ST MARCH 2024

(Amt. in Rupees)

	Current Year		Previous Year	
Schedule 1- Capital Fund				
Balance as at the beginning of the year	1,02,52,78,697	-	1,32,13,47,231	
Add: Capital Grants	7,00,00,000	1,09,52,78,697	-	1,32,13,47,231
Add/Deduct: Balance of net Income/(Expenditure) transferred from the Income & Expenditure Account	(8,02,82,816)	(8,02,82,816)	(29,60,68,534)	(29,60,68,534)
Balance as at the Year End		**1,01,49,95,882**		**1,02,52,78,697**

	Current Year		Previous Year	
Schedule 2 - Reserves & Surplus				
1, Capital Reserve:				
As Per last Account	-		-	
Addition during the year	-		-	
Less: Deduction during the year	-	-	-	-
2, Revaluation Reserve:				
As Per last Account	-		-	
Addition during the year	-		-	
Less: Deduction during the year	-	-	-	-
3, Special Reserve:				
As Per last Account	-		-	
Addition during the year	-		-	
Less: Deduction during the year	-	-	-	-
4, General Reserve:				
As Per last Account	-		-	
Addition during the year	-		-	
Less: Deduction during the year	-	-	-	-
Balance as at the Year End		-		-

Giresha Vijayan & Associates FRN 014117S

INDIAN INSTITUTE OF ASTROPHYSICS, BENGALURU

SCHEDULES FORMING PART OF BALANCE SHEET AS AT 31ST MARCH 2024

Schedule 3- Earmarked External Project Funds etc

(Amt. in Rupees)

Sl No	Funding Agency	Project Name	Opening Balance as on 01.04.2023	Received during the year	Utilisation			Total Utilisation	Balance as on 31/03/2024
					Capital Expenditure	Revenue Expenditure	Advances/LC/ Interest Returned/Amt Returned(PFMS)		
		Funded by Government Agencies							
1	DAE	DAE - TMT - B.Eswar Reddy	2,92,79,640	40,96,80,734	26,24,61,251	-	3,67,12,707	29,91,73,958	13,97,86,416
2		DAE - (1303/3/2021) COSMOS-1 - Annapurni Subramaniam	13,13,62,277	9,27,044	12,75,94,431	-	-	12,75,94,431	46,94,890
3	PSA	PSA - (J/5/2021) COSMOS-1 - Annapurni Subramaniam	2,62,34,564	4,55,405	9,55,935	74,95,017	-	84,50,952	1,82,39,017
4	MP-LAD	MPLAD - (E-135937) COSMOS-1 - Annapurni Subramaniam	1,52,00,000	1,94,782		1,52,00,000	-	1,52,00,000	1,94,782
5	DST	DST-COSMOS -Annapurni Subramaniam	-	20,00,00,000	9,82,69,545	-	97,29,704	10,79,99,249	9,20,00,751
6		DST - TMT - B.Eswar Reddy	3,859	31,78,67,805	22,48,44,003	3,29,45,305	5,92,47,569	31,70,36,877	8,34,787
7		DST Indo-South Africa (P04) - P.Parihar	55,863	-	-	-	55,863	55,863	-
8		DST Indo-Polish (P05) - CS Stalin	3,99,412	9,985	-	-	-	-	4,09,397
9		DST Indo-Belgium (P3) - D Banerjee	42,184	1,055	-	-	-	-	43,239
10		DST-WOS (17) - Margarita Safonova	-	6,00,000	-	6,00,000	-	6,00,000	-
11		DST-Ramanunan Fellow (RJN-168/2017) -Smitha Subramanian	1,30,847	2,31,991	-	2,32,260	-	2,32,260	1,30,578
12		DST- JSPS (P-363) - DK SAHU	-	2,25,000	-	1,83,482	41,518	2,25,000	-
13		DST-JSPS (P-300) D Banerjee	1,09,627	2,741	-		-	-	1,12,368
14		DST-WOS/A/PM/1/2020 -BP Hema	73,577	8,98,000	-	9,71,577	-	9,71,577	-
15		DST-INSPIRE (000563)- A J NAYANA	(6,48,096)	24,01,166.00	-	10,96,135.00	6,56,935.00	17,53,070.00	-
16		DST Inspire Fellow (IF200268) - Anisha Sen	37,030	5,69,964	-	6,06,994	-	6,06,994	-
17		DST-DAAD/P-07/2023 - Subinoy Das	-	4,35,000	-	1,45,815	2,89,185	4,35,000	-
18	ISRO	ISRO Aditya VELC	9,62,65,394	22,79,657	68,44,450	1,29,68,325	-	1,98,12,775	7,87,32,276
19	SERB	SERB (001535) - Sharanya Sur	1,21,592	-	-	-	1,21,592	1,21,592	-
20		SERB (P39) Kodai Digitization - D Banerjee	(5,79,230)	-	-	24,998	-	24,998	(6,04,228)
21		SERB-Vivek-Ramanujan Fellowship	-	7,47,581	74,635	71,935	-	1,46,570	6,01,011
22		SERB-(003786)-SPK Rajaguru & Nagaraju	5,23,359	4,216	1,12,684	1,44,780	2,70,111	5,27,575	-
23		SERB (MATRICS/000266) - Mousumi Das	83,614	1,40,925	-	2,23,614	-	2,23,614	926
24		SERB-(000755)-C Muthumariappan	1,06,546	5,55,579	-	3,18,491	-	3,18,491	3,43,634
25		SERB-(006147)-Subinoy Das	1,82,888	6,03,852	99,500	6,31,644	-	7,31,144	55,596
26		SERB Power Fellowship Annapurni Subramaniam	41,496	12,09,459	-	9,88,194	-	9,88,194	2,62,761
27		SERB-(001657)-Vivek M	4,58,090	8,089	-	67,235	-	67,235	3,98,944
28		SERB-(005174) - Arun Mangalam	9,94,261	2,11,861	-	10,45,091	-	10,45,091	1,61,031
29		SERB-WEA (000012)-Sampoorna M	3,88,101	2,199	-	56,966	3,33,334	3,90,300	-

30	SERB	SERB-(000108/2022) - Gajendra Pandey	4,48,797	3,03,994	-	4,38,204	-	4,38,204	3,14,587
31		SERB-Ramanujan Fellow - Santanu Mondal	-	24,05,907	-	19,99,586	-	19,99,586	4,06,321
32		SERB-SRG (2021/031) - Vema Reddy	2,33,623	2,54,702	-	4,73,900	-	473900	14,425
33		SERB - (02672) Smitha Subramanian	4,20,158	5,20,272	1,04,570	5,49,633	-	6,54,203	2,86,227
34		SERB - (2022/01785) Ravi Joshi	20,13,388	37,746	2,44,941	1,97,171	-	4,42,112	16,09,022
35		SERB - (01522) - ANUSHA LS	-	9,57,045	2,48,980	3,03,156	-	5,52,136	4,04,909
36		SERB - (7688) SAHU DK	-	7,74,270	-	2,98,089	-	2,98,089	4,76,181
37		SERB - (4531) MOUSUMI DAS	-	9,81,168	-	2,88,593	-	2,88,593	6,92,575
38		SERB - (2244) Mridweeka Singh	-	7,45,200	-	-	-	-	7,45,200
39		SERB - (1469) Suvedha Suresh Naik	-	7,45,200	-	-	-	-	7,45,200
40	CSIR	CSIR JRF - Sambit Ratha	18,777	421	-	-	-	-	19,198
41		CSIR Fellow Payel Nandi	(70,000)	1,63,000	-	-	-	-	93,000
42	UT-Wildlife	Wildlife Warden Fund, Ladakh - Director, IIA	-12,70,275	-	-	-	-	-	(12,70,275)
43	DRDO	DRDL-(01/2021) Star Tracker Unit - Amit Kumar	7,84,74,414	10,57,589		6,51,24,736		6,51,24,736	1,44,07,267
44	NPS	NPS Account	18,76,345	52,122	-	-	-	-	19,28,467
45	CEFIPRA	CEFIPRA-HI-CLOGS (6504-3) C.Muthumariappan	6,66,823	1,08,749	-	2,76,480	-	2,76,480	4,99,092
46		CEFIPRA (IFCAM-21) - C.Muthumariappan	4,31,896	-	-	4,31,896	-	4,31,896	-
47	INSA	INSA - (339) Geetha K Ganesha	1,23,940	2,48,477	-	3,50,335	-	3,50,335	22,082
48	IUSSTF	IUSSTF - (113/2019) Piyali Chatterjee	1,33,885	2,578	-	16,711	-	16,711	1,19,752
49	MOES	REACHOUT-(16/02/2021) MOES Shanti Kumar Singh	-	50,13,968	41,12,752	8,75,349	25,867	50,13,968	-
50	AIPL	AIPL (Alt-Air Infrasec) - Jayant Murthy	-	20,00,000	-		-	-	20,00,000
51	TIFR	HBCSE TIFR COSMOS OLYPIAD -Neeruj Mohan	-	1,52,510	-	1,52,510	-	1,52,510	-
52	INSA	INSA - GC Anupama - 2023	-	6,25,562	-	2,70,000	-	2,70,000	3,55,562
53	IPR	IPR (CPS 2022)- Piyali Chatterjee	-	7,01,081	-	7,01,081	-	7,01,081	-
TOTAL			**38,43,68,666**	**95,81,15,651**	**72,59,67,677**	**14,87,65,288**	**10,74,84,385**	**98,22,17,350**	**36,02,66,968**

INDIAN INSTITUTE OF ASTROPHYSICS, BENGALURU

SCHEDULES FORMING PART OF BALANCE SHEET AS AT 31ST MARCH 2024

(Amt. in Rupees)

	Current Year		Previous Year	
Schedule 4- Secured Loans & Borrowings				
TOTAL		-		-

	Current Year		Previous Year	
Schedule-5- Unsecured Loans & Borrowings				
TOTAL		-		-

	Current Year		Previous Year	
Schedule 6- Deferred Credit Liabilities				
TOTAL		-		-

	Current Year		Previous Year	
Schedule-7- Current Liabilities & Provisions				
A. Current Liabilities				
1. Acceptances	-	-	-	-
2. Sundry Creditors	-		-	
a) For goods	-		-	
b) Others (services)	87,37,512	-	67,97,153	-
3) Advances Received	-		-	
4. EMD, Security Dep.Caution Dep etc	2,01,05,907	-	1,30,81,793	-
5. Statutory Liabilities		-		-
a) Overdue	-	-	-	-
b) Others	-	-	-	-
6. Other Current Liabilities (Group Ins. etc.)	17,86,828	3,06,30,246.37	-	1,98,78,946
TOTAL (A)		3,06,30,246		1,98,78,946
B. PROVISIONS				
1. Taxation /Audit Fee Payable	1,00,000		97,600	
2. Gratuity	-		-	
3. Superannuation / Pension	-		-	
4. Accumulated Leave Encashment	-		-	
5. Other (specify) - GST Payable	1,50,156	2,50,156	21,600	1,19,200
TOTAL (B)		**2,50,156**		**1,19,200**
TOTAL (A+B)		**3,08,80,402**		**1,99,98,146**

Gireesha Vijayan & Associates ★ Chartered Accountants ★ FRN 014117S

INDIAN INSTITUTE OF ASTROPHYSICS, BENGALURU

SCHEDULES FORMING PART OF BALANCE SHEET AS AT 31ST MARCH 2024

Schedule 8- Fixed Assets

(Amt. in Rupees)

Description	GROSS BLOCK						Rate	DEPRECIATION				NET BLOCK	
	Cost /Valuation as at the beginning of the year	Additions during the year		Capitalized during the year	Deductions during the year	Cost / Valuation at the end of the year		As at the beginning of the year	Additions during the year	Deductions during the	As at the end of the year	As at the end of current year	As at the end of Previous Year
		More than 180 Days	Less than 180 Days										
1. Land - Freehold	2,48,98,870	-	-	-	-	**2,48,98,870**	-	-	-	-	-	2,48,98,870	2,48,98,870
NLST Land at Merak	5,65,64,200	-	-	-	-	**5,65,64,200**	-	-	-	-	-	5,65,64,200	5,65,64,200
2. Buildings - On freehold land	50,89,70,391	96,01,370	1,67,64,101	2,85,55,538	-	56,38,91,400	5%	**20,66,75,721**	1,74,41,681.43	-	22,41,17,402	33,97,73,998	30,22,94,670
3. MGK Menon Laboratory	12,25,18,973	-	-	-	-	**12,25,18,973**	5%	**4,12,01,282**	40,65,885	-	4,52,67,166	7,72,51,807	8,13,17,691
4. Vainu Bappu Telescope	5,35,97,659	-	-	-	-	**5,35,97,659**	15%	**5,33,73,413**	33,637	-	5,34,07,050	1,90,609	2,24,246
5. 2M Telescope	45,30,13,898	-	-	-	-	**45,30,13,898**	15%	**45,29,55,772**	8,719	-	45,29,64,491	49,407	58,126
6. HAGAR	5,13,02,579	-	-	-	-	**5,13,02,579**	15%	**4,64,38,911**	7,29,550	-	4,71,68,461	41,34,118	48,63,668
7. Scientific Equipments	1,32,07,48,460	2,86,82,762	3,53,13,190	-	-	**1,38,47,44,411**	15%	1,09,48,55,367	4,08,34,867	-	1,13,56,90,234	24,90,54,177	22,58,93,093
8. Vehicles	2,06,65,892	1,03,86,086	41,75,365	-	-	**3,52,27,343**	15%	**1,62,75,867**	25,29,569	-	1,88,05,436	1,64,21,907	43,90,025
9. Furniture & Fixtures	3,01,87,476	1,82,097	2,54,579	-	-	**3,06,24,152**	10%	**2,65,98,084**	3,89,878	-	2,69,87,962	36,36,190	35,89,392
10. Computers	22,58,61,130	2,55,71,082	5,76,96,902	-	-	**30,91,29,114**	40%	**19,83,73,472**	3,27,62,876	-	23,11,36,349	7,79,92,765	2,74,87,658
11. Library Books	18,56,33,883	31,15,268	23,15,585	-	-	**19,10,64,737**	40%	**17,62,09,489**	54,78,982	-	18,16,88,471	93,76,265	94,24,394
SUB-TOTAL	**3,05,39,63,411**	**7,75,38,665**	**11,65,19,722**	-	-	**3,27,65,77,336**		**2,31,29,57,378**	**10,42,75,644**		**2,41,72,33,023**	**85,93,44,313**	**74,10,06,032**
Capital Work in Progress													
Buildings at Field Stations	2,85,55,538	-	-	-	2,85,55,538	-		-	-	-	-	-	2,85,55,538
NLST	6,96,98,267	4,72,762	3,44,005	-	-	7,14,36,364		-	-	-	-	7,14,36,364	6,96,98,267
NLOT	1,68,78,832	13,94,092	-	-	-	1,73,51,594		-	-	-	-	1,73,51,594	1,68,78,832
SUB-TOTAL	**11,51,32,637**	**18,66,854**	3,44,005	-	-	**8,87,87,958**		-	-	-	-	**8,87,87,958**	**11,51,32,637**
GRAND TOTAL	**3,16,90,96,048**	**7,94,05,519**	**11,68,63,727**	**2,85,55,538**	**2,85,55,538**	**3,36,53,65,294**		**2,31,29,57,378**	**10,42,75,644**	-	**2,41,72,33,023**	**94,81,32,271**	**85,61,38,669**

INDIAN INSTITUTE OF ASTROPHYSICS,BENGALURU

SCHEDULES FORMING PART OF BALANCE SHEET AS AT 31ST MARCH 2024

(Amt. in Rupees)

	Current Year		Previous Year	
Schedule 9- Investments from Earmarked/Endowment Fund				
1. In Government Securities				
2. Other Approved Securities	-		-	-
3. Shares	-		-	-
4. Debentures and Bonds	-		-	-
5. Subsidiaries and Joint Ventures	-		-	-
6. Others	-	-	-	-
TOTAL		-		-

	Current Year		Previous Year	
Schedule-10 Investment (Others)				
1. In Government Securities	-		-	-
2. Other Approved Securities	-		-	-
3. Shares	-		-	-
4. Debentures and Bonds	-		-	-
5. Subsidiaries and Joint Ventures	-		-	
6. Others	-	-	-	-
TOTAL		-		-

Giresha Vijayan & Associates ★ Chartered Accountants ★ FRN 014117S

INDIAN INSTITUTE OF ASTROPHYSICS, BENGALURU
SCHEDULES FORMING PART OF BALANCE SHEET AS AT 31ST MARCH 2024

(Amt. in Rupees)

	Current Year		Previous Year	
Schedule 11- Current Assets, Loans & Advances				
A. CURRENT ASSETS				
1. Inventories				
a.Stores & Spares	10,74,720	-	9,28,994	-
b.Loose tools	-		-	
c.Stock in trade	-	10,74,720	-	9,28,994
2. Sundry Debtors				
a.Debts outstanding	-		-	
b.Others	-	-	-	-
3. Cash balances in hand (Including cash imprest)	2,35,387	-	1,19,969	-
4. Bank Balances				
- On Current Accounts	2,99,184		2,07,180	
- On Savings Accounts	44,53,26,551		55,30,06,047	
- On Deposit Accounts (IIA Margin LC)	6,30,000	44,64,91,122	81,89,767	56,15,22,963
[Projects Balance Rs.36,02,66,968]				
TOTAL (A)		**44,75,65,842**		**56,24,51,957**
B. LOANS/ADVANCES AND OTHER ASSETS				
1. Advances and other amounts recoverable in cash				
On Capital Account	-		-	
Deposits	22,60,129		21,92,912	
TMT - Project	7,66,113		7,66,113	
Advances to Staff Members	19,49,567	49,75,809	28,44,039	58,03,064
2. Income Accrued				
On Investments-Others	-		-	
On Loans & Advances	-	-	-	-
3. Claims Receivable (CSIR JRF)	10,90,105		10,90,105	
Other Claims	-		-	-
Tax Deducted at Source - IIA	43,79,225		41,61,715	
		54,69,330		52,51,820
TOTAL (B)		**1,04,45,139**		**1,10,54,884**
Grand Total (A+B)		**45,80,10,981**		**57,35,06,841**

Giresha Vijayan & Associates FRN 014117S Chartered Accountants

INDIAN INSTITUTE OF ASTROPHYSICS, BENGALURU
SCHEDULES FORMING PART OF BALANCE SHEET AS AT 31ST MARCH 2024

(Amt. in Rupees)

	Current Year		Previous Year	
Schedule 12- Income from Sales/Service				
1, Income From Sale	-	-	-	-
2, Income from Services	-	-	-	-
TOTAL		-		-

	Current Year		Previous Year	
Schedule 13- Grants/Subsidies				
(Irrevocable Grants & Subsidies Received)				
1. Central Government	-	-	-	-
	-		-	-
a. Revenue Grants	92,16,00,000	92,16,00,000	72,78,00,000	72,78,00,000
2. State Government	-	-	-	-
3. Government Agencies	-	-	-	-
4. Institutions/ Welfare Bodies	-	-	-	-
5. International Organisations		-	-	-
6. Others	-	-	-	-
TOTAL		**92,16,00,000**		**72,78,00,000**

	Current Year		Previous Year	
Schedule 14- Fees/Subscriptions				
1. Licence fees	-	-	-	-
2. Annual Fees/Subscriptions	-	-	-	-
3. Seminar/Program Fees	-	-	-	-
4. Consultancy Fees	-	-	-	-
5. Others Guest House/Canteen etc	1,06,37,328	-	-	-
TOTAL		-		-

	Current Year		Previous Year	
Schedule 15- Income from Investments				
(Income on investments from earmarked/endowment funds)				
1. Interest				
a) On govt. securities				
b) Other bonds/debentures	-		-	
2. Dividends	-		-	
a) On Shares				
b) On Mutual Fund Securities				
3. Rents	-		-	
4. Others	-			-
TOTAL		-		-

	Current Year		Previous Year	
Schedule 16- Income from Royalty/Publication				
1. Income from Royalty	-			
2. Income from Publications	-			
3. Others	-	-	-	-
TOTAL		-		-

	Current Year		Previous Year	
Schedule 17- Interest Earned				
1. On term Deposits				
a. With Scheduled Banks	-		-	
b. With Non Scheduled Banks	-		-	
c. With Institutions	-		-	
d. Others	-	-	-	-
2. On Savings Accounts				
a. With Scheduled Banks	45,54,031		1,36,37,486	
b. With Non Scheduled Banks	-		-	
c. Post office savings Accounts	-		-	
d. Others	-	45,54,031	-	1,36,37,486
3. On Loans				
a. Employees/Staff	9,61,723		6,18,214	
b. Others	-	9,61,723	-	6,18,214
TOTAL		**55,15,754**		**1,42,55,700**

	Current Year		Previous Year	
Schedule 18- Other Income				
1) Profit on sale/disposal of assets				
a) Own Assets				
b) Assets acquired out of grants				-
2) Licence Fee	9,08,185	-	7,96,642	
2) Overhead Income, Tender Fee and Other Receipts	72,99,065	82,07,250	63,87,888	71,84,530
TOTAL		**82,07,250**		**71,84,530**

	Current Year		Previous Year	
Schedule 19- Increase/(Decrease) in stock of finished goods				
TOTAL		-		-

INDIAN INSTITUTE OF ASTROPHYSICS, BENGALURU

SCHEDULES FORMING PART OF INCOME & EXPENDITURE A/c AS AT 31ST MARCH 2024

(Amt. in Rupees)

	Current Year	Previous Year
Schedule 20- Establishment Expenses		
a) Salaries	36,45,83,625	34,54,68,896
b) Allowances, LTC etc.	90,54,404	84,99,918
c) Contribution to Other Provident Funds NPS etc	2,75,96,740	1,76,98,403
d) Staff Welfare Expenses	4,46,42,387	4,01,34,433
e) Employees' Retirement,Terminal Benefits & Pension	21,41,21,385	21,49,36,767
TOTAL	**65,99,98,541**	**62,67,38,417**

	Current Year	Previous Year
Schedule 21- Other Administrative Expenses		
1) Advertisement	8,40,567	5,82,584
2) Audit Fee	1,00,000	1,00,300
3) AMCs/ Repairs	1,32,89,731	1,41,15,851
4) Bank Charges	1,52,844	2,26,576
5) Canteen Expenses	94,50,755	70,68,989
6) Conveyance	2,04,498	1,86,960
7) Electricity & Water Charges	1,95,37,247	1,32,35,444
8) Field Station Trips & Transport Expenses	35,29,037	24,00,775
9) Guest House Charges	91,26,303	35,92,701
10) Leased Rent for Observatories	86,332	2,61,332
11) Legal Charges/Professional Charges	1,77,000	2,79,500
12) Maintenance of campus / Outsourced Manpower etc.	12,83,19,188	12,06,04,578
13) Lab Expenses & Other Expenses	1,02,26,159	68,38,124
14) PhD/M.Tech. PhD Programme	16,28,002	13,55,332
15) Postage & Courier	58,919	81,009
16) Printing & Stationery	19,01,889	16,43,951
17) Property Tax	20,54,178	16,81,088
18) Public Outreach Expenses	1,77,858	22,500
19) Stores & Consumables	29,79,701	38,43,491
20) Summer Schools/Conference/Workshops	42,75,980	31,96,029
21) Telephone and Communication Charges	1,05,71,114	1,35,34,283
22) Travel Expenses	79,82,249	76,75,959
23) Vehicle Maintenance / Transport	31,86,924	30,09,402
TOTAL	**22,98,56,475.27**	**20,55,36,758**

	Current Year	Previous Year
Schedule 22- Expenditure on Grants, Subsidies etc		
a) Grants given to Institutions/Organisations	-	-
b) Subsidies given to Institutions/Organisations	-	-
TOTAL	-	-

	Current Year	Previous Year
Schedule 23- Interest/GIA Refund		
a) On Fixed Loans	-	-
b) On Other Loans	-	-
c) Others - Interest returned to GoI	-	1,35,16,799
d) Others - Grants-in-Aid returned GoI	3,21,12,487	12,10,21,608
TOTAL	**3,21,12,487**	**13,45,38,407**

Schedule-24: SIGNIFICANT ACCOUNTING POLICIES

1. ACCOUNTING CONVENTION:

   The Financial Statements are prepared on the basis of historical cost convention unless otherwise stated and on accrual basis of accounting. The guidelines given by the Government of India for drawing financial statements for Central Autonomous Bodies have been adopted to the extent that they are directly applicable.

2. FIXED ASSETS

   The Fixed Assets are stated at cost of acquisition less depreciation. The same was not verified physically on periodical basis by the Management.

3. DEPRECIATION:

   The Depreciation is charged on WDV at rates as stated in the Fixed Assets Schedule. The amount of depreciation has been debited to the Income & Expenditure Account as per the guidance of CAG Audit. The rate of depreciation has been charged as per the Income Tax Act, 1961 except Buildings which are depreciated at 5%. The Additions to Fixed Assets have been classified based on the period of Assets put to use and depreciation charged accordingly.

4. INVENTORY:

   The stocks on hand such as spares, materials, consumables are valued at cost.

5. GOVERNMENT GRANTS:

   Government Grants received are accounted on receipt basis and the same have been separately shown under Capital Grants and Recurring Grants in the Annual Accounts of the Institute. Out of the total Grants, the Capital Grant is directly credited to the Capital Fund Account, the Recurring Grant accounted as Income and shown in Income & Expenditure Account. The interest earned on Government Grants such as Bank Interest and Interest on Staff Advances has been credited to Income & Expenditure Account.

6. FOREIGN CURRENCY TRANSACTIONS:

   a) Transactions denominated in foreign currency are accounted at the exchange rates prevailing as on the dates of the payment.

7. RETIREMENT BENEFITS:

   a) Institute's contribution to Provident Fund and Pension Fund are charged to Income & Expenditure Account of the Institute. Apart from this, any deficit in the Provident Fund and Pension Fund amount is borne and provided for in the accounts of the Institute on payment basis.
   b) Estimated liability for Gratuity on the date of Balance Sheet has not been quantified. The same is accounted for on actual cash payment basis.

8. Income expenditure has been prepared only for the Core Grants of the Institute.

9. The Schedule-3: Earmarked / Endowment Fund / Project Fundis a statement showing amount received and spent during the year towards the projects Funded by the Government Agencies and balance of the unspent at the year end. Wherein "Received during the year"includes interest earned on such fund and "Expenditure (Capital/Revenue)" includes surrender of unspent balance of project funds to the Government Agencies.

Schedule-25: CONTINGENT LIABILITIES AND NOTES ON ACCOUNTS

A. Contingent Liabilities :

1. Claims against the Institute not acknowledged as Debt : Nil

2. Bank Guarantees given by the Institute : Nil

3. Disputed Demands in respect of Taxes:

   a. Goods and Service Tax (GST) Department of Jammu and Kashmir has issued show cause notice for the FY 2018-19, raised demand of Rs.1,01,81,160/- against receipt of Rs.5,65,62,000/- from DST. This entire amount was paid to CAMPA (Compensatory Afforestation Fund Management and Planning Authority) Fund, Forest Department of Government of Jammu & Kashmir towards compensation for use of forest land for establishment of National Large Solar Telescope. However, Institute has submitted all the relevant information and documents, stating that there are no tax dues as IIA being an autonomous Institute of the Government of India.

B. NOTES ON ACCOUNTS:

a) In the opinion of the Management, the Current Assets, Advances and Deposits have been recorded at the actual value of transactions in the ordinary course of activities. The aggregate amount is shown in the Balance Sheet.

b) In the Receipts and Payments Accounts, the amount shown in Project Receipts includes Grants received during the year, Interest received from banks.

c) Interest earned on Margin LC Deposits are accounted on receipts basis.

d) Receipts and Payments Account, the amount shown in Project Payments includesCapital Expenditure, LC Payments and the Revenue Expenditures pertaining to projects during the year.

e) Receipts and Payments Account, the amount shown in Closing Balance includes the Project Balances.

f) Previous year figures have been re-grouped wherever necessary.

g) The figures have been rounded off to the nearest rupee.

S.B.RAMESH
ACCOUNTS OFFICER

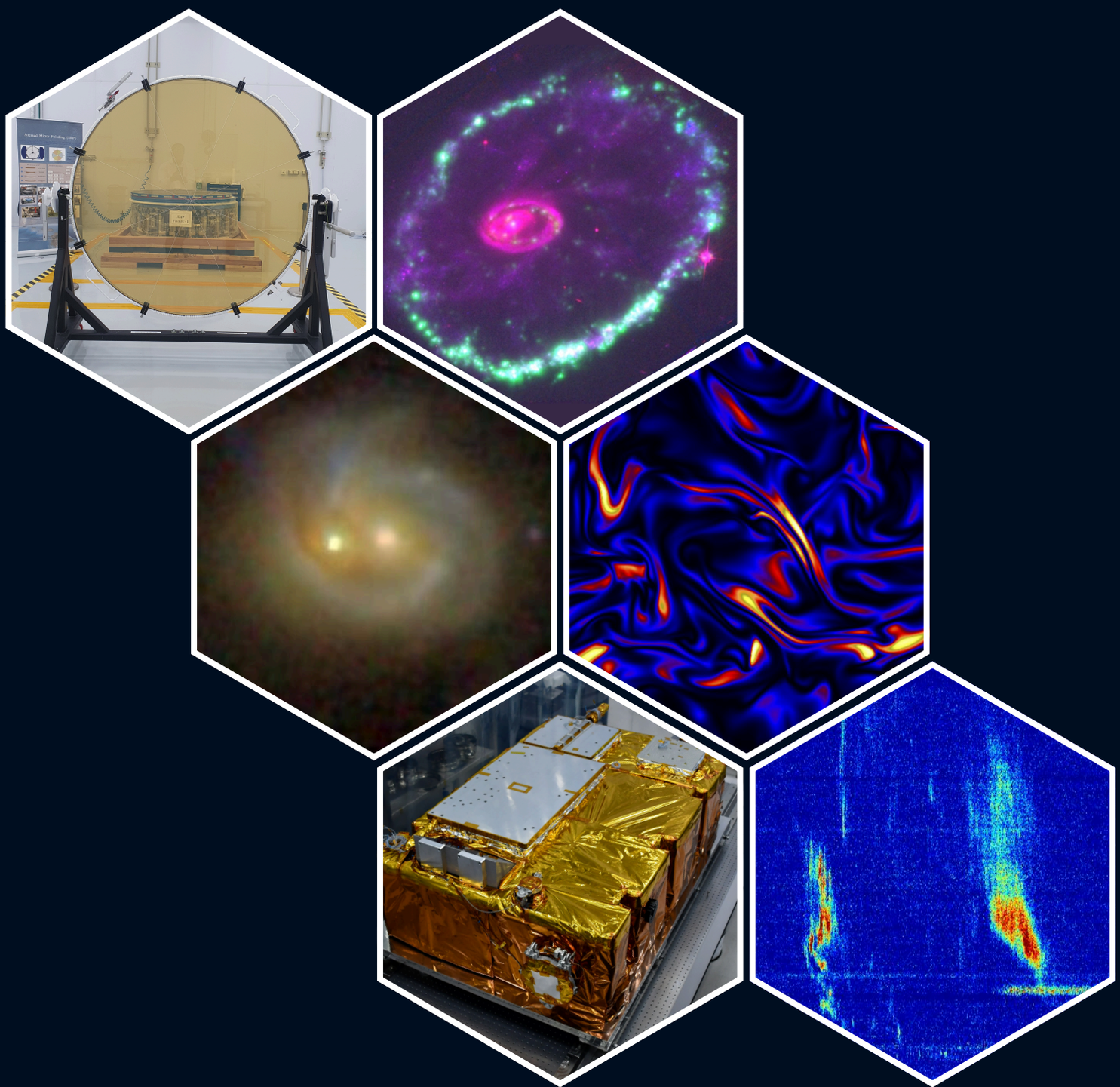
SHRIPATHI.K.
ADMINISTRATIVE OFFICER

ANNAPURNI SUBRAMANIAM
DIRECTOR

As per our report of even date
For GIREESHA VIJAYAN & ASSOCIATES
Chartered Accountants
FRN: 014117S

CA. GIREESHA T.L., B.Com, FCA, DISA.
Partner
M.No.230674
UDIN: 24230764BKCRKA8644

Date: 31.07.2024
Place : BENGALURU



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