ANNUAL REPORT

2021–2022

Azadi Ka Amrit Mahotsav

आर्यभट्ट प्रेक्षण विज्ञान शोध संस्थान

Aryabhatta Research Institute of Observational Sciences

(An Autonomous Institute under DST, Govt. of India)

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Manora Peak, Nainital

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Front Cover: Deep sky photography behind the solar tower telescope.
(image courtesy: Ritesh Patel)

Back Cover: Mesmerising view of the Himalayan range from the Devasthal campus.
(image courtesy: Ankur Ghosh)

September, 2022

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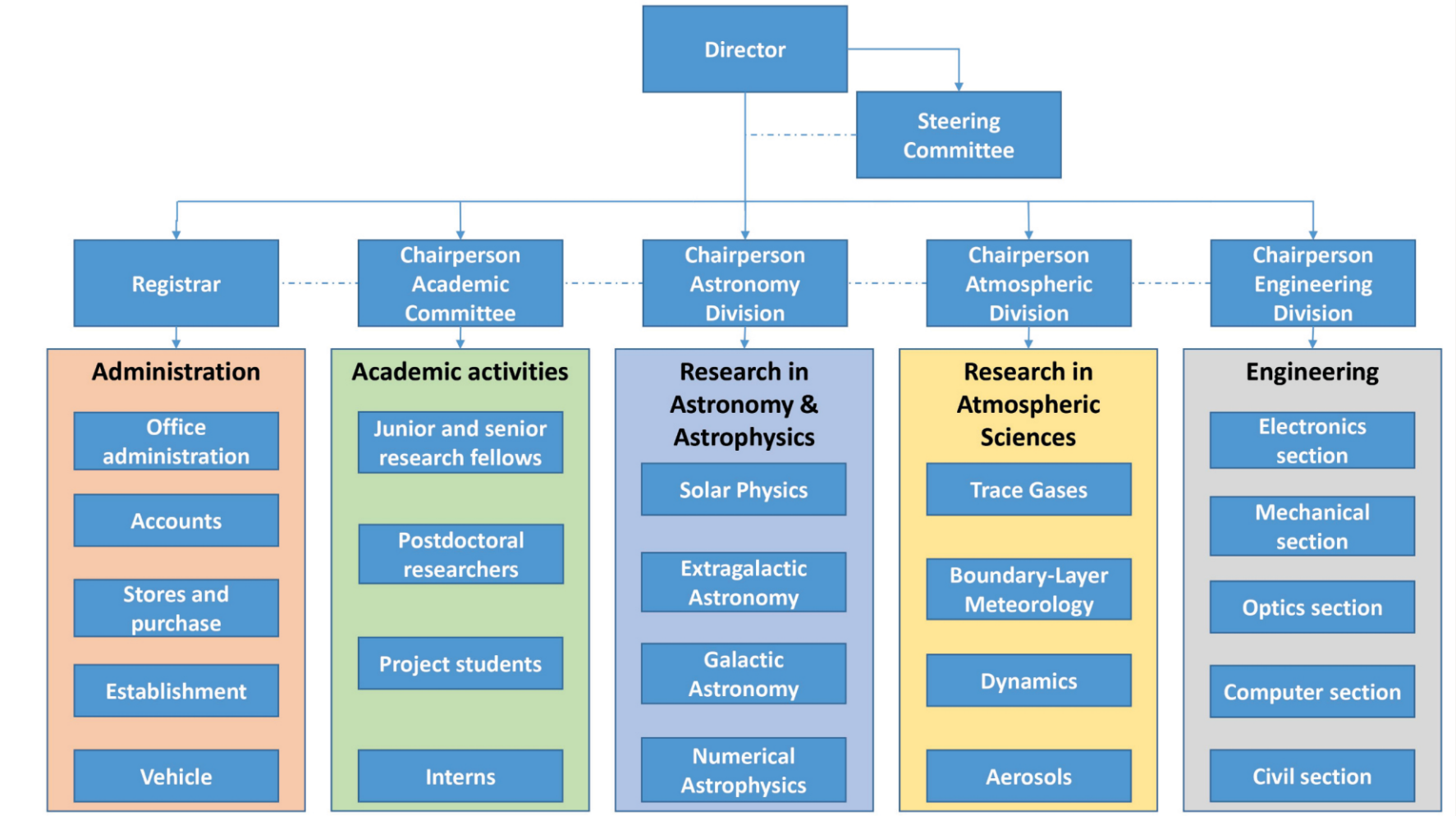

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The Year in Review

I am delighted to present the highlights of the achievements of ARIES during the year 2021-22 in this report. I am grateful to my colleagues at ARIES, DST and other collaborating institutes for their generous support throughout the year. Their commitment is the primary reason behind these achievements.

The three core divisions (Astronomy and Astrophysics, Atmospheric Sciences and Engineering) at ARIES are applauded for their effort in the smooth running of the institute and operation of the major observational facilities at the institute. The core research conducted by the Astronomy and Astrophysics division is on the observational and theoretical studies of a wide range of celestial objects. The Atmospheric Sciences division focuses on understanding the physical, chemical and dynamical processes governing the Earth's atmosphere. The Engineering division caters to the design, development, maintenance and upgradation of the instruments and support facilities.

ARIES operates many state-of-the-art observational facilities at its two campuses in Nainital, Uttarakhand. The Devasthal Observatory is a world-class astronomical site housing two functional telescopes – 1.3m Devasthal Fast Optical Telescope (DFOT) and 3.6m Devasthal Optical Telescope (DOT); and an upcoming telescope – 4.0m International Liquid Mirror Telescope (ILMT), which is scheduled to achieve the first light in spring 2022 and is eagerly awaited by the Indian, Canadian and Belgian astronomers. The main campus at Manora Peak is home to one of the oldest operational telescopes – 1.04m Sampurnanand Telescope (ST); and ARIES Stratosphere Troposphere Radar (ASTRAD). It gives me immense pride in mentioning that the ST will be completing 50 years of operation in 2022 and a golden jubilee celebration for the same is planned in October 2022.

India's largest optical and near-infrared telescope, the DOT was open for observing proposals from astronomers in India and Belgium in two four-month long cycles (DOT-2021-C2 and DOT-2022-C1). The time allocation was done as per the scientific merit of the proposals and as reviewed by the National Time allocation committee. DOT continued to provide good quality scientific data. Important findings utilising data from DOT were published in high-impact journals.

Astronomers at ARIES carry out research in the areas of solar physics, galactic and extragalactic astronomy, theoretical studies and numerical simulations of astrophysical jets, compact objects etc. These studies utilise data from various national and international facilities enabling scientific collaborations spread across the country as well as the globe. The stellar group in the institute made several significant discoveries such as 200 new stars in Pacman nebula, a chemically peculiar star with 'Heartbeat' like pulsational variability in its brightness, a new episodically accreting young star belonging to an extremely rare class of sources etc. A rare stellar occultation by Pluto was observed using ARIES telescopes which gave key insights into Pluto's atmosphere. Being located in the middle of a large longitudinal gap, ARIES's telescopes enjoy a strategic advantage for observing time-critical transient phenomena. Several studies of transients such as gamma-ray bursts and supernovae were carried out, including the detection of the first and shortest duration GRB caused by the death of a massive star. These findings provide important clues about the ongoing physical processes in these mysterious sources. The extragalactic astronomers identified the most distant gamma-ray emitting narrow-line Seyfert1 galaxy and a dozen quadruply imaged quasars which have been warped by naturally occurring cosmic lenses and split into four similar images from our vantage point. These studies would advance our understanding of the evolution of galaxies in the early universe.

Solar physicists at ARIES gave the first theoretical explanation of the existence of the Near-Surface Shear Layer (NSSL) in the Sun. Long-term studies of the Sun were done to gain insights into the extended solar cycles and the

association of solar activity with 22-year Hale (magnetic) cycles. Novel theoretical models, image analysis and automation techniques have been devised to identify different types of dynamic structures in the solar corona and plasma filaments from long-term hand-drawn synoptic maps of the sun. The filament identification would aid in constructing a composite time series of filament data stretching over a century. All these techniques will also be helpful when the *Aditya*-L1 mission starts solar observations.

The atmospheric science group's research is aimed toward understanding processes governing the Earth's atmosphere, air pollution and climate change. Accurate estimations of black carbon, the second most important global warming pollutant after CO2, were made for the first time over the central Himalayan region using a parameter called mass absorption cross-section (MAC). This will also improve the performance of numerical weather prediction and climate models. A surprising finding was that during the COVID lockdown, some regions in central-western India and north India were prone to higher air pollution exposure, implying a greater risk of respiratory health issues, even though India as a whole experienced lower pollution. With pristine dark skies, the trans-Himalayan region is one of the most promising astronomical sites globally. This was demonstrated by a study of various atmospheric parameters. With looming climate change, massive forest fires are increasingly becoming a challenge. These fires were found to cause a reduction in solar energy availability over the Indian subcontinent using remote-sensing techniques for the first time and their economic impact was estimated. A source apportionment study of aerosols revealed that dust transport from north-west India, Pakistan and the Arabian Sea is the main contributor to the aerosols over central Himalayas. These studies also highlight the sensitivity of the Himalayan region from the point of climate change.

The skilled and capable technical team of engineers and other staff in the electronics, mechanical, optics, and computer sections at ARIES are in synergy ensuring an integrated and interdisciplinary approach toward engineering challenges. They work in tandem for the design, development, upgradation and maintenance of the observational facilities and instruments as well as provide support for the smooth running of the institute's infrastructure on all campuses.

ARIES continued to strengthen the existing collaborations and foster new ones nationally and internationally on a plethora of projects. MoUs were signed with ISRO, Central University of Himachal Pradesh (CUHP), S. N. Bose National Centre for Basic Sciences (SNBNCBS) and Indian Institute of Technology Roorkee (IIT-R) for co-operation in the areas related to Physics, Astronomy & Astrophysics, Astronomical instrumentation and Atmospheric sciences. I am delighted to report that *Aditya-L1* Support Cell (AL1SC) has been set up at ARIES as a joint effort of ISRO and ARIES. It will cater to the requirements of guest observers while preparing science observing proposals and analysing scientific data. AL1SC will also help in the development of the next generation of solar physicists in the country.

To commemorate the *Azadi Ka Amrit Mahotsav*, ARIES organised four important conferences/schools- i) 'Astrophysical jets and observational facilities – A National perspective' in online mode (05-09 April, 2021), ii) 'ARIES Training School in Observational Astronomy (ATSOA-2021)' in online mode (17-24 May, 2021), iii) 'Space Radiation Workshop: Radiation Characterization from Sun to Earth, Moon, Mars and Beyond' funded by Indo-US Science and Technology Forum (IUSSTF) in online mode (24-28 January, 2022), iv) The 40th annual meeting of the Astronomical Society of India (ASI) at IIT Roorkee in hybrid mode (25-29 March, 2022). These conferences and schools witnessed good participation from both senior and young researchers from various institutes and universities across India. The schools are designed to motivate and bring awareness to young students.

Being a publicly funded institute, ARIES is deeply committed to its social scientific responsibility for science communication and public outreach. Taking a precautionary approach due to the pandemic situation in the early part of the year, *Azadi Ka Amrit Mahotsav* week (02-06 August, 2021) was celebrated with various online public outreach activities. Continuing the commemoration of *Azadi Ka Amrit Mahotsav* throughout the year, thematic outreach and awareness programmes were also conducted on world environment day, international women's day, national engineer's day, national energy conservation week etc. In the later part of the year, in-person and hybrid mode activities were taken up. A week-long celebration (22-28 February, 2022) of National Science Day was carried out with school students who participated in many online and offline competitions. Following this, observatory tours were gradually resumed for visitors. Several activities and programmes were conducted during the celebrations of Samvidhan Diwas and Hindi Pakhwara in ARIES. Vigilance Awareness Week was observed in ARIES under the theme 'Independent India @ 75: Self Reliance with Integrity'.

11 new Junior Research Fellows (JRFs) joined ARIES during this period. 2 students joined in the first batch of the newly initiated integrated M. Tech – Ph. D. (Tech) programme in Astronomical Instrumentation in collaboration with the Department of Applied Optics and Photonics, University of Calcutta. 1 new Post Doctoral Fellow (PDF) and 1 new faculty member were appointed during 2020-2021. 6 students were awarded Ph. D. degree, while 9 submitted their theses. About 50 graduate and post-graduate students from science and engineering disciplines were trained by ARIES via short-term projects on topics of current research. 4 B. Tech. students joined the newly started Computer Science Internship Programme (CSIP) and worked toward the data archival project and the development of webpage and observing tools for the *Aditya-L1* Support Cell (AL1SC). The core of the academic programme is the training of skilled manpower (project students, research scholars and PDFs), which will be further enhanced with a larger intake.

The total strength of the scientific and engineering staff during the year was 26 (including 2 INSPIRE faculty and 1 project scientist) and 12 respectively. The other staff consisted of 12 administrative and support staff, 28 scientific and technical staff and 7 laboratory assistants. The major scientific task force of the institute accounted by the PDFs and research scholars were 11 and 61 respectively. The total number of research publications by ARIES faculty in refereed journals of high impact was 129.

The new infrastructural work (laboratories, science center, hostel and canteen) at Devasthal campus started a few months ago. The road in the Devasthal campus was refurbished. With the increasing number of research scholars, a new hostel and canteen facility on the Manora Peak campus are needed and the requirement would be fulfilled in the coming year when the construction work commences.

The office premises and surrounding areas are kept clean and we strictly cohere with the *Swachh Bharat Campaign*. Constant efforts toward building an equitable work environment by shielding the interests of women, scheduled caste and tribes, and addressing the grievances of the staff members are made. The essential schemes as directed by the Government of India and the use of official language in administrative work are implemented in ARIES.

I strongly believe that our institute will continue to enhance and excel in the academic activities utilising the state-of-the-art observational facilities and participation in future projects of national and international importance.

Dipankar Banerjee

Director

Research Highlights

The scientists, research scholars and post doctoral fellows at ARIES are involved in core research in Astronomy & Astrophysics (A&A), Atmospheric Sciences and Instrumentation. These are performed under the three primary divisions at ARIES utilising their resources and expertise. The brief research highlights of the institute, during the period 2021-22, are given below.

Astronomy & Astrophysics Division

The A&A division conducts research centered around the Sun and the Solar System, Galactic sources (near earth objects, individual stars, star clusters and star forming regions), Extragalactic sources (external galaxies, active galactic nuclei, time domain studies of transients) and Theoretical and numerical simulations of compact objects.

The Sun and the Solar System

The Sun exhibits variations in different timescales starting from a few seconds to a few tens of years and even more. The variations that occur on larger time scales, for example, more than years, can be treated as long term variations. Long-term variations in the Sun are significant from the point of view of the climate and the effect on our planet and heliosphere.

The Long-term study of the Sun

The hand-drawn synoptic maps from the Meudon Observatory were calibrated to identify filaments using an automated method. The physical parameters from this filament database were extracted to perform a comparative study of their long term evolution focussing on the cotemporal period of the Meudon and McIntosh observations. The spatiotemporal evolution of filaments manifests in the form of a filament butterfly diagram, further indicating that they were intimately related to the largescale solar cycle **(Figure 1)**. This study paves the way for constructing a composite series of hand-drawn filament data with minimal gaps stretching over the time span of solar filament observations up to a century. **[Mazumder, Rakesh**, Chatterjee, Subhamoy, Nandy, Dibyendu, & **Banerjee, D.** (2021). *Astrophy. Jr., 919*: 125 (13pp)**]**.

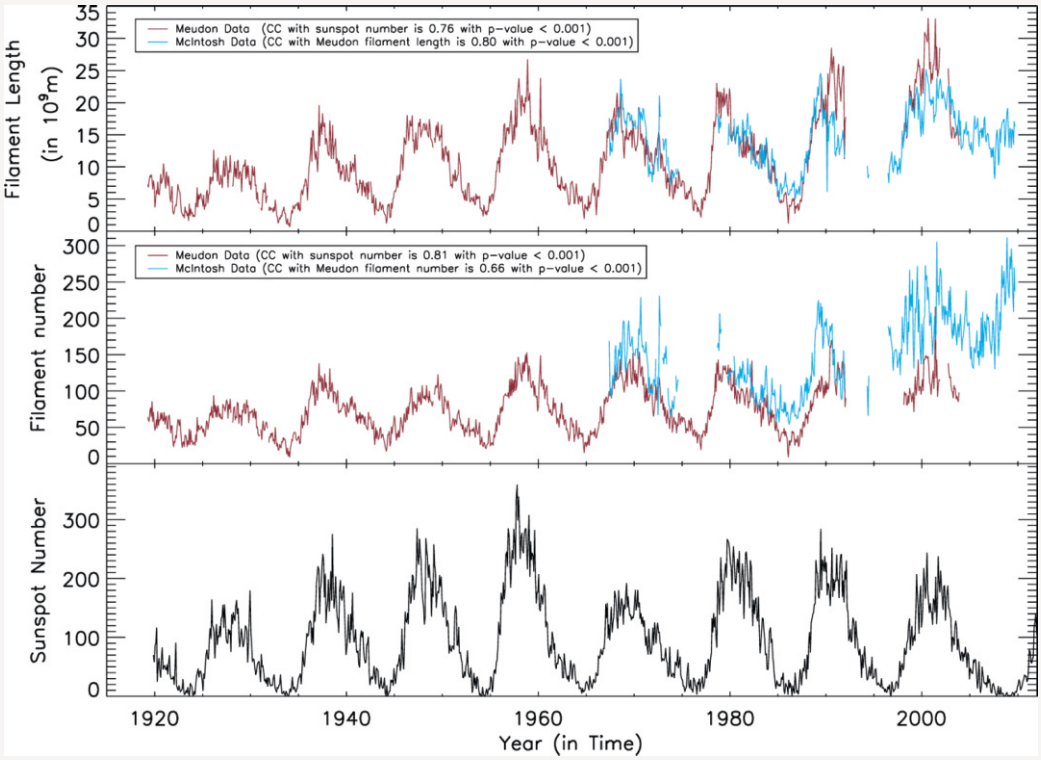

Figure 1. Long-term variation of filament number, filament length, and sunspot number. The top panel shows the variation of total filament length (L_{tot}) with time. The brown line represents the variation of L_{tot} with time from the Meudon data and the blue line represents the same for the McIntosh data. The middle panel shows the variation of total filament number (N_{tot}) with time. The brown line represents the temporal variation of N_{tot} from the Meudon data and the blue line represents the same for the McIntosh data. In the bottom panel, the black line represents the sunspot number cycle, with the data taken from the Solar Influences Data Center.

The occurrence of the "extended solar cycle" (ESC) as it occurs in a host of observational data spanning 140 years was examined. In this study a consistent picture of solar activity migration linked to the 22-year Hale (magnetic) cycle using superposed epoch analysis (SEA) and previously identified Hale cycle termination events as the key time for the SEA was developed. The analysis showed that the ESC and Hale cycle, as highlighted by the terminator-keyed SEA, is strongly recurrent throughout the entire observational record studied, some 140 years ago. Applying the same SEA method to the sunspot record confirmed that Maunder's butterfly pattern is a subset of the underlying Hale cycle, strongly suggesting that the production of sunspots is not the fundamental feature of the Hale cycle, but the ESC is. **[**McIntosh, Scott W. et al. (including **Banerjee, D.**). (2021). *Solar Physics, 296*: 189 (28pp)**].**

The evolution of solar activity and magnetic flux transport in Cycles 21–24 were studied. The critical surges of remnant flux that reach the Sun's poles and lead to the polar field reversals along with the major remnant flux surges and their sources in the time-latitude aspect were identified. It was found that the special characteristics of individual 11-year cycles are generally determined by the spatiotemporal organisation of emergent magnetic flux and its unusual properties. A complicated restructuring of high-latitude magnetic fields in Cycle 21 was observed. The leading-polarity surges during cycle minima sometimes link the following cycle and a collective effect of these surges may lead to secular changes in the solar activity. The magnetic field from a Babcock–Leighton dynamo model was generally found to be in agreement with these observations. **[**Mordvinov, A. V. et al. (including **Banerjee, D.**). (2022). *Mon. Not. Roy. Astron. Soc., 510*, 1331-1339**].**

The measurement of solar differential rotation using sunspots compared to the spectroscopic observations indicates the existence of an intriguing layer known as the near-surface shear layer (NSSL), which was further verified by a more accurate measurement by helioseismology. A theoretical explanation for NSSL based on the thermal wind balance equation was presented. The idea is based on the fact that in the top layer of the solar convection zone the temperature profile of the Sun is independent of latitude, and in addition, the sharp fall in temperature causes the thermal wind term to grow **(Figure 2)**. To compensate for the growth of the thermal wind term - the centrifugal term has to increase, leading to the observed NSSL. **[Jha, B. K. &** Choudhuri, Arnab Rai. (2021). *Mon. Not. Roy. Astr. Soc., 506*, 2189-2198**].**

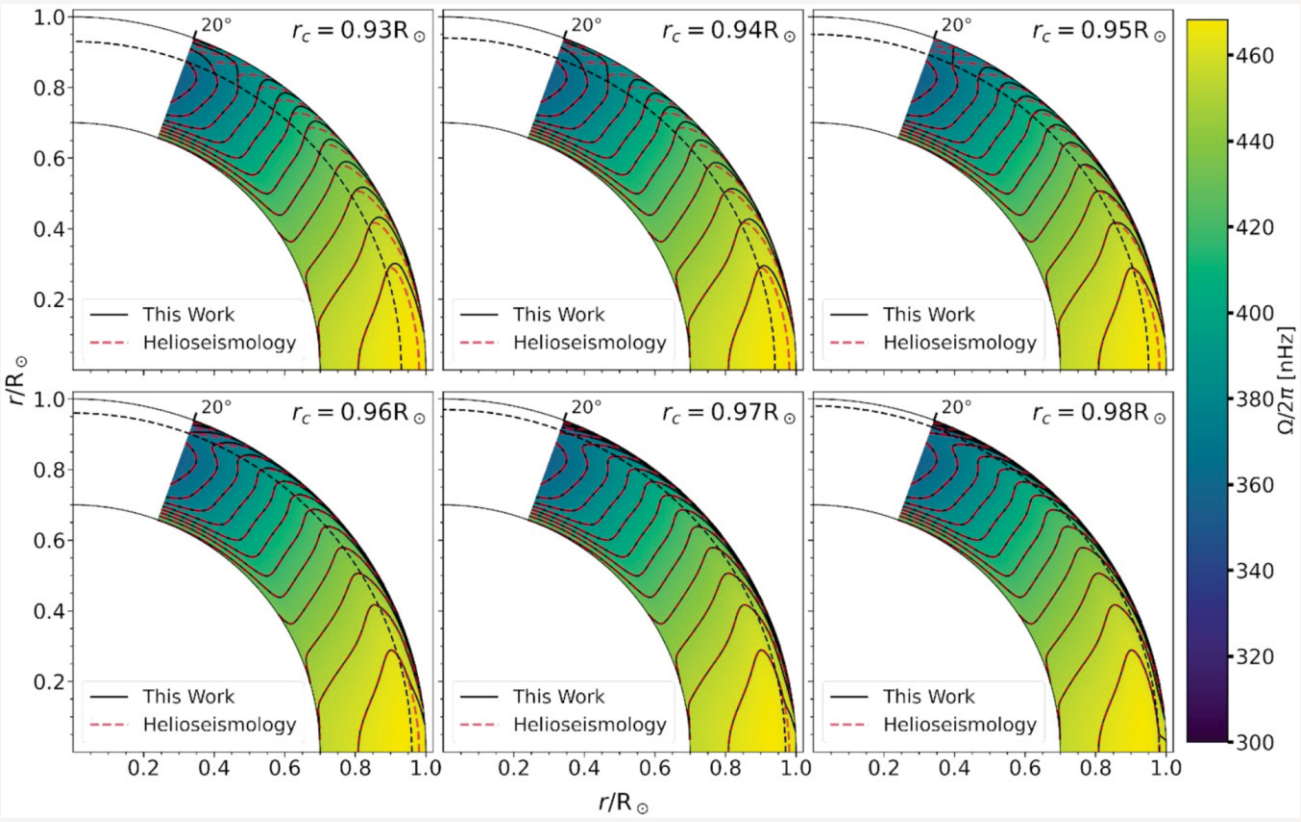

Figure 2. The profiles of $\Omega(r, \theta)$ for different values of $r = r_c$ obtained by using $\Omega(r, \theta)$ given by helioseismology as input data for $r < r_c$.

The effect of (uni) turbulence on the density filling factor of the solar corona was investigated. A novel scenario combining magnetohydrodynamic (MHD) simulations and forward modelling in which density filling factor in the solar corona increases due to the generation of turbulence with height above the solar atmosphere was presented **(Figure 3)**. The role of MHD waves in heating the solar atmosphere and accelerating the solar wind were also discussed. **[Sen, Samrat** & **Pant, Vaibhav**. (2021). *Astrophysical Jr., 923*: 178 (12pp); **Banerjee, D.** et al. (including **Pant, V.**). (2021). *Space Science Reviews, 217*:76 (37pp)**].**

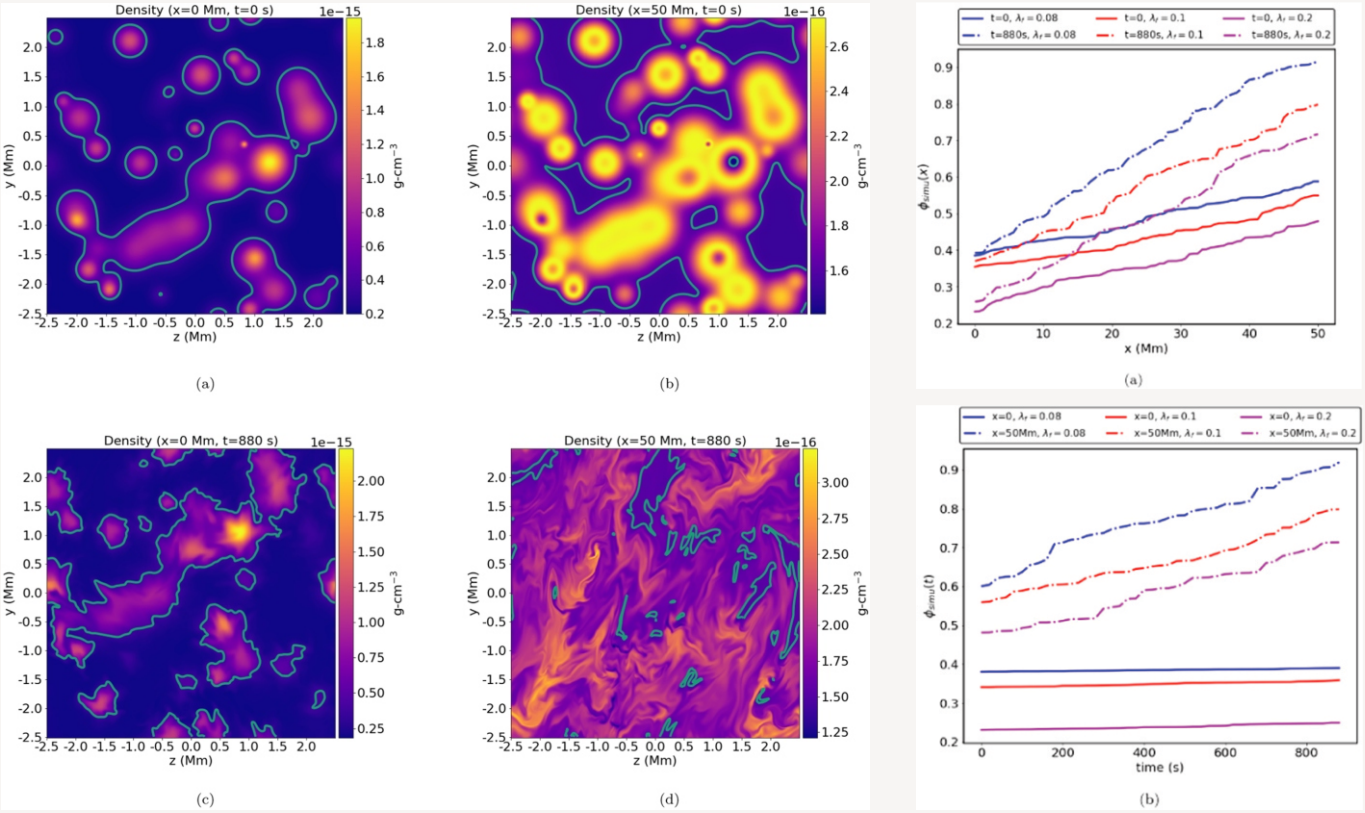

Figure 3. Left panel shows the density distribution at t=0 and t=880 at the base of the simulation. Middle panel is same as left panel except that it shows density distribution at the top of the simulation domain. It shows that the density filling factor increases with time. The right panel shows the variation of density filling factor with height and time respectively.

The validity of the theoretically predicted relationship between nonthermal line width and MHD wave energy using state-of-art MHD simulations and forward modelling was tested. This study, in near future, will serve as a test bed for the upcoming solar facilities such as UCoMP and VELC/*Aditya-L1*. **[**Fyfe, L. E. et al. (including **Pant, V.**). (2021). *Astron. & Astrophy., 656*, A56 (11pp)**].**

The kinematics of slow and fast Coronal Mass Ejections (CMEs) in the solar atmosphere were investigated. The study showed that they follow different power laws and display different acceleration profiles hinting towards different energy injection mechanisms. The slow CMEs show a steeper power law than fast CMEs (**Figure 4**). **[**Majumdar, S., **Patel, R., Pant, V.** & **Banerjee, D.** (2021). *Astrophy. Jr., 919*: 115 (8pp); **Pant, V.**, Majumdar, S., **Patel, R.**, Chauhan, A., **Banerjee, D.** & Gopalswamy, N. (2021). *Front. Astron. Space Sci., 8*:634358 (1-12pp) **].**

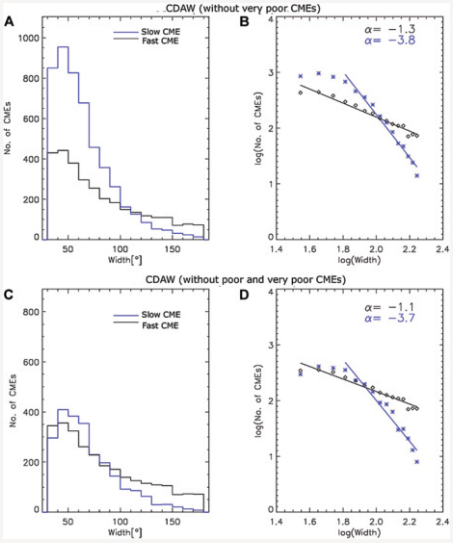

Figure 4. Number distribution of fast and slow CMEs in solar cycle 23 and 24. Slow CMEs (shown in blue) follows a power law with steeper power index than fast CMEs (shown in black).

The properties of two CMEs, showing similar source region characteristics but different evolutionary behavior in the later phases, were compared and a detailed study was performed to establish the precise CME-interplanetary CME (ICME) connection and their near-Earth consequences. Multi mission data with several instruments were useful in deciding the evolution of CMEs in the interplanetary medium and their geoeffectiveness. **[Ibrahim, Syed**, **Uddin, W.,** Joshi, B., Chandra, R. & Awasthi, A. K. (2022). *Res. Astron. Astrophy., 21 (12)*, 318 (19pp)**].**

A major X1.0 class flare, radio burst, halo CME and loop eruption from the solar active region NOAA 11893 on 19 November 2013 were analysed using multi-instrument observations in different wavebands. The evolution of the loop eruption and the link between this eruption and radio emission were established. These observations confirmed that the source of the CME was associated with a magnetic-loop eruption, which was visible before the flare initiation. **[**Shanmugaraju, A., **Ibrahim, Syed**, Suresh, K., Vijayalakshmi, P. & Dhara, S. K. (2021). *Sol. Phys., 296*, 77 (17pp)**].**

The physical relationship between the speeds of extreme ultraviolet (EUV) waves and type II radio bursts and CMEs was identified. The re-examination of the speeds of EUV waves reported in previous literature confirmed the inconsistency between the speeds of EUV waves and their associated type II radio bursts. It was found that the CME speeds have a better correlation with type II radio bursts than EUV waves. The type II speeds and their range were found to be much greater than those of EUV waves. This study suggested that the speed inconsistency would remain even if all other uncertainties were removed. **[Fulara, Arti** & Kwon, Ryun-Young. (2021). *Astrophy. Jr. Lett., 919*: L7 (6pp)].

Advanced automated methods were developed to detect accelerating solar eruptions by implementing the parabolic Hough transform. The manual detection were compared with the automated catalogue of CMEs in the heliosphere. A fairly good match was found between the two suggesting that the automated detection of CMEs in the heliosphere is successful. The Hough transform was also used to develop advanced automated methods to detect accelerating solar eruptions. **[**Rodriguez, L. et al. (including **Pant, V.**). (2022). *Sol. Phys., 297*: 27 (16 pp); **Patel, Ritesh**, Majumdar, S., **Pant, V.** & **Banerjee, D.** (2022). *Sol. Phys., 297*: 27 (16pp)**].**

The spectral channels of the upcoming *Aditya-L1* mission were characterised so that the science observations with VELC could be planned. A strategy for the slit optimisation was introduced and it was found that the slit width of 50 micro-meter would be reasonable to obtain enough signal-to-noise in different regions. **[Patel, R.**, Megha, A., **Shrivastav, Arpit Kumar, Pant, V.**, Vishnu, M., Sankarasubramanian, K., & **Banerjee, D.** (2021). *Front. Astron. Space Sci., 8,* 660992 (11 pp)**].**

Galactic Astronomy

Variability in stars and star clusters

Variability studies in stars and identification of variable stars in star clusters using long term multi-wavelength observations have been performed.

Five chemically peculiar stars in the region of the open cluster M44 were studied using high resolution spectroscopy and K2 space photometry. It was found that the light variations in HD 73045 and HD 76310 were rotational in nature and caused by spots or cloud-like co-rotating structures, which were non-stationary and short-lived. The study also confirmed that HD 73045 does not show any periodic variability on time-scales shorter than 1.3 day,

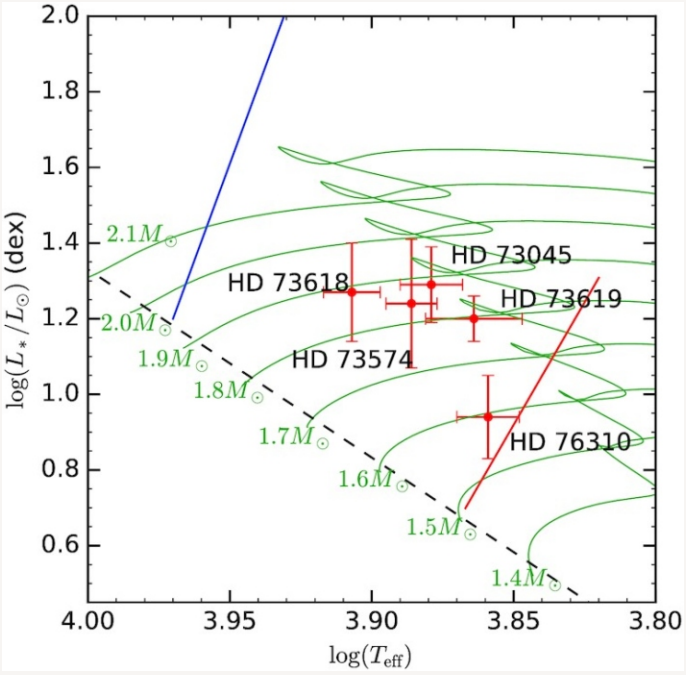

Figure 5. Location of the five stars in the HR diagram. The solid green lines represent the theoretical evolutionary tracks for masses from 1.4 $M_\odot$ to 2.1 $M_\odot$ taken from Murphy et al. (2019). The blue and red edges of the observational δ Scuti instability strip are over-plotted with blue and red lines, respectively. The black dashed line represents the ZAMS.

contrary to previous reports in the literature. Additionally a new heartbeat system, HD 73619, was discovered with no pulsational signatures belonging to the peculiar Am class, with either a weak or no magnetic field. In the Hertzsprung-Russell (HR) diagram, these stars evolved from the main sequence and were found to be situated in the δ Scuti instability strip **(Figure 5)**. **[Joshi, S.** et al. (including **Sarkar, M.**). (2022). *Mon. Not. Roy. Astro. Soc., 510*, 5854–5871**].**

A spectroscopic study of a sample of "hump and spike" stars in the nominal Kepler field were studied. The spectral types of these stars and their atmospheric stellar parameters such as effective temperatures, surface gravities, projected rotational, microturbulent, and radial velocities were determined. These stars were confirmed as Am stars, marginal Am stars and non-Am stars. Based on their spectra and chemical abundance pattern, the previously available classification for two stars was updated. **[**Trust, O., Jurua, E., Cat, P. D., **Joshi, S.** & Lampens, P. (2021). *Mon. Not. Roy. Astron. Soc., 504*, 5528–5542**].**

Multiwavelength photometric and spectroscopic follow-up observations of Gaia 20eae identified it as the newest member of the FUor/EXor family of sources **(Figure 6)**. The observed brightening (~4.25 mag) in the source was indicative that it was not due to the dust-clearing event but due to an intrinsic change in the spectral energy distribution. The light curve displayed a transition stage during which most of its brightness (~3.4 mag) occurred on a short timescale of 34 days with a rise rate of 3 mag/month, followed by a decay (rate of 0.3 mag/month) in the light curve. Strong P Cygni profile in Hα was detected indicating the presence of winds originating from regions close to the accretion. During the outburst phase, very strong and turbulent outflow and accretion signatures were observed. A redshifted absorption component in all the Ca II IR triplet was detected consistent with a signature of hot infalling gas in the magnetospheric accretion funnel. This investigation allowed to constrain the viewing angle with respect to the accretion funnel and indicated that the outburst was due to magnetospheric accretion. **[Ghosh, Arpan, Sharma, S.** et al. (including **Pandey, Rakesh, Sinha, Tirthendu** & **Panwar, Neelam**). (2022). *Astrophy. Jr., 926*: 68 (14pp)].

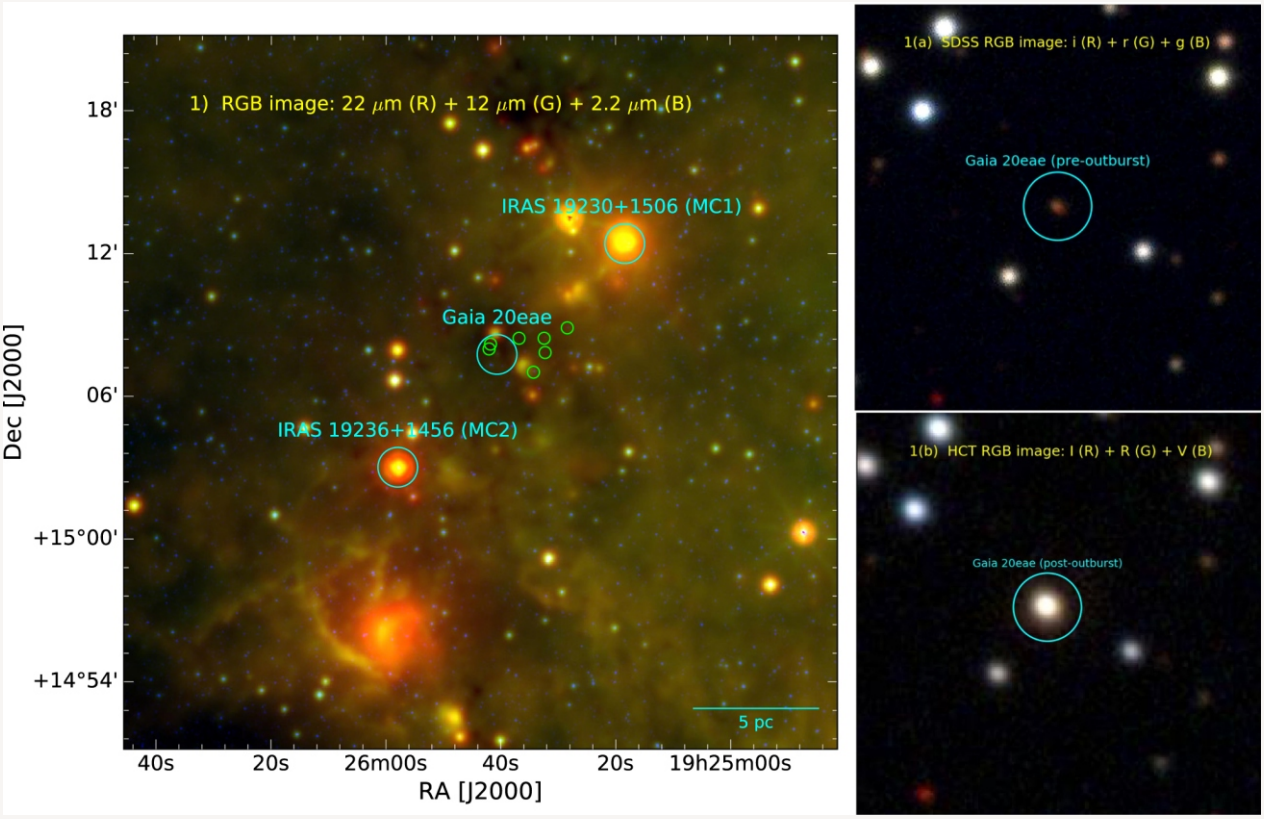

Figure 6. Colour-composite image obtained by using the WISE 22 μm (red), WISE 12 μm (green), and 2MASS 2.2 μm (blue) images of the ~30'x30' field of view around Gaia 20eae. The locations of Gaia 20eae, IRAS 19230 + 1506, and IRAS 19236 + 1456 (Retes-Romero et al. 2017) are shown by cyan circles. Locations of standard stars from the Zwicky Transient Facility (ZTF) sky survey are also shown with green circles. Subpanels 1(a) and 1(b) show the pre-outburst and post-outburst phases of Gaia 20eae in optical colour-composite images taken from Sloan Digital Sky Survey (SDSS) and Himalayan Chandra Telescope (HCT), respectively.

Time series photometric observations of young open cluster NGC 281 resulted in identification of 228 periodic variables of which a total of 81 variables were found to be members of the cluster and the remaining 147 variables could belong to the field population. Of these 81 variables, 30 and 51 were found to be probable main-sequence and pre-main-sequence members, respectively. The identified 30 main sequence variables could be β Cep, δ Scuti, slowly pulsating B type or a new class of variables. Whereas majority of the 51 pre-main-sequence variables were found to be weak line T Tauri stars. The variability characteristics of the 147 field population indicate that these could be RR Lyrae, δ Scuti, and binaries-type variables **(Figure 7). [Lata, Sneh, Pandey, A. K., Pandey, J. C., Panwar, Neelam** & Paul, Paulomi. (2021). *Mon. Not. Roy. Astron. Soc., 504,* 101-117].

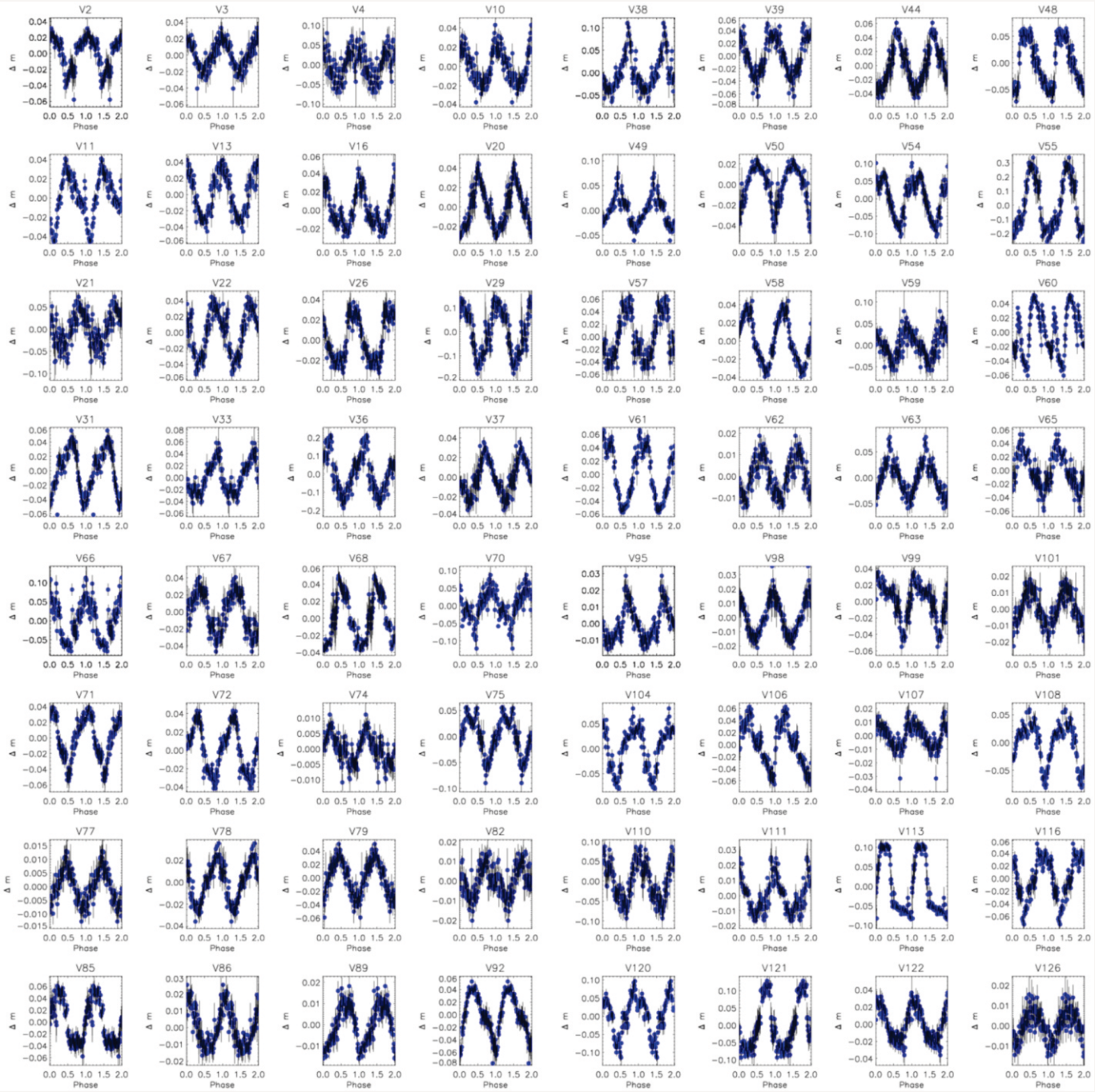

Figure 7. The V band phased light curves of probable periodic variable stars.

The continuous and short-cadence observations of TX Col with TESS confirmed its variable disk-overflow accretion nature and the changes occurring in the system on one day timescale. The system was found to be a disk-overflow system with stream-fed dominance for majority of the time. However, pure disk-fed and pure stream-fed accretions

cannot be ruled out. The presence of quasi-periodic oscillations (QPOs) for a few days with a period of 5850-5950 sec was also reported. These appear to be due to the beating of the Keplerian period of the orbiting "blobs" with the spin period **(Figure 8). [Rawat, N., Pandey, J. C.** & Joshi, A. (2021). *Astrophy. Jr., 912*, 78 (10pp)**].**

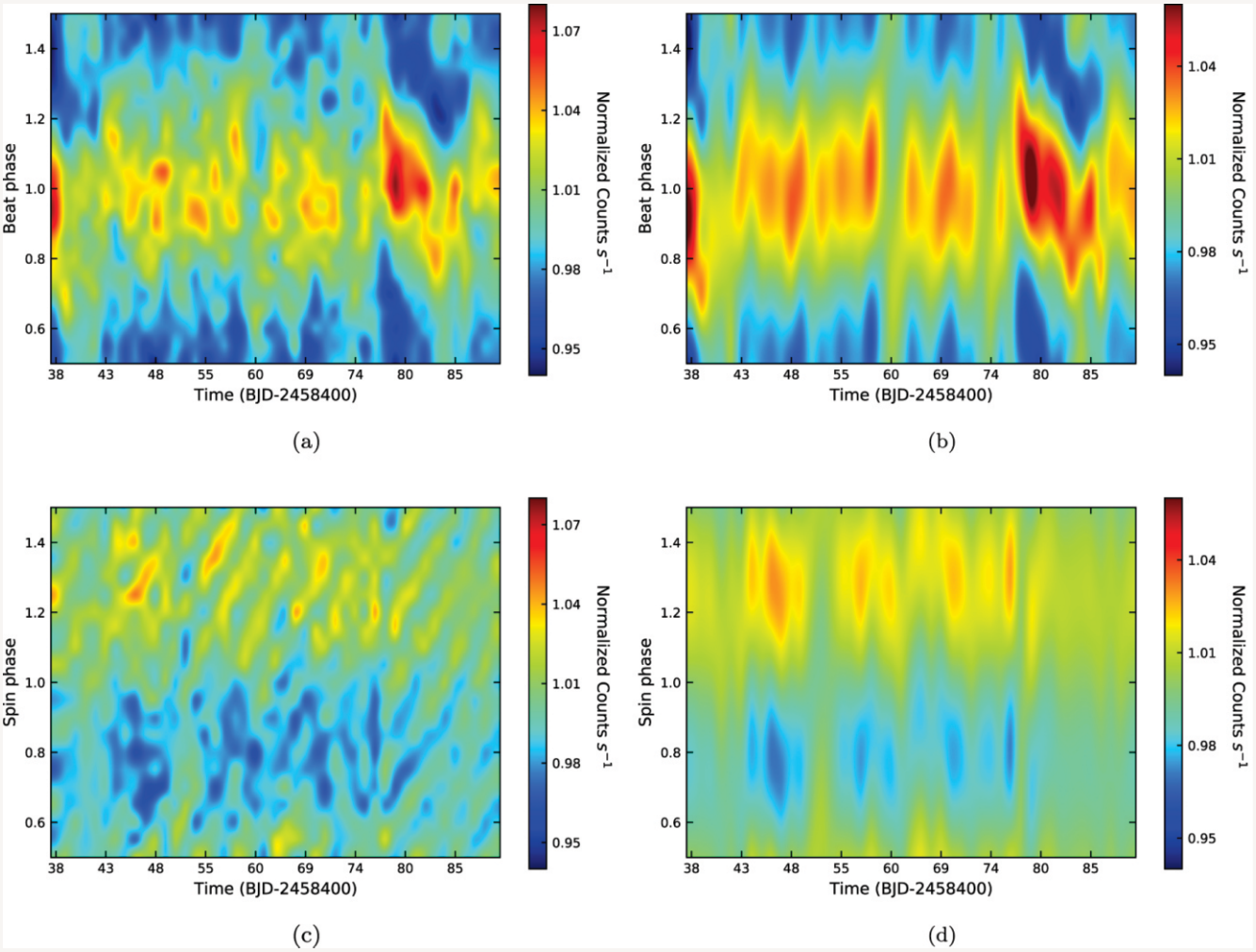

Figure 8. Phased light curves of TX Col corresponding to spin and beat phases. Left panels show the observed and right panels show the modelled light curves.

The X-ray observations of IGR J16547-1916 confirmed the detection of the X-ray spin period at 546 sec, consistent with previously reported optical spin period, and the nature of this system as an Intermediate Polar (IP). The presence of the strong spin pulse, with no sign of orbital or side-band periodicities in the X-rays, indicated that the system is accreting predominantly via a disk. The double-humped X-ray spin pulse profile indicated two-pole accretion geometry with tall accretion regions in the source. The X-ray spectra in the energy range of 0.5–78.0 keV were explained with a maximum temperature of 31 keV and a blackbody temperature of 64 eV, along with an equivalent hydrogen column of 1.8×10^{23} cm^{-2} and a power-law index of -0.22 for the covering fraction. **[**Joshi, A. et al. (including **Pandey, J. C.** & **Rawat, N.**). (2022). *Astron. & Astrophy., 657*, A12 (12pp)**].**

The long period colliding wind binary, WR 125 showed recent brightening in the K band (observed with DOT) which was attributed to an episode of dust formation similar to the one reported in the beginning of 1990s. Both of these outbursts were reasonably coincident with a periastron passage in an eccentric long-period orbit. In 2020, the source switched to a low state in X-rays indicating a recent periastron passage. This drop could be attributed to a significant photoelectric absorption close to perisatron. A low emission state was previously reported in 1991 suggesting the occurrence of a periastron passage. Both X-ray and IR analysis suggested that WR 125 is a long period colliding wind binary with orbital period of 28-29 years. **Figure 9** represents the speculated orbit of WR 125. **[Arora, Bharti, Pandey, J. C.**, Becker, Michaël De, **Pandey, S. B.**, Chakradhari, Nand K., **Sharma, S.** & **Kumar, Brijesh**. (2021). *Astron. Jr., 162*: 257 (14pp)**].**

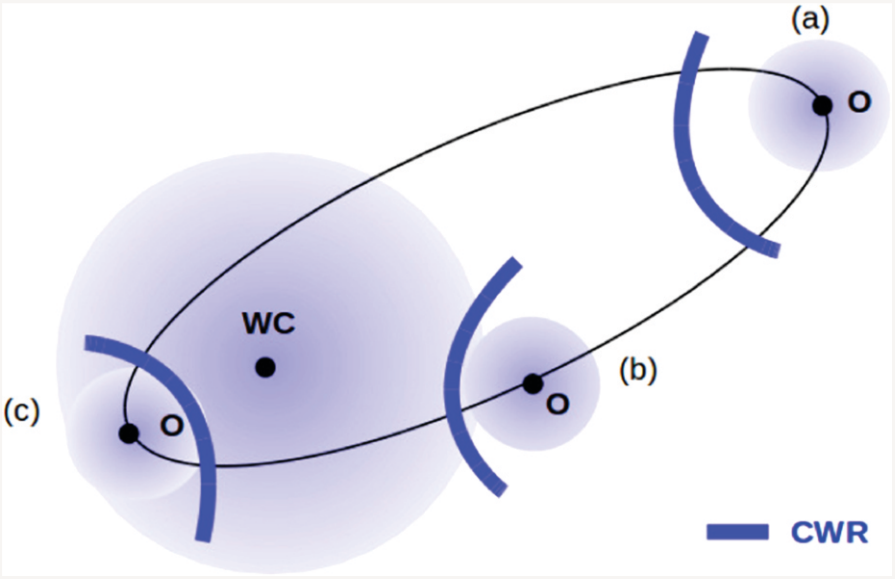

Figure 9. Sketch of the likely eccentric orbit of WR 125, illustrating three specific orbital phases: (a) close to apastron, (b) intermediate phase, and (c) close to periastron. Blue spheres represent the (not to scale) radio photospheres.

The first pointed X-ray observations of FR Cnc, the active fast rotator, showed variable coronal emission. The X-ray light curve in 0.5-2.0 keV energy band was found to be rotationally modulated with 17% degree of modulation around the mean flux. The simultaneous *AstroSat* X-ray and ground based observations showed anti-correlated optical and X-ray variation in the source **(Figure 10)**. This indicated that the higher X-ray flux corresponds to more active regions on the surface of FR Cnc. A two-temperature plasma model was used to explain the X-ray spectra with temperatures of 0.34 and 1.1 keV. **[Pandey, J. C.**, et al. (**Karmakar, S.** & **Joshi, A.**) (2021). *Astron. Jr., 42*, 65 (7pp)**].**

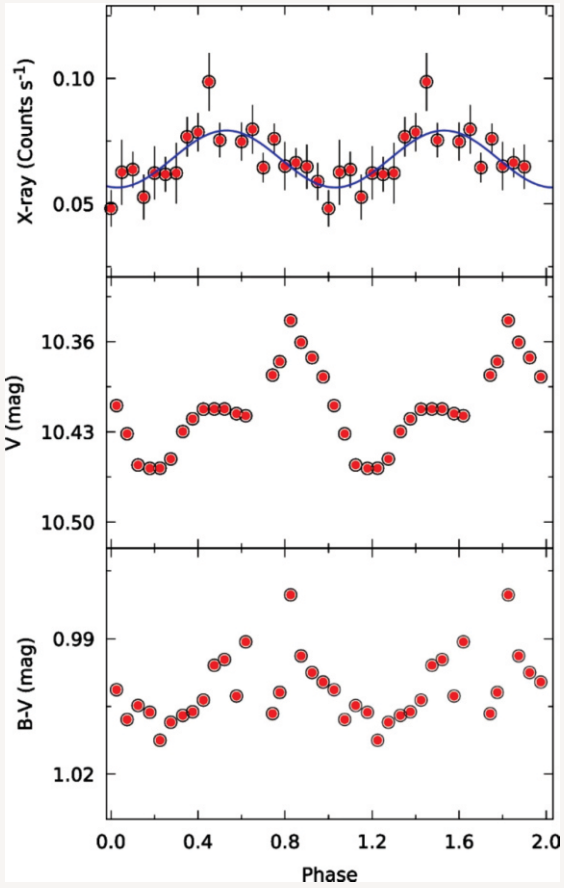

Figure 10. Folded X-ray light curve of FR Cnc in X-ray and optical bands. The colour curve is shown in the bottom panel. The continuous blue curve in the top panel is the best-fit sinusoidal curve to the folded X-ray light curves.

The photometric monitoring of several W Ursae Majoris (W UMa) eclipsing binaries were carried out using ARIES telescopes as a part of a long term survey programme. The orbital period change in these systems were determined using the photometric data. Some systems show an increase or a decrease in the orbital period while some do not show any orbital period change. It is likely that angular momentum loss via magnetic braking might also be responsible for the observed orbital period change in at least one system. The mass transfer rate from the primary to the secondary component in these systems was determined using the orbital period change. The light curve modelling is used to explain the asymmetry of the light curves assuming cool spots on one of the components of the system. It was found that the secondary component was more evolved than the primary component in these systems when placed in the mass-radius and mass-luminosity planes. Some of these systems were found to be shallow-type contact binaries. **[Panchal, A., Joshi, Y. C.**, DeCat, Peter, & Tiwari, S. N. (2022). *Astrophy. Jr, 927*: 12 (18pp); **Panchal, A.** & **Joshi, Y. C.** (2021). *Astron. Jr., 161*: 221 (14pp)**].**

Three large long-duration X-ray flares, with temperatures 22.7, 16.1 and 17.3 MK, were detected on an active M-dwarf binary star EQ Peg with *AstroSat* **(Figure 11)**. The X-ray luminosity during the flare peak was found to be in the range of 5-10 x 10^{30} erg s^{-1}, typically 2-4 times higher than the quiescent state luminosity. This corresponds to energy in the flares between 10^{34}-10^{35} erg categorising these as superflares. Using the quasi-static cooling loop model, the loop lengths of these flares were estimated to be of the order of 10^{11} cm. The density and magnetic field during these flares were of the order of 10^{10} cm^{-3} and a few tens of gauss respectively. The mean outward velocities of the associated CMEs on EQ Peg corresponding to the flares F1, F2, and F3 were ~5500, ~4600, and ~3900 km s^{-1}. **[**Karmakar, Subhajeet et al. (including **Pandey, J. C.**). (2022). *Mon. Not. Roy. Astron. Soc., 509*, 3247–3257].

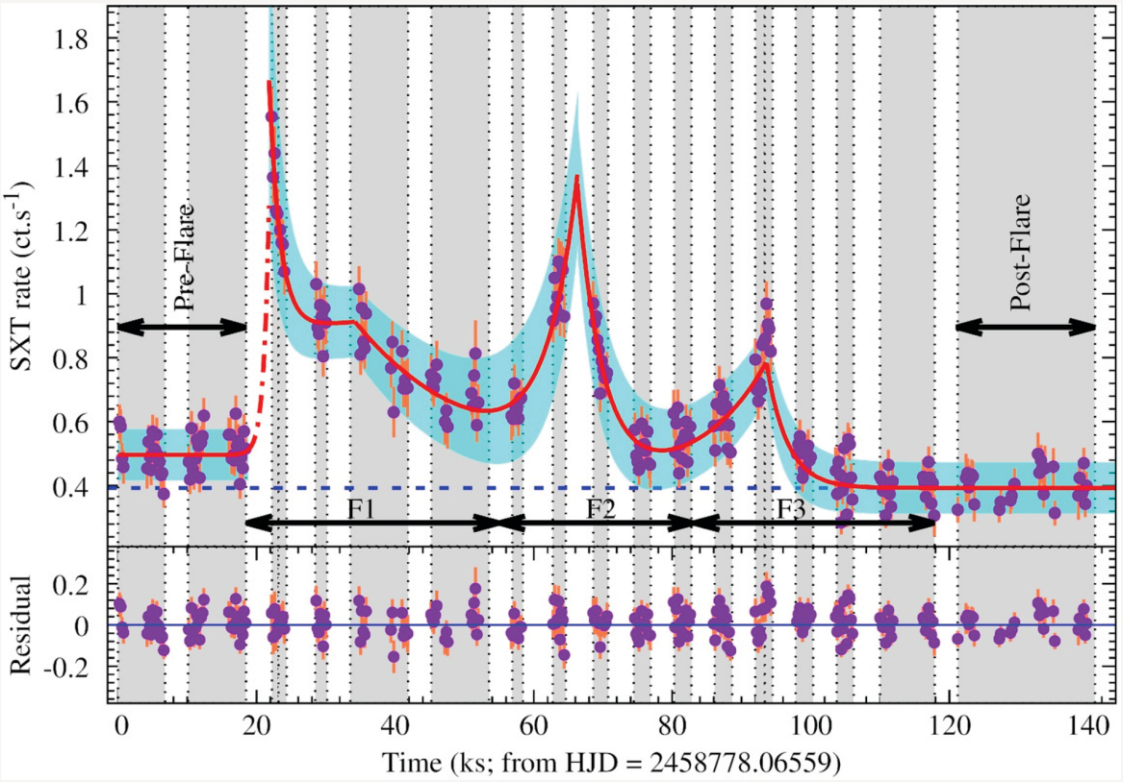

Figure 11. The background-subtracted *AstroSat*/SXT light curve of EQ Peg is shown in 0.3–7 keV energy band. The solid red line shows the superimposed best-fitting model to the light curve. While the cyan shaded region shows the 1σ variations from the best-fitting model. The approximate duration of the flares (F1, F2, and F3), the 'Pre-flare', and the 'Post-Flare' segments have been marked with black arrows. In the bottom panel, the (data model) residual have been plotted.

A detailed photometric and kinematic study of the poorly studied sparse open clusters SAI 44 and SAI 45 was performed and their characteristic parameters were evaluated. The stellar memberships were determined using a statistical method based on Gaia eDR3 kinematic data. 204 and 74 members were found in SAI 44 and SAI 45 respectively. The colour-magnitude diagram of SAI 45 hosts an extended main-sequence turnoff (eMSTO) which indicated that eMSTO is a stellar evolution rather than star formation phenomenon and eMSTO is mainly caused by the different rotation rates of stars. **[Maurya, J., Joshi, Y. C.**, Elsanhoury, W. H., & **Sharma, S.** (2021). *Astron. Jr., 162*: 64 (14pp)**].**

A comprehensive analysis of two pairs of binary clusters, (NGC 5617 and Trumpler 22) and (NGC 3293 and NGC 3324), located in the fourth quadrant of our Galaxy was done. 584, 429, 692, and 273 most probable cluster members were identified toward the regions of these clusters. The extinction toward the first cluster pair was found to be normal whereas an abnormal extinction was seen toward the second cluster pair. These clusters have circular orbits identified on the basis of kinematical analysis. The ages and the distances of these clusters were estimated. New stellar object candidates were also identified in NGC 5617 and Trumpler 22. Mass segregation effect was also seen in these clusters. [Bisht, D., et al. (including **Yadav, R. K. S.**). (2021). *Mon. Not. Roy. Astro. Soc., 503*, 5929-5947].

A detailed investigation of an old age open cluster King 11and an intermediate-age open cluster SAI 35 (Juchert 20) was carried out to determine the basic parameters like proper

motion, limiting radius, age, distance and spatial velocity. 676 and 214 most probable cluster members were identified in King 11 and SAI 35 respectively. The blue straggler stars in King 11 showed a centrally concentrated radial distribution. Galactic orbital parameters were determined using Galactic potential models. **[**Sariya, D. P., et al. (including **Yadav, R. K. S.**) (2021). *Astron. Jr., 162*:146 (11pp); Bisht, D. et al. (including **Yadav, R. K. S.**). (2021). *Astron. Jr., 161*: 182 (14pp)**].**

A stellar occultation by Pluto was observed on 06 June, 2020 with the 1.3 m and 3.6 m telescopes located at Devasthal, Nainital, India, using imaging systems in the I and H bands, respectively **(Figure 12)**. A surface pressure for Pluto's atmosphere of p_{surf}= 12.23(+0.65, -0.38) μbar was derived

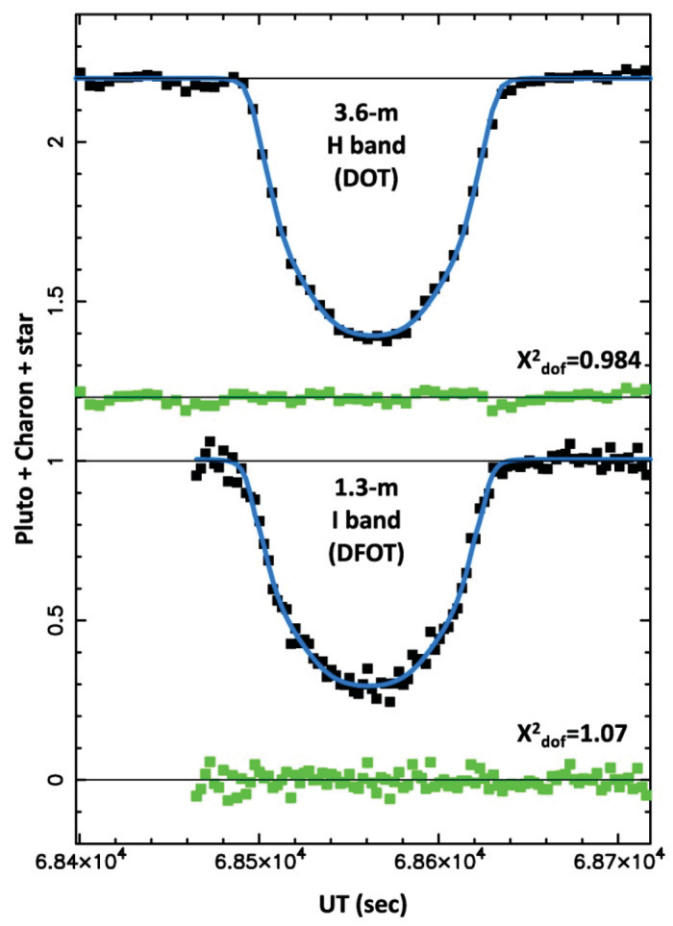

Figure 12. The blue curves are simultaneous fit to the 06 June, 2020 Pluto occultation light curves (black squares) obtained with the 3.6m and 1.3m telescopes of ARIES at Desvasthal, over a 320 s interval bracketing the event. The residuals (observation-minus-model) are plotted in green below each light curve. The value of χ^2 per degree of freedom for each fit is displayed at the lower right corner of each light curve. The lower and upper horizontal lines are the normalized total flux (star+Pluto+Charon) and the zero flux levels, respectively. The DOT light curve has been shifted vertically by +1.2 for better viewing.

indicating that Pluto's atmosphere has been in a plateau phase since mid-2015. This result is an agreement with a previous study (Meza et al.) but does not support the pressure decrease reported by other teams. **[**Sicardy, B. et al. (including **Sharma, S.**). (2021). *Astrophy. Jr. Lett., 923*: L31 (5pp)**].**

Star Formation and Evolution

The evolution and formation of stars in star clusters and HII regions was studied using multi-wavelength data.

An observational diagnosis of triggered star formation processes in the prominent HII region Sh2-142 was conducted. Sh2-142 is associated with the young star cluster NGC 7380 and hosts some bright-rimmed clouds. Young stellar candidates, including a few embedded infrared sources having spectral energy distributions indicative of active accretion were identified using the NIR data. The young stellar sample, the CO line emission, a positional and aging sequence relative to the neighboring cloud complex, and to the bright-rimmed clouds provided an inference that the propagating stellar birth may be responsible, at least partially, for the formation of the cluster a few million years ago, and for the ongoing activity now witnessed in the cloud complex. **[**Sharma, Tanvi, Chen, Wen Ping, **Panwar, Neelam**, Sun, Yan & Gao, Yu. (2022). *Astrophy. Jr., 928*: 17 (16pp)**].**

Multiwavelength investigation of a massive young cluster IRAS 05100+3723 and its environment indicated that it is a distant and moderate mass young cluster with its most massive star being an O8.5V type. The radio continuum observations revealed that the star has ionized its environment, forming a HII region. The dust and 13CO gas analyses indicated that the formation of the HII region occurred at the very end of a long filamentary cloud around 3 Myr ago, likely due to edge collapse of the filament. The study also showed that the HII region is currently compressing a clump of mass in which several point sources of intermediate mass and class 0 nature were observed attributed as the second-generation stars of the complex. **[**Yadav, R. K. et al. (including **Pandey, A. K., Sharma, S.** & **Panwar, Neelam**). (2022). *Astrophy. Jr., 926*: 16 (20pp)**].**

The galactic HII region Sh 2-305/S305 was examined using the [C II] 158 μm line data. The integrated [C II] emission map at [39.4, 49.5] km s^{-1} spatially traced two shell-like structures (i.e., inner and outer neutral shells) having a total mass of ~565 Me. The inner neutral shell encompassed an O9.5V star at its center and has a compact ring-like

appearance. However, the outer shell was seen with more extended and diffuse [C II] emission, hosting an O8.5V star at its center, and surrounds the inner neutral shell. The outer shell appears to be older than the inner shell, hinting that these shells are formed sequentially. The [C II] profiles toward S305 were either double peaked or blue skewed and have the brighter redshifted component. The redshifted and blueshifted components spatially trace the inner and outer neutral shell geometry, respectively. The ionized, neutral, and molecular zones in S305 were seen adjacent to one another around the O-type stars. The regularly spaced dense molecular and dust clumps around the neutral shells could have originated as a result of gravitational instability in the shell of collected materials. **[**Bhandari, N. K. et al. (including **Sharma, S.**). (2021). *Astrophy. Jr., 922*: 207 (12pp)**].**

A cluster of young stellar objects (YSOs) was identified in the northeast (NE) direction of the HII region Sh2-301. The Hα and radio continuum images trace the distribution of the ionized gas surrounding a massive star, ALS 207, and the S301 H II region was bounded by an arc-like structure of gas and dust emission in the southeastern direction. The distribution of warm dust emission, ionized gas, and neutral hydrogen together suggested a blistered morphology of the S301 H II region powered by ALS 207, which appears to be located near the edge of the cloud. The location of the NE cluster embedded in the cold molecular cloud is found opposite to the blistered morphology. There is a noticeable age difference investigated between the massive star and the NE cluster. This age difference, pressure calculation, photodissociation regions, and the distribution of YSOs favor the positive feedback of the massive star ALS 207 in S301 (**Figure 13**). **[Pandey, Rakesh** et al. (including **Sharma, S., Panwar, N., Ghosh, Arpan,** & **Sinha, Tirthendu**). (2022). *Astrophy. Jr., 926*: 25 (17pp)].

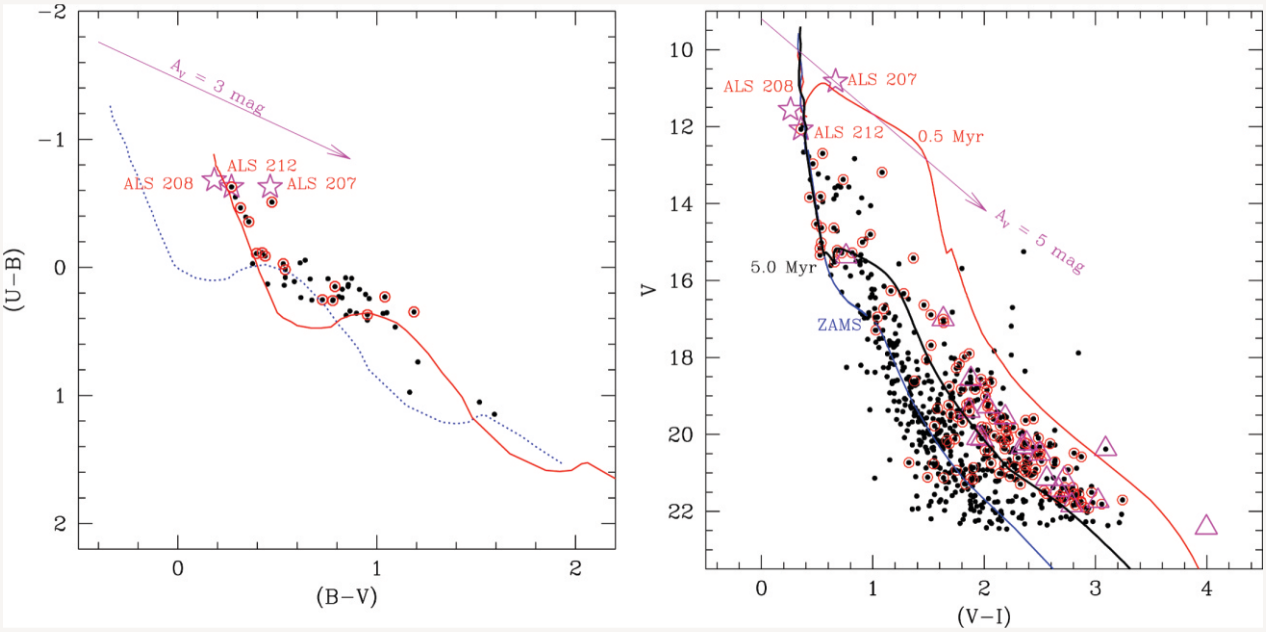

Figure 13. Left: (U − B) vs. (B − V) two-colour diagram for the sources in the NE-cluster region (radius <3 3, black dots). The identified member stars using proper motion analysis are also plotted with red circles. The dotted blue curve represents the intrinsic zero-age main sequence (ZAMS) for Z = 0.02 by Schmidt-Kaler (1982). The red continuous curve represents the ZAMS shifted along the reddening vector by E(B − V)cluster = 0.50 mag for the stars associated with the cluster. **Right:** V vs. (V − I) colour– agnitude diagram for the same sources. The ZAMS (blue continuous curve) and pre-main-sequence isochrone for 0.5 and 5 Myr (red and black continuous curves) by Pastorelli et al. (2019), corrected for the distance of 3.54 kpc and reddening E(B − V) = 0.50 mag, are also shown. The location of massive stars and young stellar objects by star and triangle symbols are also plotted in both the figures.

Time-series imaging data of the star-forming region Sh 2–190 resulted in an identification of 85 PMS variables out of which 37 were Class II sources and 48 were Class III sources. 45 PMS variables show periodicity in their light curves **(Figure 14)**. The periods of the stars showed a decreasing trend with increasing mass in the range of ~0.5–2.5 Me. The variability in Class II sources was ascribed to the presence of a thick disk, while the presence of cool spots on the stellar surface caused the brightness variation in Class III sources. X-ray activity in the PMS stars was found to be at the saturation level reported for the main - sequence stars while the younger counterparts of the PMS variables showed less X-ray activity, hinting at a less significant role of a stellar disk in X-ray generation. **[Sinha, Tirthendu, Sharma, S., Panwar, Neelam**, Matsunaga, N., Ogura, K., Kobayashi, N., Yadav, R. K., **Ghosh, A., Pandey, Rakesh** & Bisht, P. S. (2021). *Astrophy. Jr., 921*: 165 (16pp)].

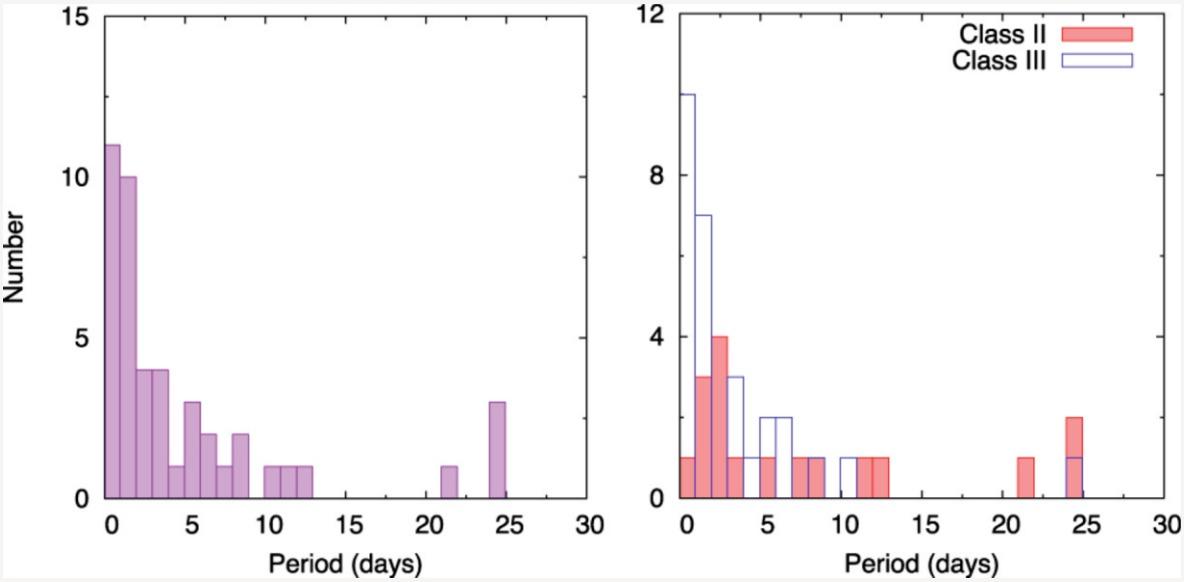

Figure 14. Left: Period distribution of all periodic PMS variables. **Right:** Period distribution of Class II and Class III variables.

Extra-Galactic Astronomy

Time Domain Astronomy

Supernovae (Sne), Gamma-Ray Bursts (GRBs) and other astrophysical transients were studied in time domain astronomy utilising the longitudinal location of ARIES observational facilities combined with data at wavelengths.

The TeV detected long GRB 190114C (z = 0.425) was extensively observed at radio bands from ~1 to ~140 d after the burst and up to ~25 d after the burst in optical bands. Long-term radio/mm observations revealed the complex nature of the afterglow, which does not follow the spectral and temporal closure relations expected from the standard afterglow model. The multi-wavelength modelling indicated that the microphysical parameters of the external forward shock, representing the share of shock-created energy in the non-thermal electron population and magnetic field, were evolving with time. It was also found that the presence of a constant density ambient medium demanded almost an order of magnitude higher energy than in the prompt emission, while a stellar wind-driven medium required approximately the same amount of energy as in prompt emission. **Figure 15** shows the multiband modelling of the afterglow in ISM and wind density environments. **[Misra, K.**, et al. (including **Ghosh, Ankur, Dimple, Gupta, R.** & **Pandey, S. B.**) (2021). *Mon. Not. Roy. Astron. Soc., 504*, 5685–5701**].**

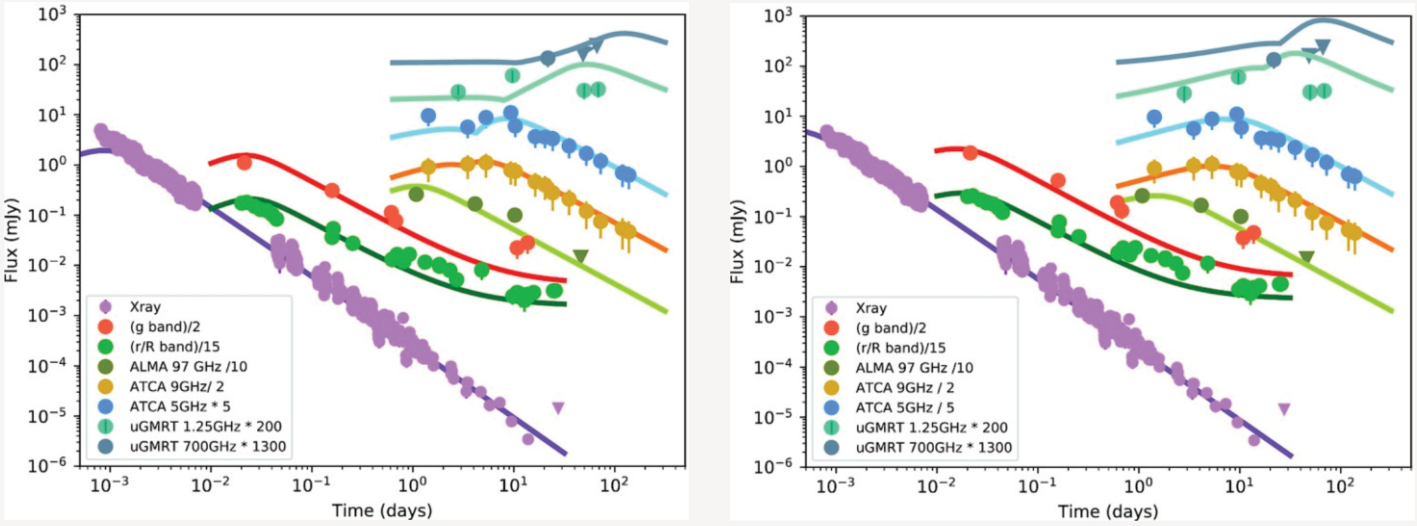

Figure 15. Multiband afterglow light curves and the best fit models in ISM (left) and wind (right) density environments.

Time-resolved spectroscopic investigation of the prompt emission in an optically bright GRB 140102A revealed that the changes in the peak energy (E_p) track the intensity and the low-energy spectral index followed the intensity of the first episode. This tracking behaviour was less clear during the second episode **(Figure 16)**. The early optical afterglow was well described with a reverse shock (RS) emission consistent with the thin shell scenario of the constant ambient medium whereas the late time afterglow evolution was found to be consistent with the prediction of the external forward shock (FS) model. The estimated magnetization parameter in GRB 140102A indicated a moderately magnetized baryonic dominant jet composition. **[Gupta, Rahul** et al. (including **Pandey, S. B., Kumar, Amit, Aryan, A., Kumar, B., Dimple** & **Misra, K.**). (2021). *Mon. Not. Roy. Astrn. Soc., 505*, 4086–4105**].**

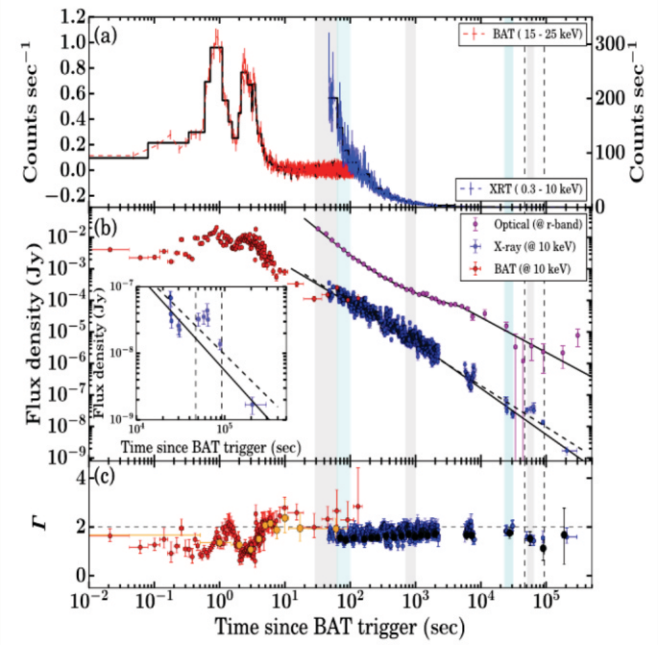

Figure 16. Multiwavelength light curve of GRB 140102A: (a) Count rate BAT and XRT light curves overlaid with the Bayesian Block analysis. (b) The X-ray and optical/UV afterglow light curves of GRB 140102A overlaid with the best-fitting models. The inset plot shows the late re-brightening activity in the X-ray light curve. (c) Evolution of photon indices within the BAT (red) and XRT (blue) window. The vertical dashed lines indicate the late re-brightening activity in the X-ray light curve (at 10 keV).

The discovery of a fast fading optical transient , ZTF20abwysqy (At2020scz), was reported. X-ray and radio emission of the transient confirmed that it is the afterglow. Excess emission above the afterglow was reported at rest-frame 16.5 days which was found to be consistent with a supernova emission but unexplainable with an underlying kilonova emission. Although the duration classified this GRB as a short burst, panchromatic observations confirmed a collapsar origin for the burst. GRB 200826A is the shortest long GRB found with an associated collapsar sitting on the brink between a successful and a failed collapsar. **[**Ahumada, T., et al. (including **Pandey, S. B.**) (2021). *Nature Astronomy, 5*, 917-927**].**

The basic parameters of three type IIP SNe (2014cx, 2014cy and 2015cz) were evaluated using photometric and spectroscopic analysis. All of these were normal luminosity type II SNe with an absolute magnitude at mid-plateau in range -16.6 – -17.4 mag but with different decline rates and plateau lengths **(Figure 17)**. A relatively broad range of ^{56}Ni

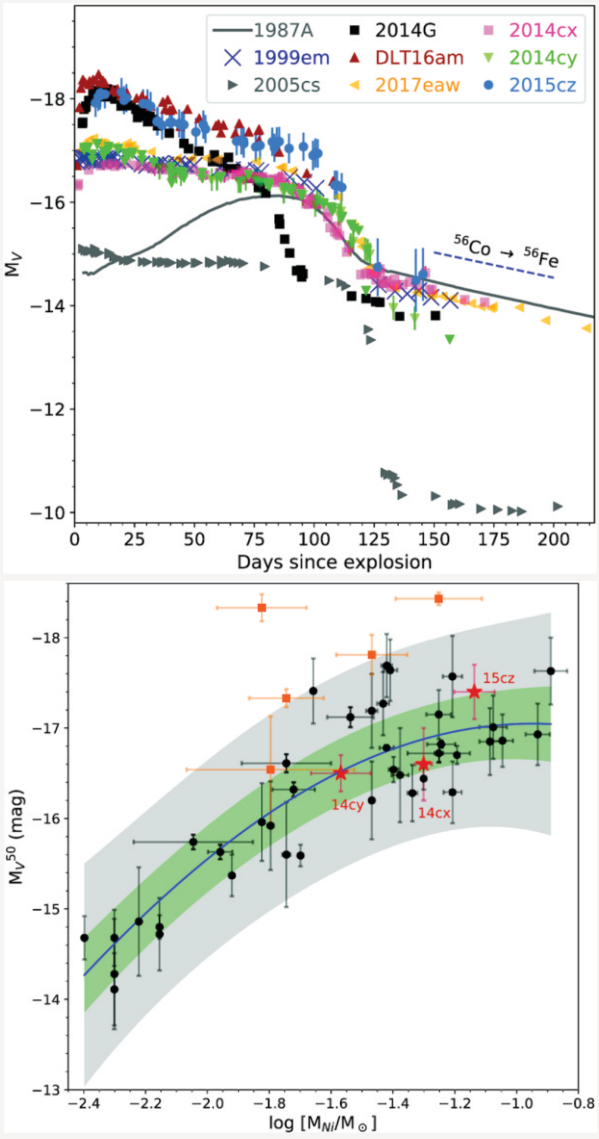

Figure 17. Left: The absolute V-band magnitudes of SNe 2014cx, 2014cy, and 2015cz are shown with those of a sample of SNe II. **Right:** Position of SNe 2014cx, 2014cy, and 2015cz (labelled with red stars) in the V-band absolute magnitude at 50 d (M_{50V}) and ^{56}Ni mass diagram. The Gaussian fit is shown by the solid blue line and the 1σ and 3σ fits are shown with shaded green and grey regions, respectively.

masses was ejected in these explosions (0.027-0.070 $M_{\odot}$). The analytical modelling of the bolometric light curve of these three events yielded similar progenitor radii, a range of ejecta masses, and a modest range of explosion energies. The spectra displayed the classical evolution of type II SNe, dominated by a blue continuum with broad H lines at early phases and narrower metal lines with P Cygni profiles during the plateau. **[Dastidar, R.**, et al. (including **Misra, K., Singh, M., Gangopadhyay, A., Kumar, B.** & **Pandey, S. B.**). (2021). *Mon. Not. Roy. Astro. Soc., 504*, 1009-1028**].**

An investigation of four type Ib SNe, located in nearby galaxies, was undertaken using optical and NIR photometric and spectroscopic data. The light curve and spectroscopic features identified in these SNe (2021au, 2015ap, 2016bau and 2017iro) were used to constrain the progenitor and explosion properties. The early time photometric evolution of SNe 2012au (luminous, slow decaying) and 2017iro (moderately luminous) was similar while the late time evolution of SN 2017iro matched well with SN 2009jf **(Figure 18)**. The P Cygni profiles of the different lines present in the spectra of these SNe were used to determine the velocity evolution of the ejecta. Further, in SN 2012au the early-time imaging polarimetric observations indicated the signatures of asphericity in the ejecta. A clear absence of the first overtone of carbon monoxide (CO) features in the NIR spectra of SN 2012au was noticed. Semi-analytical modelling, using the MINIM code, of the bolometric light curve of SN 2012au supported a spin-down millisecond magnetar-powered model **(Figure 19)** which was consistent with the results obtained through MESA, STELLA and SNEC explosion models with an estimated progenitor mass of around 20 $M_{\odot}$. Similar modelling in SN 2015ap indicated a 12 $M_{\odot}$ star as the possible progenitor while the progenitor of SN 2016bau was found to be slightly less massive, being close to the boundary between SN and non-SN as the final product. The [O I]/[Ca II] flux ratio and the semi-analytical light curve modelling in SN 2017iro favoured a progenitor mass in the range ~13-15 $M_{\odot}$, most likely in a binary system, for SN 2017iro. **[Pandey, S. B.**, et al. (including **Kumar, Amit, Kumar, Brajesh, Aryan, A., Gupta, R.** & **Misra, K.**). (2021). *Mon. Not. Roy. Astro. Soc., 507*, 1229-1253; **Aryan, A.**, et al. (including **Pandey, S. B., Kumar, Amit, Gupta, Rahul** & **Misra, K.**) (2021). *Mon. Not. Roy. Astron. Soc., 505*, 2530– 2547; **Kumar, Brajesh** et al. (2022). *Astrophy. Jr., 927*: 61 (17pp)**].**

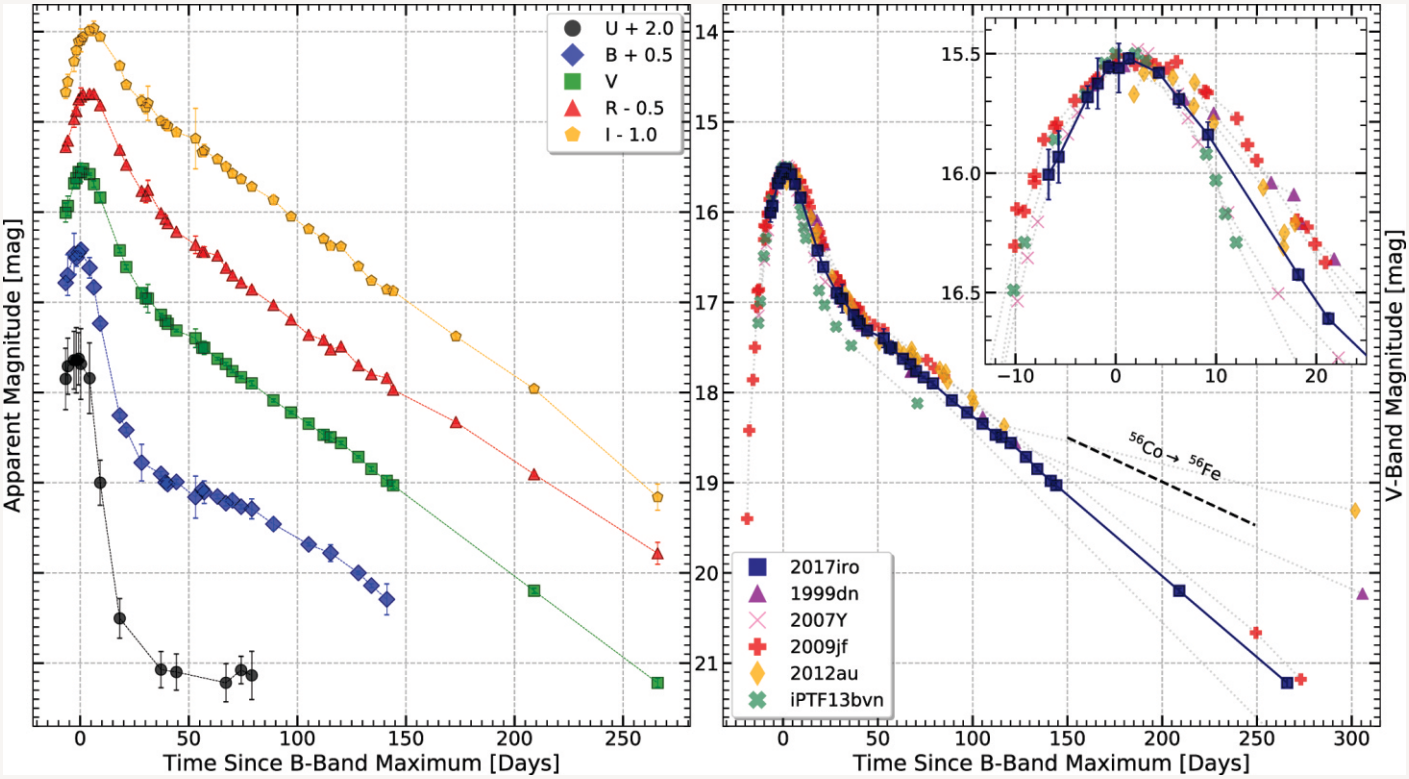

Figure 18. Left panel: The observed UBVRI light curves of SN 2017iro. For clarity, the light curves in different bands have been shifted vertically by the indicated amount. Right panel: The V-band magnitude of SN 2017iro is over-plotted with other Type Ib events (iPTF13bvn, SN 2012au, SN 2009jf, SN 2007Y, and SN 1999dn). The light curves of other events have been shifted arbitrarily to match the date of maximum and the peak magnitude to SN 2017iro. The evolution of light curves near the peak is also shown in the inset.

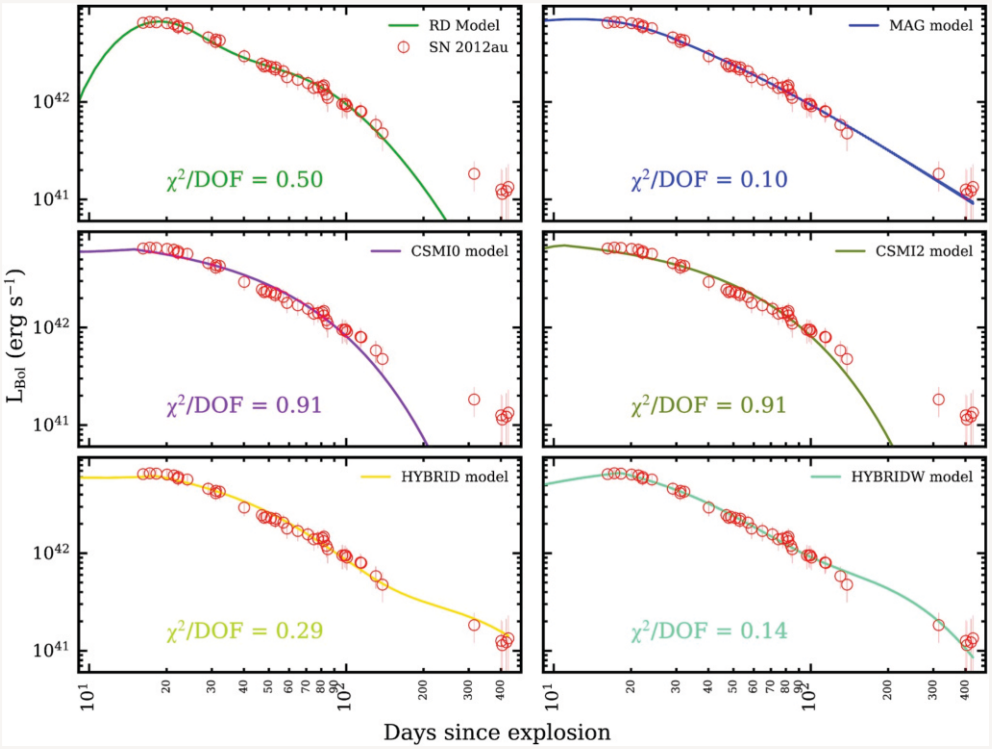

Figure 19. Semi-analytic light curve models (RD, MAG, CSMI0, CSMI2, HYBRID, and HYBRIDW) fitted to the bolometric light curve of SN 2012au using the MINIM code.

SN 2020ank (z = 0.2485) was one of the brightest hydrogen-deficient superluminous supernova (SLSN) with a peak magnitude of $M_{g,peak}$ ~-21.84 ± 0.10 mag) **(Figure 20)**. The semi-analytical light-curve modelling using the MINIM code suggested a spin-down millisecond magnetar with P_i ~2.2 ± 0.5 ms and B ~$(2.9 \pm 0.1)x10^{14}$ G as a possible powering source for SN 2020ank. The near-peak spectra of SN 2020ank were enriched with W-shaped O II features but with weaker signatures of C II and Fe III bearing resemblance with the fast-evolving SN 2010gx. **[Kumar, Amit**, et al. (including **Kumar, Brajesh, Pandey, S. B., Singh, Avinash, Aryan, A., Gupta, R. & Misra, K.**). (2021). *Mon. Not. Roy. Astron. Soc., 502*, 1678-1693.]

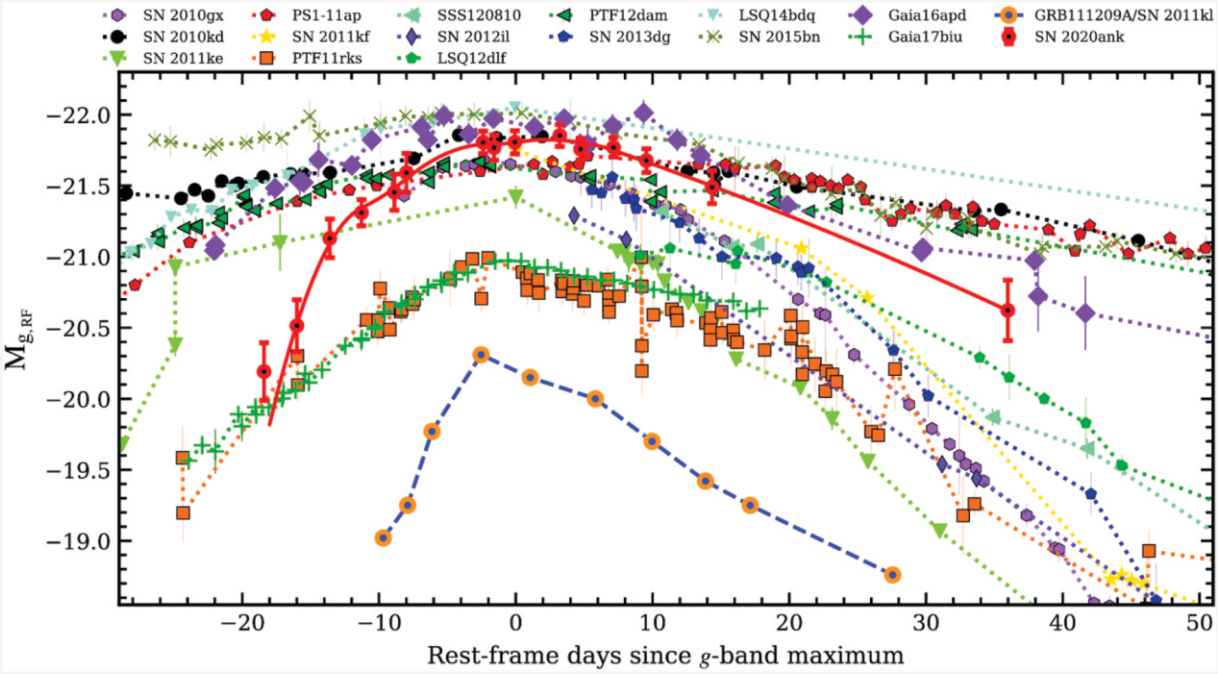

Figure 20. Comparison of the rest-frame M_g light curve of SN 2020ank with other well-studied SLSNe I and the long GRB connected SLSN 2011kl. The light curves are corrected for Galactic extinction, and K-corrections.

Deep *Chandra* X-ray observations of two nearby type Ia SNe, SN 2017cbv and SN 2020nlb, revealed no X-ray emission down to a luminosity $L_X \lesssim 5.3x10^{37}$ and $\lesssim 5.4x10^{37}$ erg s^{-1} (0.3–10 keV) respectively at ~16-18 days after the explosion. These limits were used to constrain the pre-explosion mass-loss rate of the progenitor system and the number density limit assuming the supernova environment was a constant density medium. The X-ray and radio limit (in the case of SN 2020nlb) ruled out the most plausible symbiotic progenitor systems **(Figure 21)**. **[**Sand, D. J. et al. (including **Misra, K.** & **Dastidar, R.**). (2021). *Astrophy. Jr., 922*: 21 (14pp)**].**

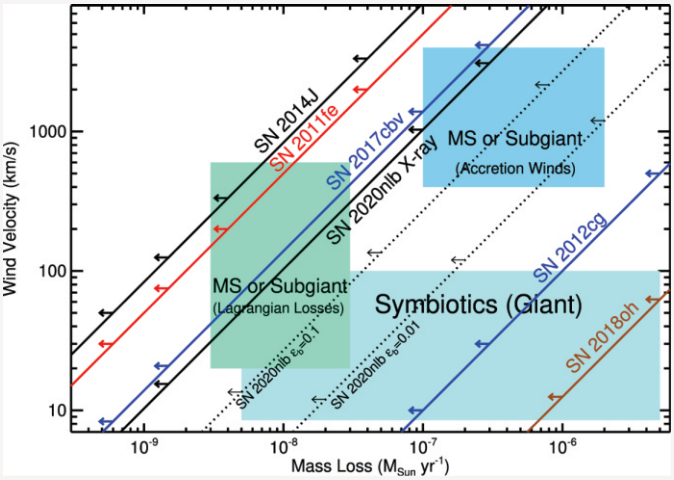

Figure 21. X-ray constraints on a wind-like CSM for SN 2017cbv (blue line) and SN 2020nlb (solid black line) with respect to other prominent results in the literature. Regions of parameter space not ruled out are toward the upper left of the plot, in the direction of the arrows. The colour blocked regions represent areas of parameter space where plausible SN Ia progenitors and their expected CSM would inhabit.

Active Galactic Nuclei

Various classes of Active Galactic Nuclei (AGN) were studied using multiwavelength datasets.

A correlation analysis on a large sample of Narrow Line Seyfert (NLSy1) and Broad Line Seyfert (BLSy1) galaxies using 11 physical parameters and Principal Component Analysis (PCA) was performed. The NLSy1 galaxies showed traces of outflow through the asymmetry observed in the H-beta emission profile. The PCA results indicated that the NLSy1 and BLSy1 galaxies occupy different parameter spaces, which challenges the notion that NLSy1 galaxies are a subclass of BLSy1 galaxies. **[Jha, Vivek Kumar, Chand, Hum,** Ojha, V., **Omar, A.** & Rastogi, S. (2022). *Mon. Not. Roy. Astro. Soc., 510*, 4379–4393**].**

A sample of 100 high resolution quasar spectra at z~4 were used to study the longitudinal proximity effect. It was found that the effect was evident up to 12 Mpc and was luminosity dependent. This analysis estimated the extent of over density to 6 Mpc which was found to be consistent with the previous study. **[Jalan, P., Chand, Hum** & Srianand, R. (2021). *Mon. Not. Roy. Astron. Soc., 505*, 689-701**].**

The Gaia Gravitational Lenses Working Group (GraL) has been discovering quasars that have been warped by a naturally occurring cosmic "lens" and split into double or four similar images. In these studies, the nature of the pre-selected lensed quasar images were confirmed and verified with optical spectroscopy. **[**Stern, D. et al. (including **Jalan, P.**). (2021). *Astrophy. Jr, 921*: 42 (16pp); Connor, T. et al. (including **Jalan, P.** & **Negi, Vibhore**). (2022). *Astrophy. Jr., 927*: 45 (11pp)**].**

A sample of 16 high-redshift Flat-Spectrum Radio Quasars (FSRQs) were examined in the X-ray bands. Their X-ray spectra were fit with a power law including free excess absorption and one multiplied by an exponential roll-off to account for the intrinsic jet-based processes **(Figure 22)**. To distinguish between these spectral models required to understand the origin of the spectral flattening, a detailed statistical analysis was performed. The model selection is indistinguishable in 10 out of the 16 FSRQs. 4 FSRQs indicated intrinsic jet-based radiative processes where the inferred energy breaks were consistent with their expectation from the external Compton-scattering of low-energy ambient photons. 2 of the FSRQs showed mixed results, supportive of either scenario, illustrating the

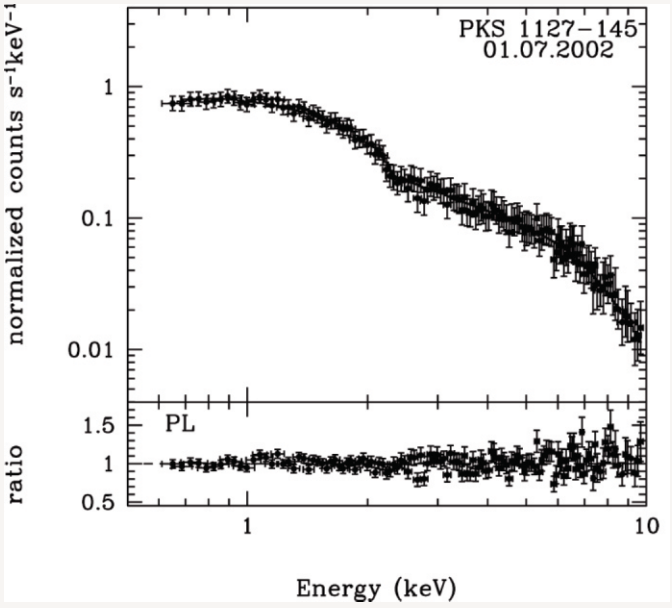

Figure 22. Example of the X-ray spectra fit with the PL model and the corresponding ratio. The name and date of observation of each blazar is provided in the upper right corner.

difficulty of identifying X-ray absorption signatures. A clear detection can be employed to disentangle the relative contributions from the intergalactic medium and the intracluster medium, the method applied to two sources. **[Gaur, H.**, Mohan, P. & Pandey, A. (2021). *Astrophy. Jr., 914*, 46 (11pp)**].**

The properties of five known Quasi-Periodic X-ray Eruptions (QPE) host galaxies were studied and evidence of AGN was found in each one of them. This study suggested that a long-lived accretion flow likely plays an integral part in the QPE phenomenon (**Figure 23**). **[**Wevers, T. et al. (including **Jalan, P.** & **Rakshit, Suvendu**). (2022). *Astron. & Astroph., 659*, L2 (10pp)**].**

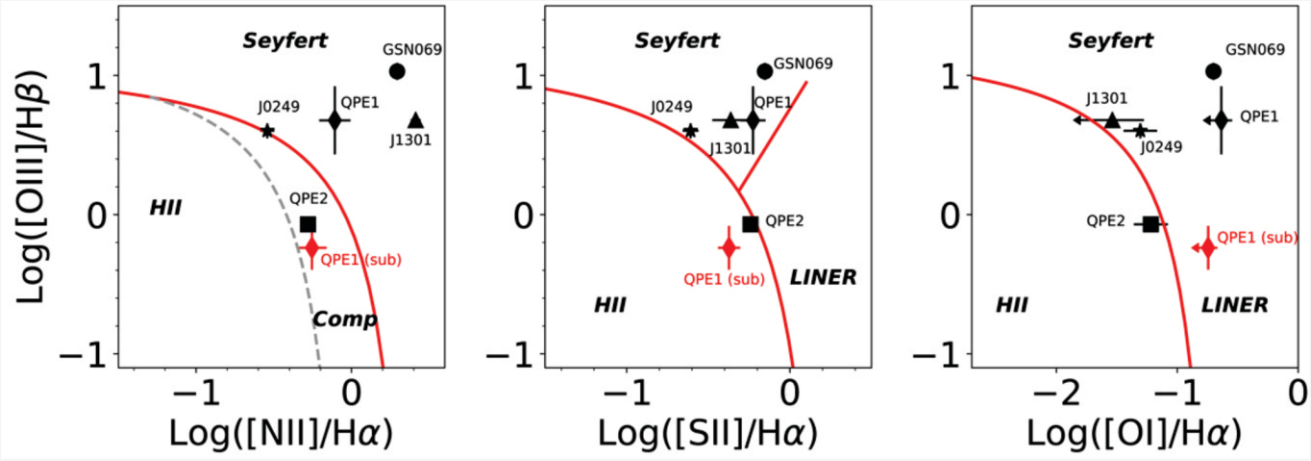

Figure 23. BPT diagram of the five QPE host galaxies. All sources are beyond the pure star-formation (grey dashed) line, indicating that they very likely host an – in some cases low luminosity – AGN.

A handful number of changing look AGNs, undergoing a transition from Type 1to Type 1.8 or 1.9, have been found so far. Mrk 590 is one such AGN where reappearance of optical broad emission lines was noticed after ~10 year of absence while the AGN optical continuum flux was still ~10 times lower than that observed during the most luminous state in the 1990s **(Figure 24)**. Using several photometric and spectroscopic observations, a high variability in Mrk 590 with a BLR size of 22 days and a black hole mass of ~200 million $M_{\odot}$ was estimated. **[**Mandal, A. K. et al. (including **Rakshit, Suvendu**). (2021). *Mon. Not. Roy. Astron. Soc., 508*, 5296–5309**].**

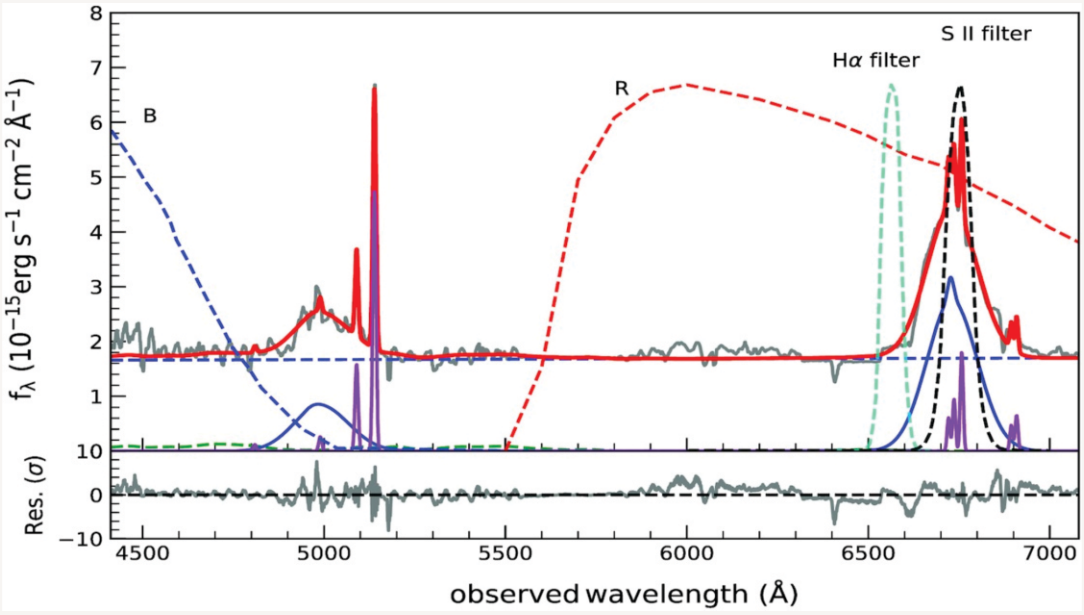

Figure 24. Subaru spectrum of Mrk 590. **Top:** the observed data (grey), best-fitting model (red), and decomposed power-law (PL) continuum model (black dashed), broad line (blue), and narrow line (magenta) are shown. The broad B, R, and narrow H α and S II filters are overplotted with limited x-axis for illustration. **Bottom:** residual in the unit of flux uncertainty. The spectrum was smoothed by a 300 pixel box-car for visualization purpose.

Variability in Blazars

Blazars are the most luminous and energetic class of AGNs with a relativistic jet. Temporal flux and spectral variabilities of different blazars were studied on diverse time scales using multiwavelength data. Flux and spectral variabilities are a dominant tool to explain jet as well as disk emission from blazars at different epochs of observations.

Intraday flux variability in the high energy peaked TeV blazar PG 1553+113 was reported, using long term X-ray observations, with a duty cycle of ~84 percent. A discrete correlation function analysis of the intraday light curves in the soft and hard X-ray bands peaked at zero lag. This indicated that the emission in hard and soft bands were co-spatial and emitted from the same population of leptons. The power spectral density (PSD) of the light curves is dominated by red-noise dominates. The optical/UV variations were not correlated to those in the X-ray band, indicating that the optical/UV and X-ray emissions were from two different populations of leptons. Although the optical and UV variability patterns were almost identical and well correlated, as are the soft and hard X-ray bands, on longer time scales **(Figure 25)**. **[Dhiman, V., Gupta, A. C., Gaur, H.** & Wiita, P. (2021). *Mon. Not. Roy. Astr. Soc., 506*, 1198-1208**].**

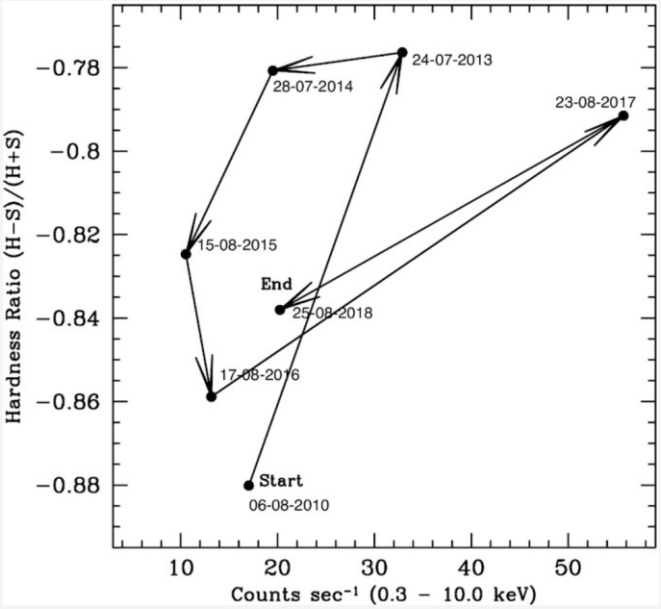

Figure 25. The hardness ratio plotted against flux at different times.

The variability in 10 blazars was characterised using the optical data. The results of flux and colour variations of the sample on intraday and short timescales obtained using the power-enhanced F-test and the nested-ANOVA tests, along with their spectral behavior were reported. The single flat spectrum radio quasar in the sample showed significant intra-day variability with an amplitude variation of ~12%. Although a few of the BL Lacs showed probable variation in some nights, none of them passed the variability tests at 99.9% significance level. 78% of the sources showed significant negative colour-magnitude (CM) correlations, i.e., a redder-when-brighter (RWB) spectral evolution. Those that do not show strong or clear chromatism predominantly exhibit a RWB trend. Unlike on hourly timescales, the high-synchrotron-peaked blazars in the sample showed strong flux variation on timescales of days to months, where again a decreasing trend of the spectral slope with brightness was detected **(Figure 26)**. A global steepening of the optical spectrum with increasing flux on the intranight timescale for the entire blazar sample was observed. The nonvariability in the BL Lacs in the sample might be caused by the distinct contribution from the disk as well as from other components in the studied energy range. **[**Kalita, Nibedita, **Gupta, A. C.** & Gu, Minfeng. (2021). *Astroph. Jr. Suppl. Sr., 257*: 41 (14pp)**].**

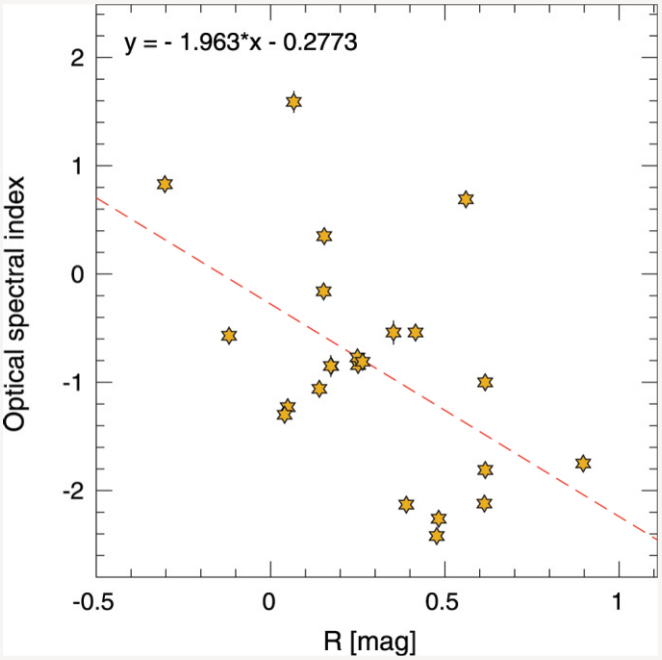

Figure 26. Relation between the optical spectral indices evaluated on nightly timescales and their corresponding averaged R-band magnitude for the entire blazar sample studied in this work. Vertical and horizontal error bars are not visible in most of the points because their sizes are smaller than the size of the points. The dashed red line denotes the linear regression fitting using the equation shown on the upper left side of the plot.

The blazar OJ 287 showed high optical to X-ray flux variations, accompanied mainly by strong spectral changes **(Figure 27)**. The optical to X-ray flux variations were found to be correlated and simultaneous except for two durations when they were anti-correlated. The flux variations were

anti-correlated with the X-ray spectral state while correlated with the optical-UV. Around the highest X-ray activity the *Fermi*-LAT data showed a few detections with a log-parabola model but none with a power law. Strong spectral change was also observed in the NIR data resembling a thermal component. The combined optical to gamma-ray broadband spectrum established the observed variations to a new high-energy-peaked broadband emission component, similar to the one seen during the highest reported X-ray flux state of the source in 2017. The observed activities indicated peculiar features characteristic of this emission component, while its appearance a few years around the claimed ~12 years optical outbursts strongly indicated a connection between the two. **[Kushwaha, P.** et al. (including **Gupta, A. C.**). (2021). *Astrophy. Jr., 921*:18 (11pp)**].**

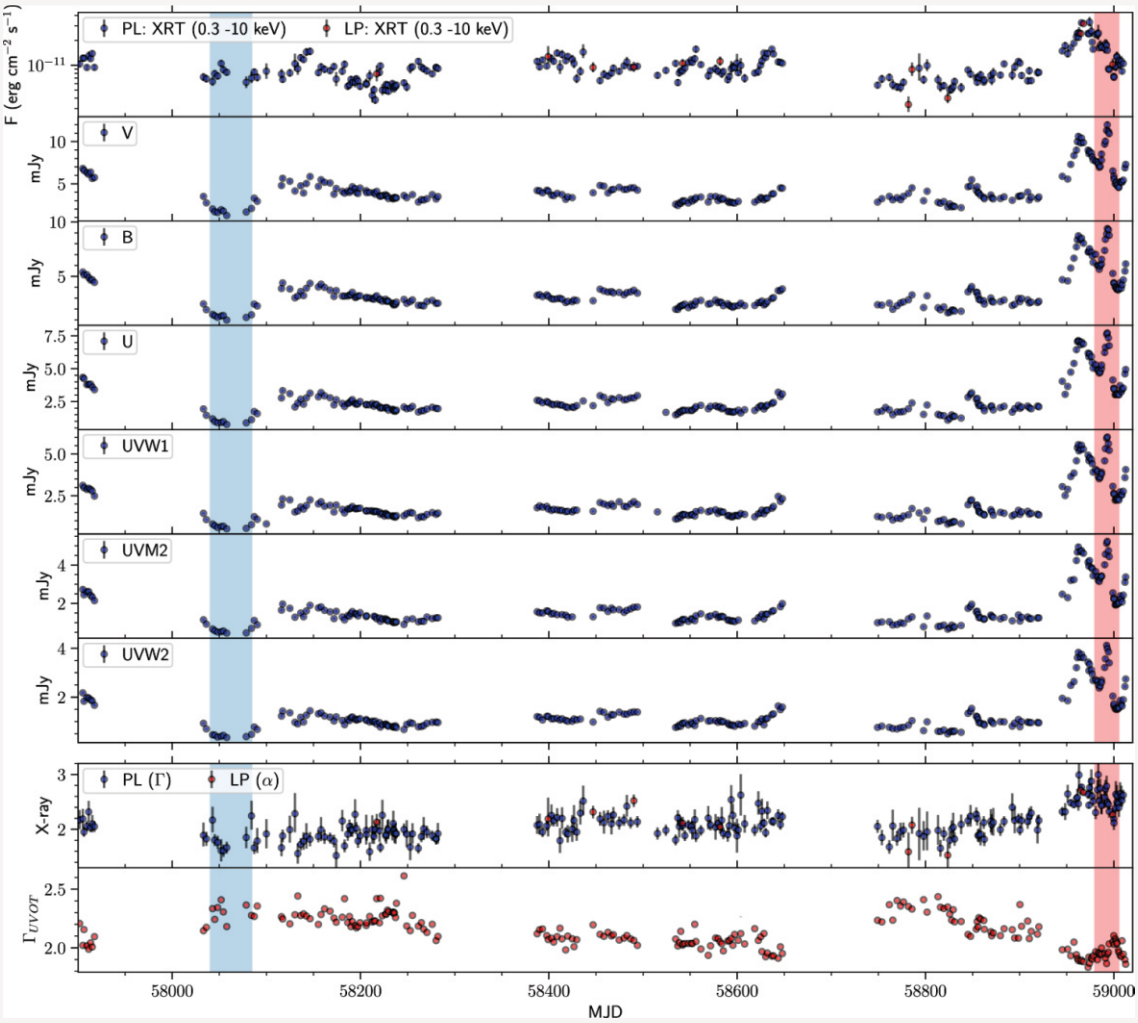

Figure 27. Top: Multiwavelength light curve of OJ 287 from X-ray to optical energies from 27 May, 2017 to 10 June, 2020 (MJD 57,900–59,010). The X-ray flux is in log scale. **Bottom:** Spectral indices for X-ray and UVOT. For X-ray, a power law (blue) and a log-parabola (red) models were used, while for UVOT only a power law model was used. The shadowed regions mark the duration when the X-ray evolution is at odds with the optical–UV. Similar odd trends were also seen during the 2017 activity.

Characterisation of intranight variability of the blazar class from the perspective of (rest-frame) UV emission was reported for the first time. This study suggested that the synchrotron radiation of blazar jets in the UV/X-ray regime arises from a relativistic particle population distinct from the one responsible for their synchrotron radiation up to near-IR/optical frequencies. **[Chand, Krishan** et al. (including **Omar, A.** & **Chand, Hum**). (2022). *Mon. Not. Roy. Astro. Soc. Lett., 511*, L13 (6pp)**].**

An INOV study was performed for Bal blazar candidates and normal blazars using data obtained with several observational facilities. A stark contrast in INOV was found between Bal blazar candidates and normal blazars which suggested that there could be a probable physical interaction of the relativistic jet with the thermal wind, within a sub-parsec range from the nucleus. The consequent enfeebling of the jet would additionally explain the striking deficiency among BAL quasars of powerful FR II radio lobes on the

much larger scale of 10 – 100 kpc. **[Mishra, S., Gopal-Krishna, Chand, Hum, Chand, Krishna, Kumar, Amit & Negi, Vibhore.** (2021). *Mon. Not. Roy. Astro. Soc.: Lett., 507*, L46–L51**].**

The detection of two transient quasi-periodic oscillations (QPOs) were reported in the γ-ray light curve of the TeV blazar PKS 1510-089. The Lomb–Scargle periodogram, Weighted Wavelet Z-transform, REDFIT, and the Monte Carlo light-curve simulation techniques were employed to find any periodicity and the corresponding significance. A significance of ~3.5σ and ~7.0σ were reported for the two QPOs at 3.6 day and 92 day respectively. The different physical models were explored to explain these transient QPOs. **[**Roy, A. et al. (including **Gupta, A. C.**). (2022). *Mon. Not. Roy. Astro. Soc., 510*, 3641-3649**].**

Numerical and Theoretical Astrophysics

Numerical simulation and theoretical investigation of astrophysical jets are studied. Jets and accreting flows around compact objects are relativistic in nature and can be modelled as magnetised or non-magnetised fluids.

A new relativistic hydrodynamic code based on Weighted Essentially Non-Oscillatory scheme (WENO) was developed which are employed for solving hyperbolic systems of conservation equations. The code is equipped with different WENO versions like fifth order accurate WENO-JS, WENO-Z and WENO-ZA, and different time integration methods **(Figure 28)**. The code could quite easily handle very high Lorentz factors and is a very robust code. **[**Seo, J., Kang, H., Ryu, D., Ha, S. & **Chattopadhyay, I.** (2021). *Astrophy. Jr., 920*:143(16pp)**].**

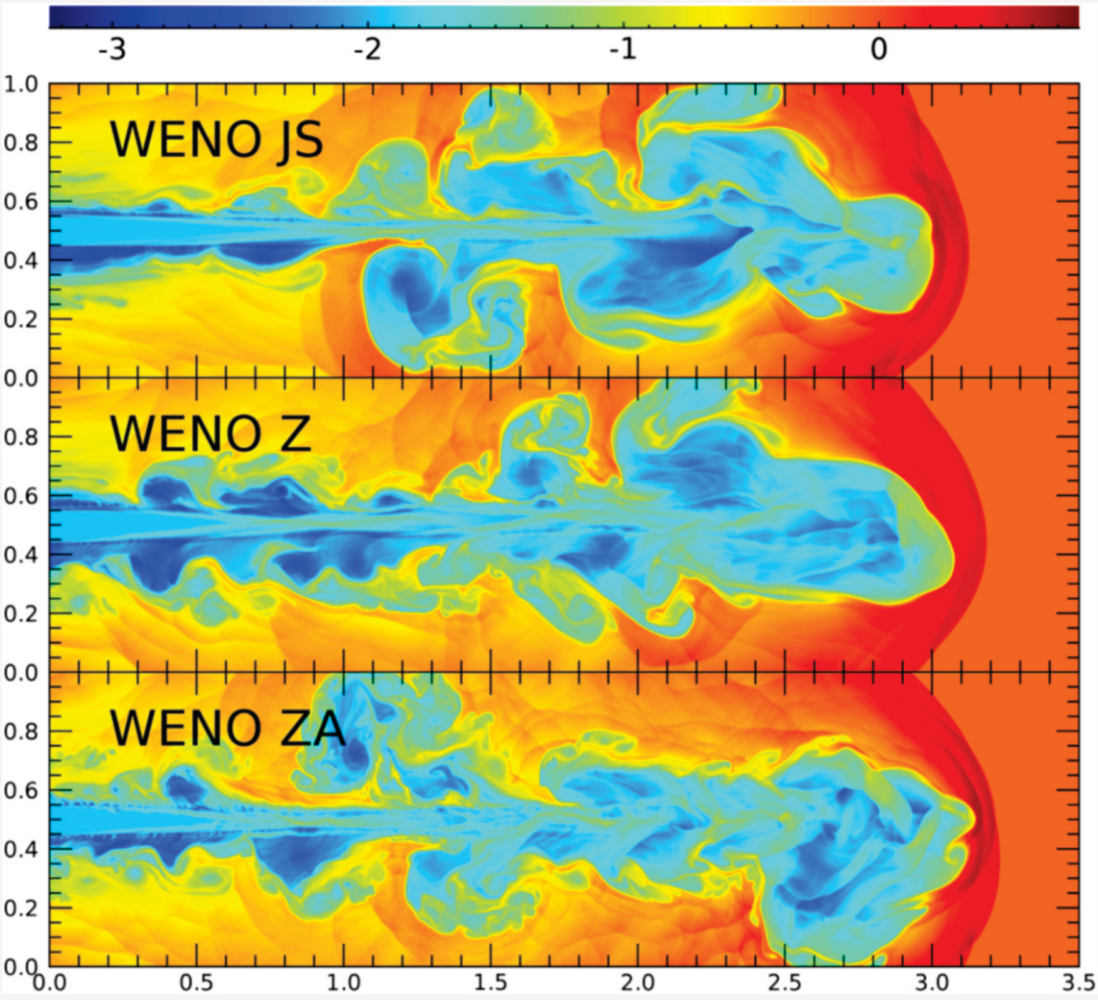

Figure 28. 2D plane-parallel (slab) jet with the Lorentz factor Γjet = 7, injected from the left boundary into a uniform background. The computational domain consists of [0, 3.5] × [0, 1] with 1050 × 300 grid zones, and the width of the jet nozzle is 0.1. The rest-mass density, log r, from simulations using different WENO versions, WENO-JS (top), WENO-Z (middle), and WENO-ZA (bottom), is shown. Otherwise, the default code setup with SSPRK, RC, CFL = 0.8, and the transverse-flux averaging is adopted.

Exact solution of the Riemann problem for one-dimensional relativistic jets using the Chattopadhyay-Ryu or CR equation of state was solved. The exact condition was obtained when an initial value problem (Riemann problem) will evolve as relativistic jets and when it will evolve as a typical shock tube. For completeness, exact solutions to all types of Riemann problem like shocktube, wall shock, shock-shock, rarefaction-rarefaction problems was obtained. In addition, the effect of composition on one dimensional relativistic jets was studied, and it was found that, indeed composition do play an important role **(Figure 29)**. **[Joshi, Raj K., Chattopadhyay, I.**, Ryu, D. & Yadav, L. (2021). *Mon. Not. Roy. Astron. Soc., 502*, 5227-5244**].**

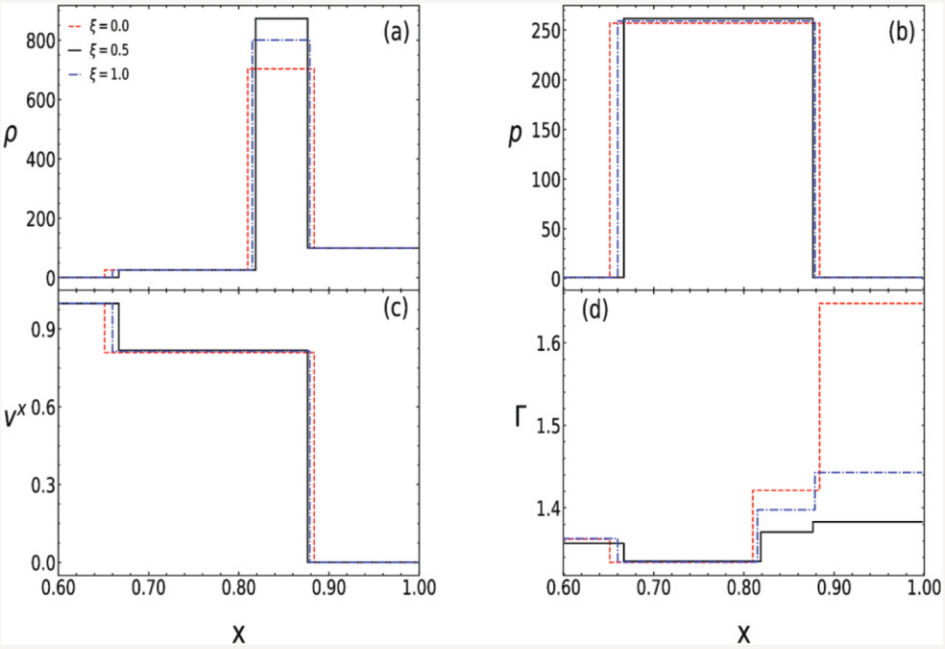

Figure 29. Flow variables (a) density ρ, (b) pressure p (c) velocity vx and (d) adiabatic index Γ as a function of x. Composition parameter ξ (fractional proton content) is in legends.

A Total Variation Diminishing (TVD) code based on Newtonian equations of motion and CR equation of state was used to study the time dependent bipolar outflows. The code was compared with steady state analytical solutions to test the robustness of the code. The radiation arising out of the accretion disc can provided a wide range of jet solutions, depending upon parameters like the intensity of disc, location of the inner corona etc. Time dependence of the radiation field was ensured by inducing oscillation of the inner corona of the accretion disc. The radiation field then makes the bipolar outflow time dependent **(Figure 30)**. It was shown that a non-steady radiation field arising out of disc oscillations can generate the internal shocks closer to the jet base. **[Joshi, Raj Kishor, Chattopadhyay, I.**, & Yadav, L. (2022). *Mon. Not. Roy. Astron. Soc., 509*, 85–99**].**

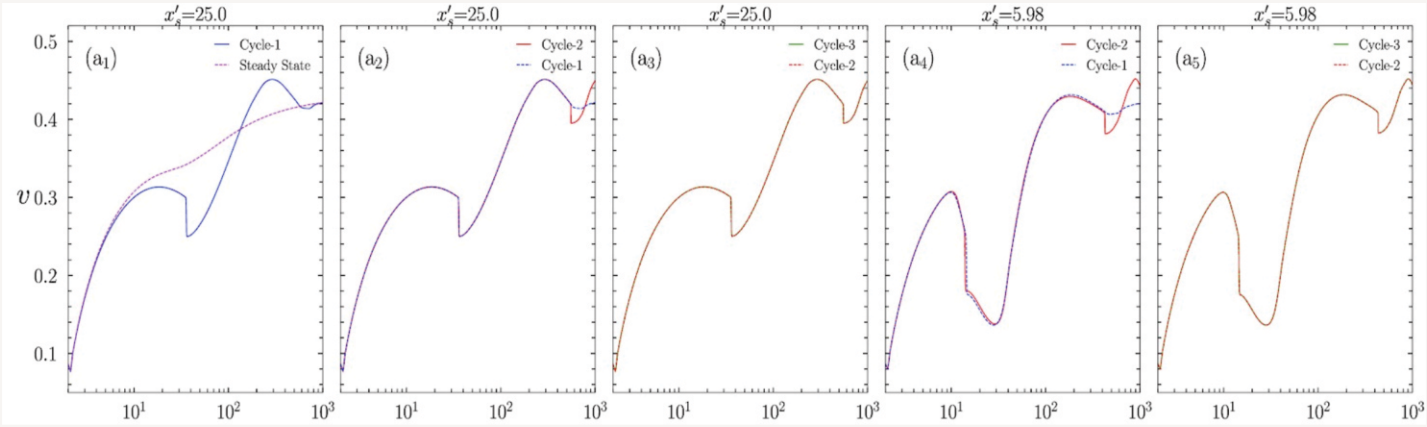

Figure 30. Multiple shock formation in time dependent outflows. Velocity v versus r at various stages of inner disc oscillation (electron proton or ξ=1, outflow).

Atmospheric Sciences Division

The research activities in Atmospheric Sciences division are oriented to understand the complex physical, chemical and dynamical processes governing the Earth's lower atmosphere.

Aerosols and Meteorology

The Indo-Gangetic Plain experiences heavy air pollution due to various anthropogenic and natural activities which are further exacerbated by seasonal meteorological conditions. As a result, this region is a major aerosol hotspot.

Study of Water vapour radiative effects over Himalayan sites

Long-term (2008-2018) aerosol and precipitable water vapour (PWV) properties were studied to understand seasonal variation in combined aerosol and water vapour radiative effects at two remote sites over the central (Nainital, ~2200m above mean seal level) and western Trans-Himalayas (Hanle, ~4500m above mean seal level). PWV was found to exhibit a positive radiative effect of the order of 10 W m^{-2} at Nainital and 7.4 W m^{-2} at Hanle at top of the atmosphere (TOA). Vertical distribution of water vapour radiative effects revealed that the highest (~ −60 W m^{-2} at an altitude of ~2–3 km) water vapour radiative forcing rate is seen during the Indian summer monsoon (June to September) and the lowest (~ −20 W m^{-2}) during winter (December to February) **(Figure 31)**. The heating rates with the inclusion of water vapour show differences in the vertical profiles, with increases between 6 and 8 km during the summer months, while the heating rate profiles without inclusion of water vapour show a smooth increasing tendency with altitude **(Figure 32)**. **[Dumka, U. C.** et al. (including **Sheoran, Rahul**). (2022). *Atmos. Pollut. Res., 13*, 101303 (15 pp)**].**

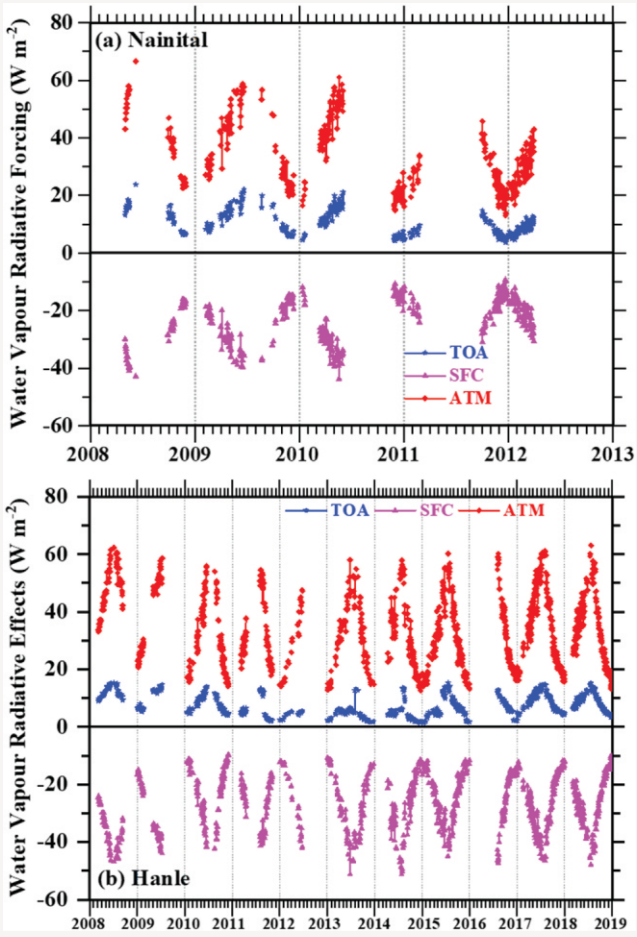

Figure 32. Water vapour radiative effect at surface (SFC), TOA and Atmosphere (ATM) over (a) Nainital in the central Himalayan region and (b) Hanle in the Trans-Himalayan region.

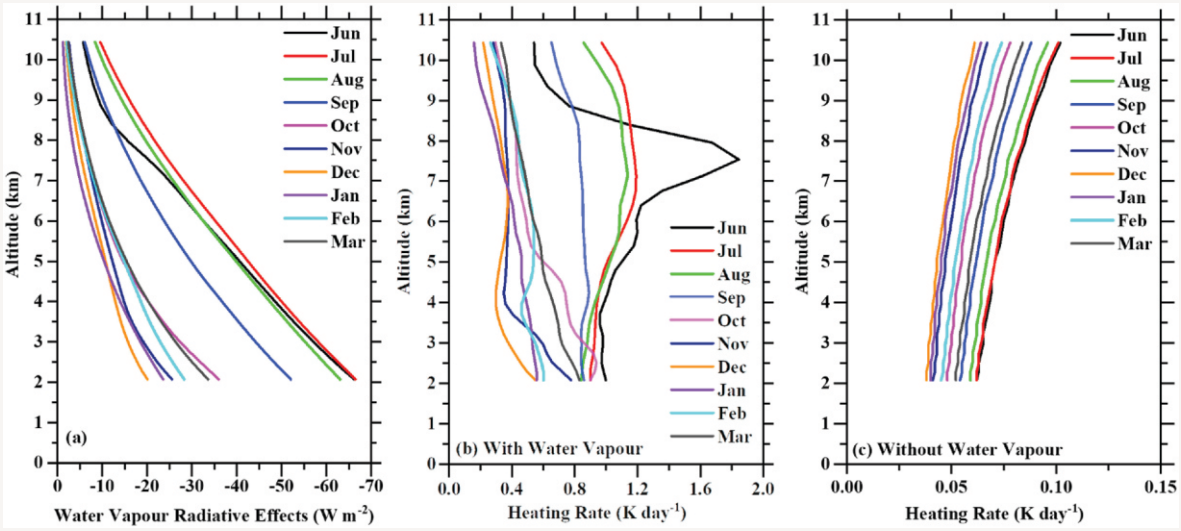

Figure 31. Monthly vertical profiles of water vapour radiative effect (a), heating rate profiles with (b) and without water vapour (c) over Nainital during June 2011 to March 2012 under the GVAX campaign.

Impact of aerosols and clouds on solar energy production over India

The attenuation of solar radiation reaching the earth's surface by aerosols, clouds, smoke as well as dust is manifested as change in global horizontal irradiance (GHI) and beam horizontal irradiance (BHI), which affects the efficiency of solar power plants. This was studied at a country scale using remote sensing techniques. On an annual basis, the aerosol attenuation was 105 kWh m^{-2} for GHI and 266 kWh m^{-2} for BHI, respectively. The corresponding cloud effect is much larger with 245 and 271 kWh m^{-2} for GHI and BHI, respectively. On annual basis, the financial losses (FL) on photovoltaic (PV) and Concentrated solar power (CSP) were found to be 8.5 million INR and 6.7 million INR respectively **(Figure 33)**. Further, during massive forest fires from January to April 2021, the total attenuation due to aerosols and clouds was 116 and 63 kWh m^{-2} for GHI and BHI respectively. The FL value was 8 million INR due to aerosols and 14 million INR due to clouds for the total Indian solar plants' capacity potential (40 GW). **[Dumka, U. C.** et al. (2021). *Remote Sensing, 13*, 3248 (19pp.); **Dumka, U. C.** et al. (including **Sheoran, Rahul**). (2022). *Remote Sensing, 14*, 549 (22pp)**].**

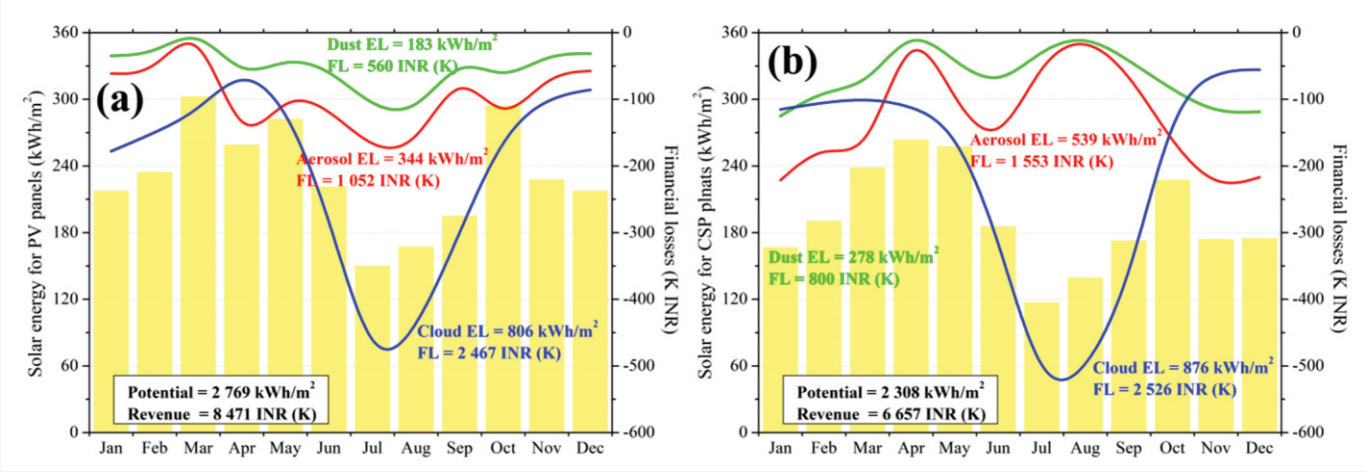

Figure 33. Financial analysis of aerosol, dust, and cloud impact on solar energy from CSP (a) and PV (b) installations with nominal power of 1 MW in the region.

Mountain meteorology and atmospheric transport processes

A dust storm over the central Himalayas was investigated using in situ measurements, satellite data, and model reanalysis. Results shown an enhancement in the dust from 1.5 to 2.5 Tg (~70%) over the northern Indian subcontinent, with about half of the contribution from the Thar Desert **(Figure 34)**. Dust storms also had significant impact on turbulent kinetic energy (2.9–9.6 m^2s^{-2}), vertical momentum flux (0.9–3.3 Nm^{-2}), and sensible heat flux (34.8 to −33.9 Wm^{-2}), suggesting turbulent mixing of

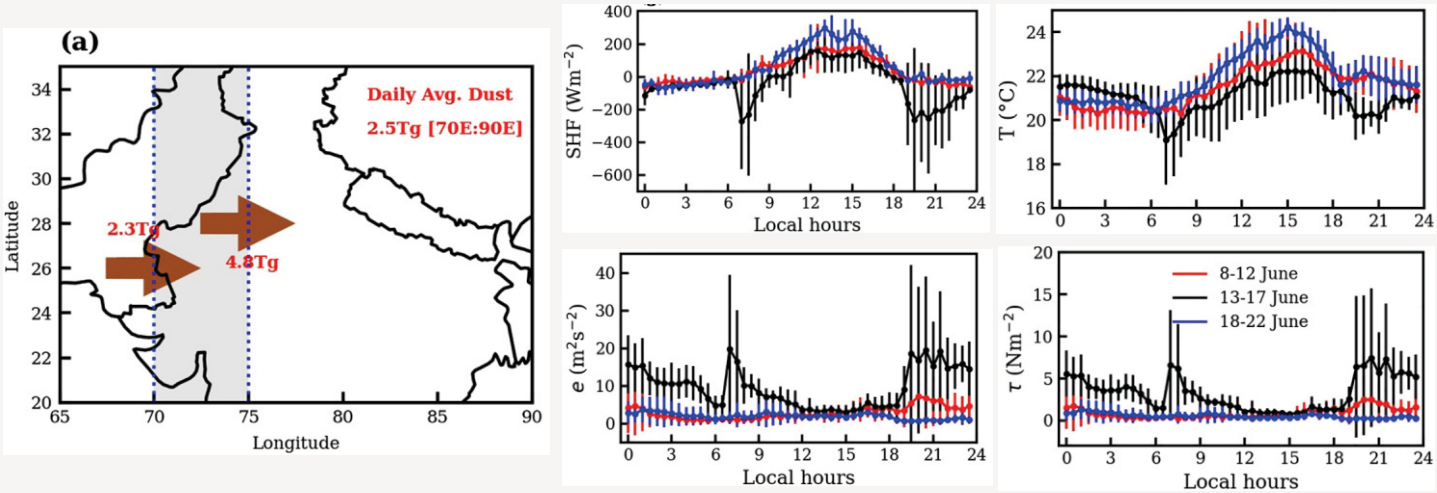

Figure 34. Estimation of dust budget before, during, and after the dust episode (13–17 June, 2018), sensible heat flux (SHF), turbulent kinetic energy, and momentum flux (τ) observed using a Sonic anemometer in the central Himalaya (Manora Peak).

aerosols and cooling near the surface. A systematic and reliable approach is needed along with a long-term data set to understand the mountain meteorology to improve weather forecasting. **[Singh, Jaydeep** & **Singh, Narendra** et al. (2022). *Earth and Space Science, 9*, e2021EA001702 (16pp)**].**

The crucial role of mountain meteorology in impacting physical processes such as atmospheric turbulence has been investigated. During weak synoptic flows, regional mountainous effects dominate due to vertical mixing of fluxes higher into the atmosphere. Strong synoptic flows suppress local effects in turbulence mixing and weaken the turbulence intensity. Thus, mountain barriers can modify the mechanisms of weather patterns relative to the background atmospheric conditions **(Figure 35)**. **[Rajput, Akanksha, Singh, N., Singh, Jaydeep** & Rastogi, S. (2022). *Jr. Atmos. Sol. Terr. Phy., 235*, 105895 (16pp)**].**

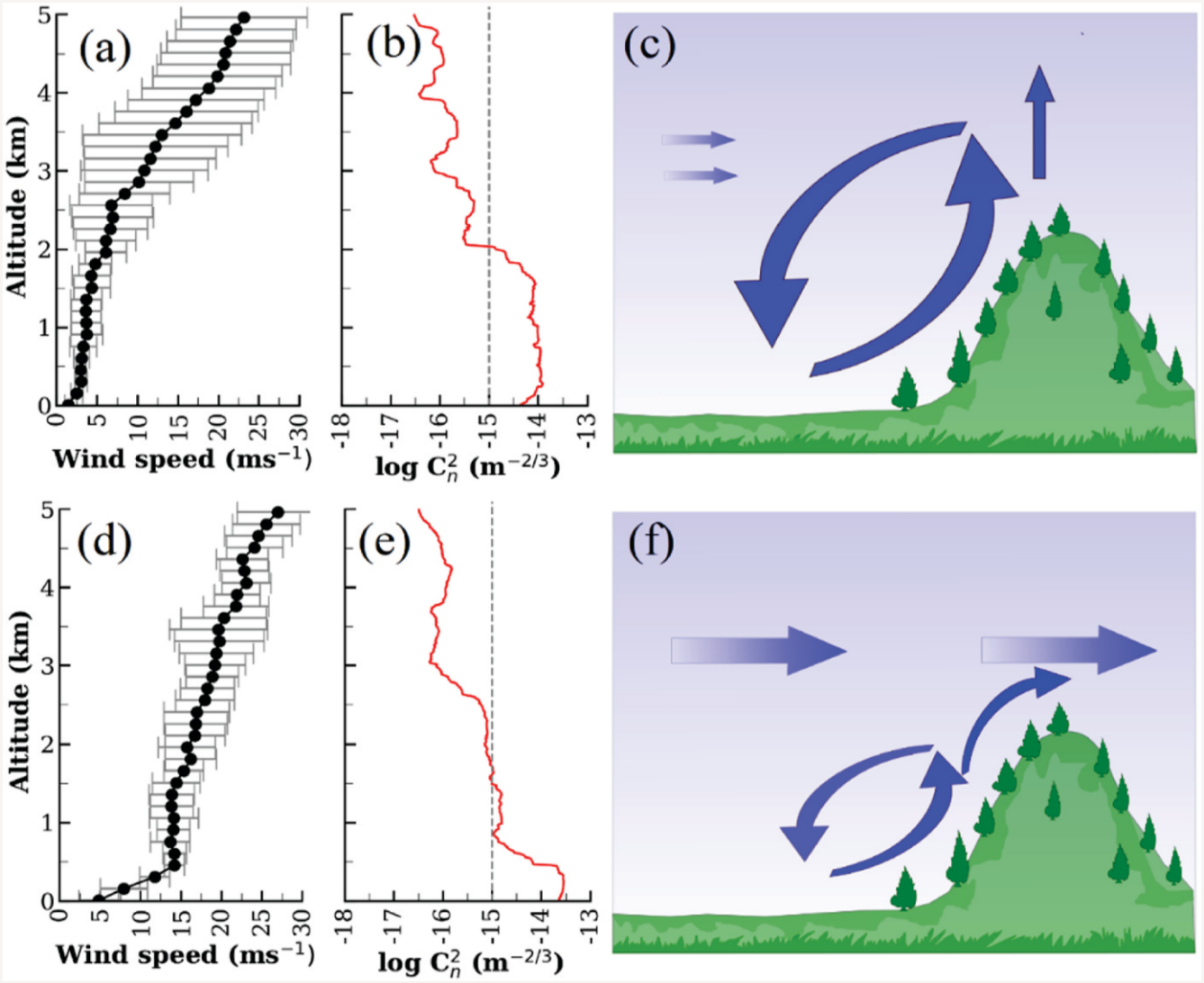

Figure 35. Schematic plot showing the change in turbulence intensity for weak (top) and strong (bottom) mountain-induced local circulation and synoptic flows.

Implications of site-specific Mass Absorption Cross-section (MAC) to black carbon observations at a high-altitude site in the central Himalaya

MAC derived using simultaneous observations (2014-2017) from an EC-OC analyzer and an Aethalometer (AE42) at Nainital. MAC shows significant monthly variations for all wavelengths with significantly lower annual mean (5.03 ± 0.03 m^2g^{-1}) than the value used by the instrument manufacturer (16.6 m^2g^{-1}) at 880 nm **(Figure 36)**. The seasonal variability of elemental carbon (EC), air mass variation and meteorological parameters play an important role in the changes in MAC. Multi-wavelength MAC shows the contribution of absorption by species other than EC at shorter wavelengths. The slope of EC vs corrected equivalent black carbon (eBC) showed a significant improvement during all seasons when compared with

uncorrected eBC **(Figure 37)**. This lends credibility to the fact that the use of site-specific MAC leads to more reliable estimates of eBC over the central Himalayan region. **[Srivastava, P.**, et al. (including **Naja, M.** & **Dumka, U. C.**). (2022). *Asia-Pacific Jr. Atmos. Sci., 58*: 83–96**].**

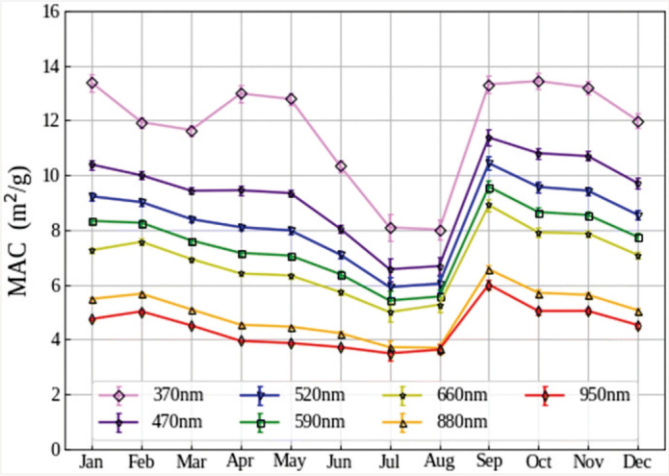

Figure 36. The monthly average variations (2014-2017) in MAC at seven wavelengths ranging from 370 to 950nm. Error bars for each point in the plot represent errors in the slope of the regression fit made for the absorption coefficient and EC for that month at a particular wavelength.

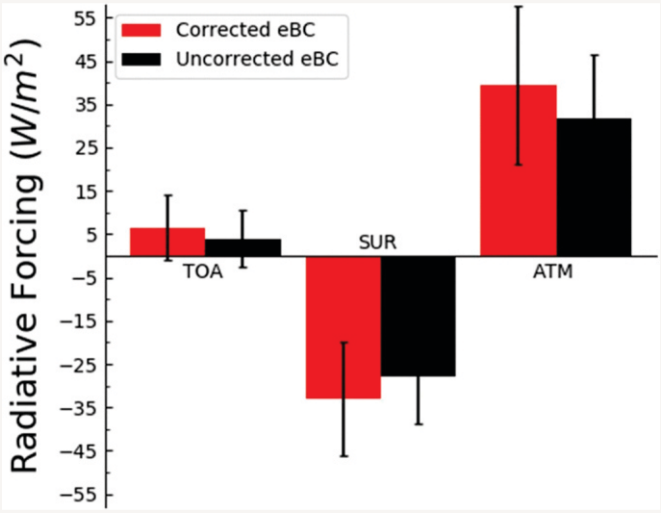

Figure 37. Diurnally averaged clear-sky shortwave (0.25–4.0 mm) direct aerosol radiative forcing (Wm^{-2}) at the SUR, in the ATM and at the TOA for corrected eBC and uncorrected eBC.

Trace Gases

Regional characteristics of seasonal and long-term variations in greenhouse gases at Nainital

Measurements of greenhouse gases (CO_2, CH_4, CO, H_2, N_2O, and SF_6) and carbon and oxygen isotopic ratios of CO_2 ($\delta^{13}C$-CO_2 and $\delta^{18}O$-CO_2) were done at Nainital from 2006 to 2021 and the factors behind their seasonal variations were investigated. Peak in CH_4 is mainly due to CH_4 emissions from paddy fields. Enhancements in N_2O coincided with the application of nitrogen fertilizers and the burning of biomass. H_2 emissions were related to biomass burning in addition to production from the reaction of OH and CH_4. SF_6 level was similar to Mauna Lao, suggesting few anthropogenic SF_6 sources. Variability of the CO_2 growth rate at Nainital was different from Mauna Loa, which is more closely linked to the El Niño–Southern Oscillation (ENSO). In addition, CH_4 and SF_6 growth rates were anti-correlated with those at Mauna Lao, indicating that the frequency of southerly air masses strongly influenced these. The findings showed that large regional climatic conditions considerably controlled interannual variations in GHGs, $\delta^{13}C$-CO_2 and $\delta^{18}O$-CO_2. **[**Nomura, S. et al. (including **Naja, Manish**). (2021). *Atmos. Chem. Phys., 21*, 16427–16452**].**

Distribution of HCHO, NO2 and water vapor

High precision balloon-borne measurements and satellite retrievals of water vapour were made. It is found that periods of organized summer monsoon convective activity over the Indian subcontinent and Bay of Bengal promote divergence of water vapour flux in Upper Troposphere (UT)/Lower Stratosphere (LS). The Tibetan anticyclonic circulation causes widespread distribution of the UT/LS water vapour. In addition to the Asian monsoon convection, global climate drivers such as ENSO, Brewer–Dobson circulation (BDC), and Quasi-Biennial Oscillation (QBO) can contribute to nearly 38% of the UT/LS water vapour variability over the Asian monsoon region. Widespread spatial distribution and accumulation of water vapour in the LS tend to co-occur with organized monsoon convection, intensified divergence of water vapour flux in the UT/LS and intensified Tibetan anticyclone. On the other hand, the circulation response and LS water vapour distribution to pre-monsoon localized deep convection tend to have a limited spatial scale confined to Southeast Asia. **[**Singh, B. B. (including **Naja, M.**). (2021), *Climate Dynamics, 57*, 1709–1731**].**

Remote sensing study of ozone, NO_2, and CO: some contrary effects of SARS-CoV-2 lockdown over India

Changes in emission sources during the lockdown in India were assessed using satellite data of ozone, NO_2 and CO with a primary focus on the tropospheric profiles of ozone and carbon monoxide (CO). A significant reduction (> 20%) in the tropospheric ozone was seen over northern and northeast regions compared to 2018, while a dramatic increase (> 20%) compared to 2019 was seen **(Figure 38)**. CO profiles showed a consistent increase (as high as 31%) in the free troposphere over the majority of cities and thermal power

plants. The CO total column also showed an increase (~20%) over central and western India and a slight decrease (5%) over northern India **(Figure 39)**. Similar to CO, an increase (~ 15%) of NO_2 column over the western region was observed. However, unlike ozone and CO, reduction of tropospheric NO_2 columns was seen over the major part of India, with the highest reduction over northern regions (20-52%). Contrary to surface-based studies, the present study shows an increase in CO, ozone (decrease), and NO_2 at several locations and in the free troposphere during the lockdown. **[Rawat, Prajjwal & Naja, Manish**. (2022). *Environ. Sci. Pollu. Res., 29*: 22515–22530**].**

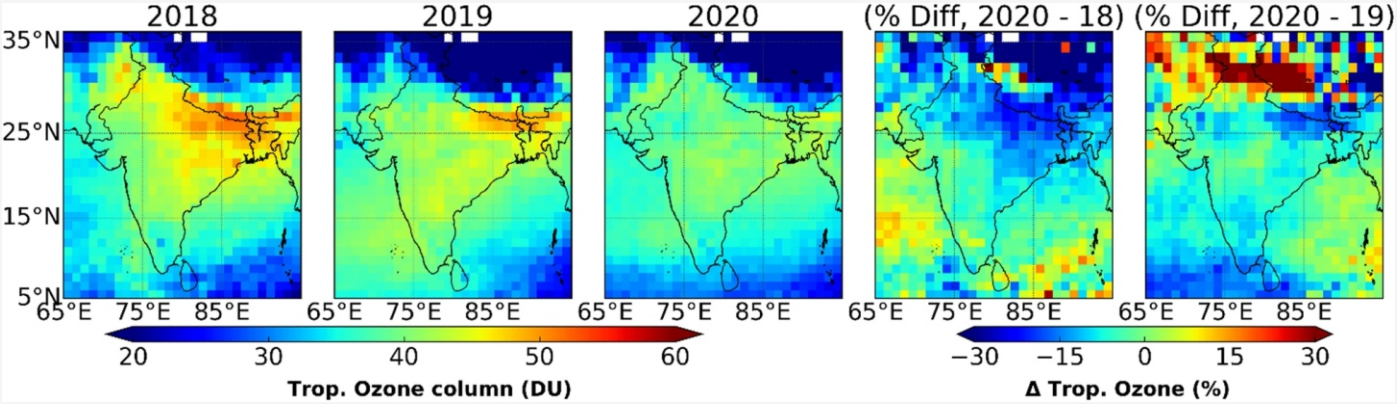

Figure 38. Tropospheric ozone column over India during 24 March - 20 April in 2018, 2019, and 2020 from IASI+GOME-2 synergic observations. Changes in the tropospheric ozone column are also shown.

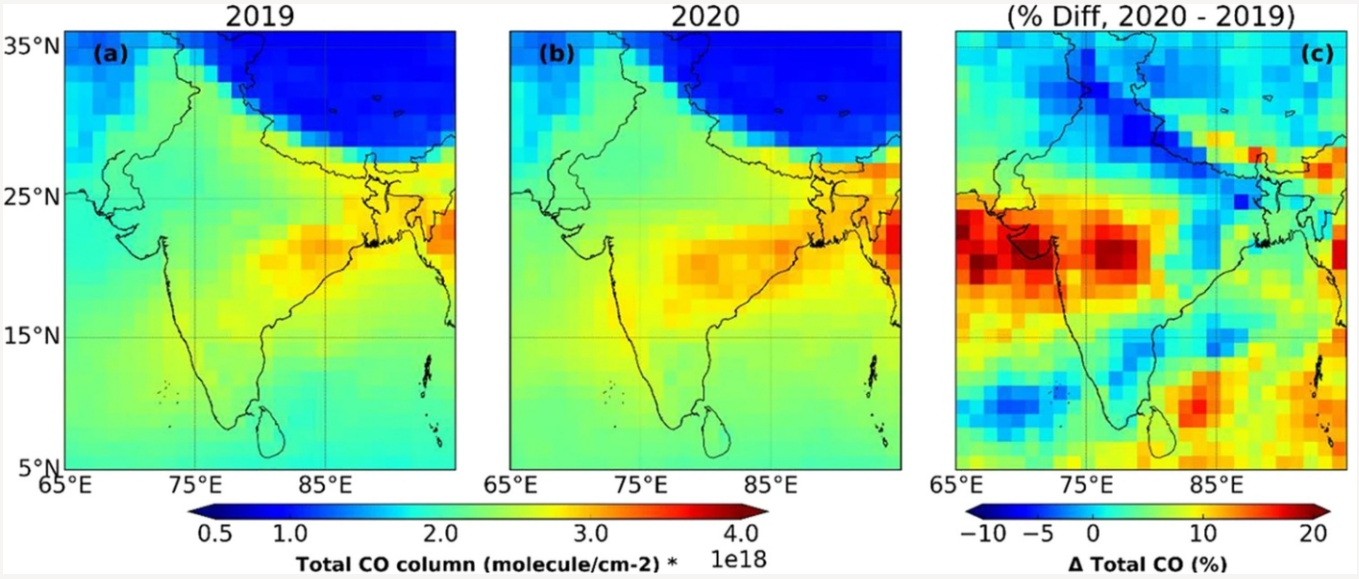

Figure 39. TROPOMI total CO observed in (a) 2019 and (b) 2020 during lockdown period (24 March – 20 April) in India. (c) The percentage difference between 2020 and 2019 is also shown.

List of Publications

Refereed Journals

Astronomy & Astrophysics

1. **Kumar, Amit,** et al. (including **Kumar, Brajesh, Pandey, S. B., Singh, Avinash, Aryan, A., Gupta, R. & Misra, K**.) (2021). SN 2020ank: a bright and fast-evolving H-deficient superluminous supernova. *Mon. Not. Roy. Astron. Soc., 502*, 1678-1693.

2. Mandal, A. K., **Rakshit, S.,** Stalin, C. S., Petrov, R. G., Mathew, B., & Sagar, R. (2021). Estimation of the size and structure of the broad line region using Bayesian approach. *Mon. Not. Roy. Astron. Soc., 502*, 2140–2157.

3. **Joshi, Raj K., Chattopadhyay, I.,** Ryu, D. & Yadav, L. (2021). Exact solution of one-dimensional relativistic jet with relativistic equation of state. *Mon. Not. Roy. Astron. Soc., 502,* 5227-5244.

4. Dutta, A., **Singh, Avinash**, Anupama, G. C., Sahu, D. K. & **Kumar, Brajesh**. (2021). SN 2017hpa: a carbon-rich Type Ia supernova. *Mon. Not. Roy. Astron. Soc., 503*, 896–910.

5. Ding, X. et al. (including **Chand, H.** & **Kumar, S. R.**). (2021). Time delay lens modelling challenge. *Mon. Not. Roy. Astron. Soc., 503*, 1096–1123.

6. Bisht, D. et al. (including **Yadav, R. K. S.**). (2021). A deep study of an intermediate-age Open Cluster SAI 35 (Juchert 20) using ground-based imaging and Gaia EDR3 astrometry. *Astron. Jr., 161*: 182 (14pp).

7. **Paliya, V. S.** et al. (2021). The Central Engines of Fermi Blazars. *Astrophy. Jr. Suppl. Sr. 253*: 46 (16pp).

8. **Panchal, A. & Joshi, Y. C.** (2021). Photometric and spectroscopic analysis of four contact binaries. *Astron. Jr., 161*: 221 (14pp).

9. Nayak, P. K. et al. (including **Bandyopadhyay, A.**). (2021). UVIT-HST-Gaia-VISTA study of KRON 3 in the Small Magellanic Cloud: A cluster with an extended red clump in ultraviolet. *Mon. Not. Roy. Astro. Soc., 503*, 5291-5309.

10. Bisht, D., et al. (including **Yadav, R. K. S.**). (2021). Multi-colour photometry and Gaia EDR3 astrometry of two couples of binary clusters (NGC 5617 and Trumpler 22) and (NGC 3293 and NGC 3324). *Mon. Not. Roy. Astro. Soc., 503*, 5929-5947.

11. **Lata, Sneh, Pandey, A. K., Pandey, J. C., Panwar, Neelam & Paul, Paulomi**. (2021). Photometric observations of NGC 281: detection of 228 variable stars. *Mon. Not. Roy. Astron. Soc., 504,* 101-117.

12. **Rakshit, S.** et al. (including **Paliya, V. S.**). (2021). TXS 1206+549: a new γ-ray detected narrow-line Seyfert 1 galaxy at redshift 1.34?. *Mon. Not. Roy. Astro. Soc. Lett., 504,* L22-L27.

13. Majumdar, S., et al. (including **Patel, R.**) (2021). Imaging and Spectral Observations of a Type-II Radio Burst Revealing the Section of the CME-Driven Shock that Accelerates Electrons. *Sol. Phys., 296*, 62 (16pp).

14. **Dastiar, R.,** et al. (including **Misra, K., Singh, M., Gangopadhyay, A., Kumar, B. & Pandey, S. B.**) (2021). The optical properties of three type II supernovae: 2014cx, 2014cy and 2015cz. *Mon. Not. Roy. Astro. Soc., 504, 1009-1028.*

15. Buckley, D. A., et al. (including **Omar, A.**) (2021). Towards a BRICS Optical Transient Network (BRICS-OTN). *Annals of the Brazilian Academy of Sciences, 93*, e20200917 (1-22 pp).

16. **Mishra, Sapna**, Vivek, M., **Chand, H.** & Joshi, R. (2021). Appearance vs Disappearance of broad absorption line troughs in quasars. *Mon. Not. Roy. Astro. Soc., 504,* 3187–3202.

17. **Rawat, N., Pandey, J. C. & Joshi, A.** (2021). TESS observations of TX Col: Rapidly varying accretion flow. *Astrophy. Jr., 912,* 78 (10pp).

18. Shanmugaraju, A., **Syed Ibrahim, M.,** Suresh, K., Vijayalakshmi, P. & Dhara, S. K. (2021). Temporal and spatial association between a solar flare, CME, and radio burst on 19 November 2013. *Solar Phys., 296,* 77 (17pp).

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(2021). HERMES spectroscopy of normal A and Am stars. *Mon. Not. Roy. Astron. Soc., 504,* 5528–5542.

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27. **Patel, R.**, Megha, A., **Shrivastav, Arpit Kumar, Pant, Vaibhav**, Vishnu, M., Sankarasubramanian, K., & **Banerjee, D**. (2021), Characterizing spectral channels of visible emission line coronagraph of Aditya-L1. *Front. Astron. Space Sci., 8*, 660992 (11 pp).

28. Bisht, D., et al. (including **Yadav, R. K. S.**) (2021). Detailed analysis of the poorly studied northern open cluster NGC 1348 using multi-color photometry and GAIA EDR3 astrometry. *Publ. Astron. Soc. Japan, 73,* 677-691.

29. **Gaur, H.**, Mohan, P. & Pandey, A. (2021). Breaks in the X-Ray Spectra of High-redshift Blazars and the Intervening Medium. *Astrophy. Jr., 914,* 46 (11pp).

30. Rani, S., et al. (including **Pandey, Sindhu**) (2021). UOCS. V. UV study of the old open cluster NGC 188 using AstroSat. *Jr. Astrophys. Astron., 42,* 47 (11pp).

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35. Kumari, N., Srivastava, A. & **Dumka, U. C.** (2021). A long-term spatiotemporal analysis of vegetation greenness over the Himalayan Region using Google Earth Engine. *Climate, 9,* 109 (21pp).

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42. Jadhav, V. V., **Pandey, S.,** Subramaniam, A. & **Sagar, R.** (2021). UOCS. IV. Discovery of diverse hot companions to blue stragglers in the old open cluster King 2. *Jr. Astrophys. Astron., 42,* 89 (14pp).

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46. **Mishra, S.,** Gopal-Krishna, **Chand, Hum, Chand, Krishna, Kumar, Amit & Negi, Vibhore** (2021). A search for blazar activity in broad-absorption-line quasars. *Mon. Not. Roy. Astro. Soc. Lett., 507,* L46–L51.

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48. **Banerjee, D.** et al. (including **Pant, V.**). (2021). Magnetohydrodynamic waves in open coronal structures. *Space Science Reviews, 217*:76 (37pp).

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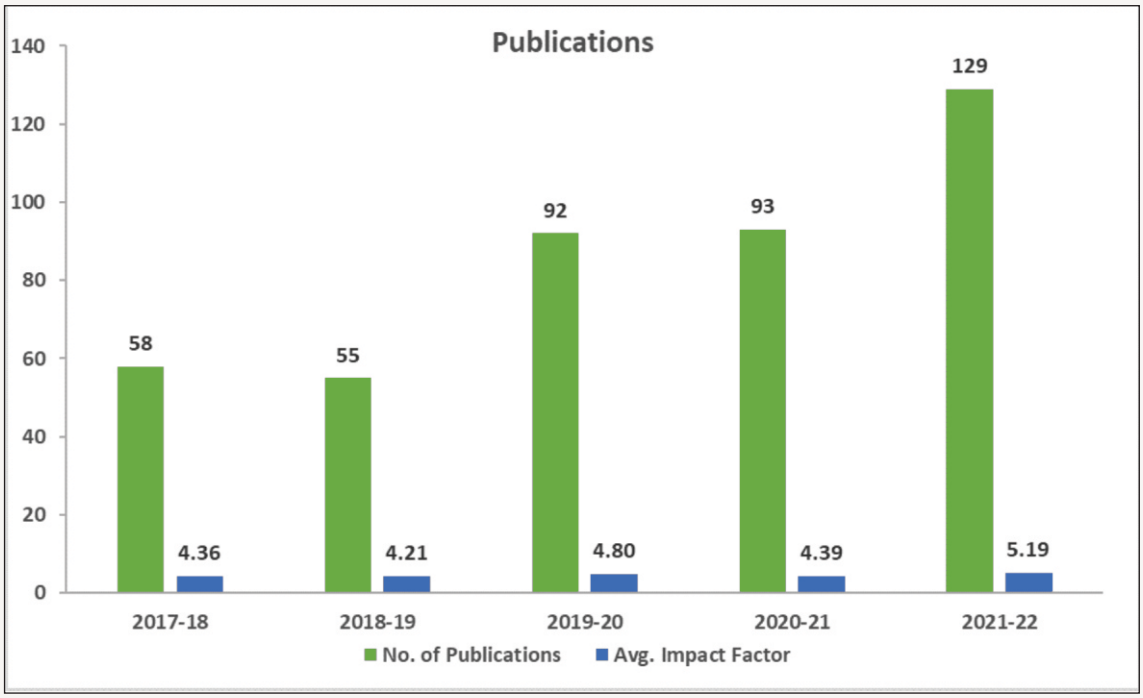
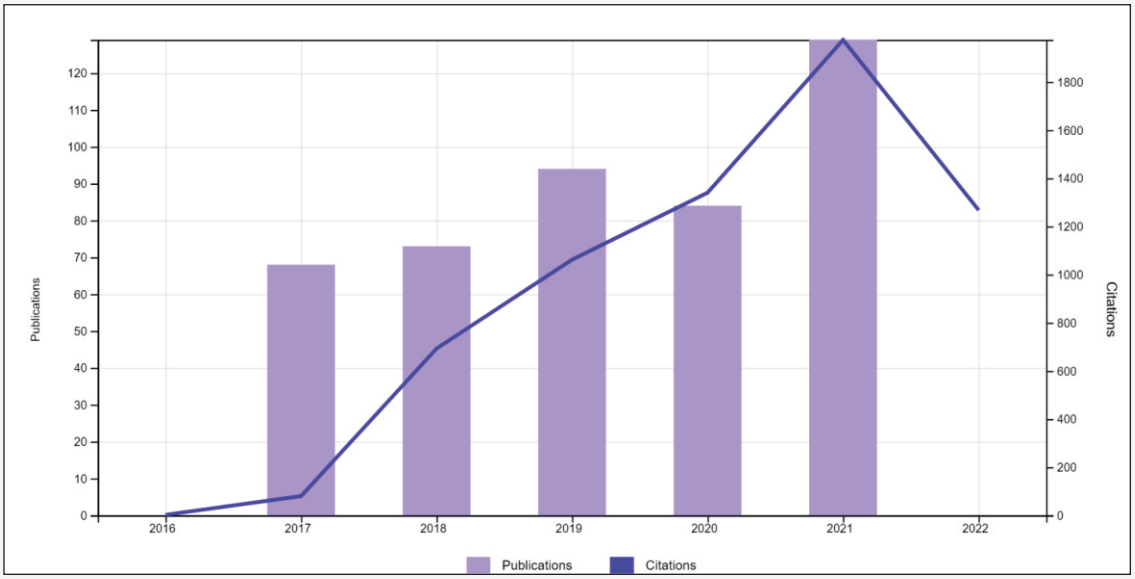




International and National Research Projects

Name of Project: Indo-Thai collaboration for studying pulsating variables at different evolutionary stages.
Co-PI (ARIES): Santosh Joshi
PI of the Collaborating institute: Aruna Goswami, IIA, Bengaluru and David Mkrtichian, NARIT, Thailand
Funding Agency: DST, Govt. of India
Project Code: DST/INT/Thai/P-16/2019

Name of Project: Belgo-Indian Network for Astronomy and Astrophysics (BINA)-2
P. I. (ARIES): Santosh Joshi
P. I. of the Collaborating Institute: Peter De Cat, ROB, Belgium
Funding Agency: DST, Govt. of India
Project Code: DST/INT/BELG/P-09/2017

Name of Project: Influence of massive stars on the formation and evolution of low mass stars.
PI (ARIES): Saurabh
PI of the Collaborating institute: Ramkesh Yadav, NARIT, Thailand
Funding Agency: DST, Govt. of India
Project Code: DST/INT/Thai/P-15/2019

Name of Project: International Liquid Mirror Telescope (ILMT).
PI (ARIES): Kuntal Misra
PI of the collaborating institute: Jean Surdej, University of Liège, Belgium
Funding Agency: ARIES (DST, Govt. of India), Belgium and Canada
Project Code: CSNOF-09

Name of Project: Probing of hot Jupiters environmental and physical conditions: numerical modeling vs observations.
PI (ARIES): Yogesh C. Joshi
PI of the collaborating institute: Navin Dwivedi, Space Research Institute, Graz, Austria
Funding Agency: DST, Govt. of India
Project Code: INT/AUSTRIA/BMWF/P-14

Name of Project: Probing fundamental characteristics of extreme astrophysical phenomenon.
PI (ARIES): Shashi B. Pandey
PI of the collaborating institute: IUCAA Pune, IIT Bombay, IKI Moscow Russia, SAAO and other institutes of South Africa
Funding Agency: DST, Govt. of India and BRICS consortium
Project Code: DST/IMRCD/BRICS/PILOTCALL1/PROFCHEAP/2017G

Name of project: An interdisciplinary study toward clean air, public health and sustainable agriculture: the case of crop residue burning in North India.
PI (ARIES): Narendra Singh
Funding Agency: Research Institute for Humanity and Nature (RIHN), Japan

Name of project: Indo-Uzbek proposal: search for variable stars in open star cluster.
PI (ARIES): Ramakant S. Yadav

PI of the collaborating institute: Alisher Hojaev, Ulugh Beg Astronomical Institute, Uzbekistan Academy of Sciences, Tashkent.

Funding Agency: DST, Govt. of India

Project code: INT/Uzbek/P-19

Name of project: Observations of trace gases at a high altitude site in the Central Himalayas.

PI (ARIES): Manish Naja

Funding Agency: Indian Space Research Organization (ISRO), India.

Name of project: Study of the aerosol characteristics over central Himalayas.

PI (ARIES): Manish Naja

Co-PI (ARIES): Umesh C. Dumka

Funding Agency: Indian Space Research Organization (ISRO), India.

Name of project: Atmospheric Boundary Layer Network & Characterization: Network of Observatories for Boundary Layer Experiments (ABLN&C: NOBLE).

PI (ARIES): Narendra Singh

Funding Agency: VSSC, ISRO, Trivandrum

Name of Project: Probing Influence of radiative feedback in massive star-forming complexes.

P. I. (ARIES): Neelam Panwar

Funding Agency: SERB (DST)

Project Code: CRG/2021/005876

Name of Project: Study of Stability and Outburst in Luminous Blue Variables (LBV).

P. I. of the Collaborating Institute: Abhay Pratap Yadav, NIT, Rourkela

Co-P.I. (ARIES): Santosh Joshi and Yogesh C. Joshi

Funding Agency: SERB (DST)

Project Code: CRG/2021/007772-G

Name of Project: Supermassive black holes in AGN through spectro-polarimetry at 3.6m DOT using in-country developed spectrograph and camera.

P. I. (ARIES): Suvendu Rakshit

Funding Agency: SERB (DST)

Project Code: SRG/2021/001334

Highlights from Engineering Division

The engineering division was setup as a multi-disciplinary group to cater toward the instrumentation and functional requirements of the institute. The resources, such as the laboratories, skill sets and tools, in the engineering division are centrally managed and available as a common pool. The division has four sections- Electronics and Electrical, Mechanical, Optics and Computer and each of these are managed by the section coordinators. All the sections have setup common area/laboratories for shared access of the available design and development tools like software, hardware etc. The tasks are handled in project or mission mode and resources are used dynamically based on the availability and skill sets required. Each member of the division takes responsibility to deliver the projects. Tasks such as managing the overall site activities, planning the preventive maintenance of overall facilities, managing the overall project, work of system engineering etc. are smoothly managed by the division.

Electronics/Electrical section

The electronics section caters toward instrumentation requirements for the observational facilities. Currently, the atmospheric section activities are handled by dedicated laboratory in the ASTRAD building and other support laboratories. Thus, the electronics laboratories under electronics section mainly caters towards telescope facilities and consists of motion control laboratory, opto-electronics laboratory and backend instrument laboratory. The laboratories are equipped with ESD safe environment and share a common set of sophisticated measurement tools like MSO, arbitrary waveform generator, programmable precision power supply, precision LCR meter etc. Also CAD software for PCB design, electrical design and electro-mechanical design are available. Additionally the electrical section caters toward reliable power supply and uninterrupted availability of UPS to run the facilities and sophisticated instruments at ARIES.

1) The motion control laboratory

This laboratory is established in the electronics section where motion controller are designed, developed, validated and implemented. For simulations Matlab environment is utilized, rapid prototyping and evaluating are done on hardware-in-loop setup and depending on the cost and complexities the controllers are implemented on both custom designed embedded boards as well as commercial-off-the-shelf (COTS) controllers. A section in the laboratory is purposed for training activities, another portion is used for CAD and fabrication activities to support electrical control panel development. Spare part of telescopes are stored in a separate inventory room which are periodically energized and tested in order to ensure their good health and understanding them. **Figure 40** displays the different areas of the motion control laboratory.

The CCD laboratory, software development and electronics laboratory for telescopes and instruments work toward integrated design and development work. At Devasthal campus, electronics maintenance and support laboratory is upcoming.

Figure 40. Motion control laboratory with designated areas for training, development, CAD and prototyping.

2) Opto-electronics laboratory

This laboratory is developed and led by electronics section and situated on the ground floor of the optics section. It is developed to support interdisciplinary design and development activities related to CCD imagers, wavefront sensors, profiling instruments and adaptive optics **(Figure 41)**. Using the required optical and opto-mechanical components, the profiler has been aligned and two simultaneous pupil images were taken. Recently, this lab was used jointly by engineers from optics, electronics, mechanical and software disciplines to develop a new sCMOS based auto guider system for the DOT. The details of the activities performed by each section is mentioned in the corresponding section reports.

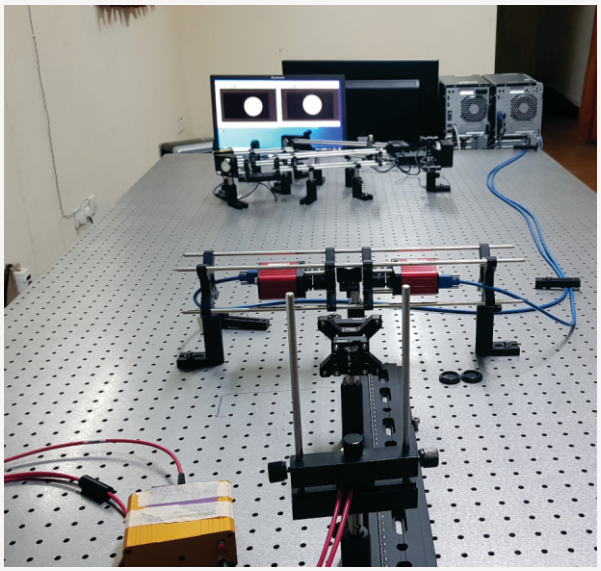


Figure 41. Adaptive optics and profiler setup.

3) Back instrument laboratory

This laboratory has been developed by renovating the old support lab of ST telescope and maintains ESD safe and humidity-controlled environment **(Figure 42)**. It is being utilized for maintenance and upgradation of backend instruments of all the telescopes. The laboratory has been provided with access to the backend instrument storage room to avoid exposure to static and humid atmosphere.

Figure 42. Backend instrument laboratory in ST telescope building.

4) Upgradation of observing facilities

A brief description of upgradation activities undertaken by electronics/electrical section are given below.

3.6m DOT

i) Electronics spares for DOT mirror control system including hexapod leg, M2 kinematic PC, M1 dispatcher PC, M1 transducers etc have been ordered. Other spares including the encoders, drives, micromotors, PLCs, M1 valves, etc. that were ordered in the previous year have been delivered **(Figure 43)**. It is important to maintain the control panel environment temperatures close to ambient. Hence, control panel accessories and consumables including panel temperature monitor, seals etc. have been ordered.

ii) Procurement of spare altitude and repair of azimuth motor have been initiated and being pursued with MACCON, Germany. However, due to heavy backlogs and supply chain uncertainties the firm is not ready to take up new orders.

iii) A **d**edicated all-sky camera has been installed on DOT building.

iv) Spare guider and WFS cameras are being developed with involvement from all other sections of the engineering division.

v) Under process: PLC and motion controllers upgradation work has been initiated and the controllers are being evaluated.

1.3m DFOT

The upgradation work on DFOT has been initiated. The new generation Linux based multi-axes controllers which have support within country are being procured. The delivery and training for these controller is expected in near future.

1.04m ST

The electrical distribution panels in ST have been replaced and upgraded with modern components.

4.0m ILMT

I) A temperature controller has been developed to monitor

the temperature near the rotating bowl of telescope which is logged wirelessly.

ii) The computer GUI used to operate the prime focus motion controller Socabelec panel has been upgraded. The GUI is used to monitor and adjust the optical focus of CCD remotely.

iii) A GPS and an all-sky camera have been installed for obtaining precise time stamp and sky condition respectively.

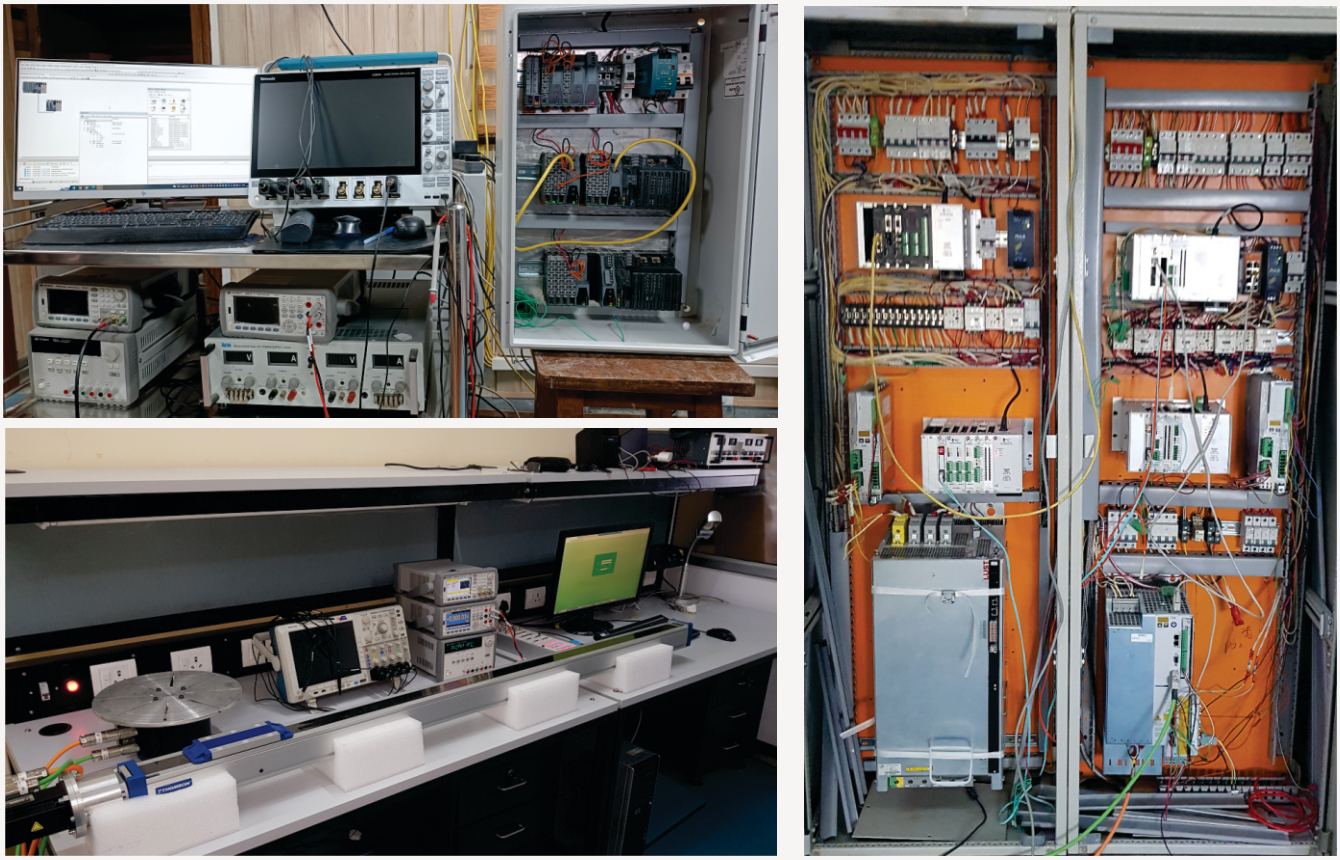


Figure 43. DOT PLC and motion controller spares being energised and evaluated and upgraded in the laboratory

Support facilities

Annual Maintenance Contract (AMC) for the support facilities like substations, DG sets and UPS systems etc. have been implemented. The batteries of the 100 kVA + 100 kVA UPS providing supply to DOT have been replaced after a period of 7 years. A new 20 kVA UPS has been procured and installed in the DFOT facility to replace the obsolete and faulty old UPS system. **Figure 44** displays the Supervisory Control and Data Acquisition (SCADA) based power distribution system for Devasthal and high capacity UPS systems.

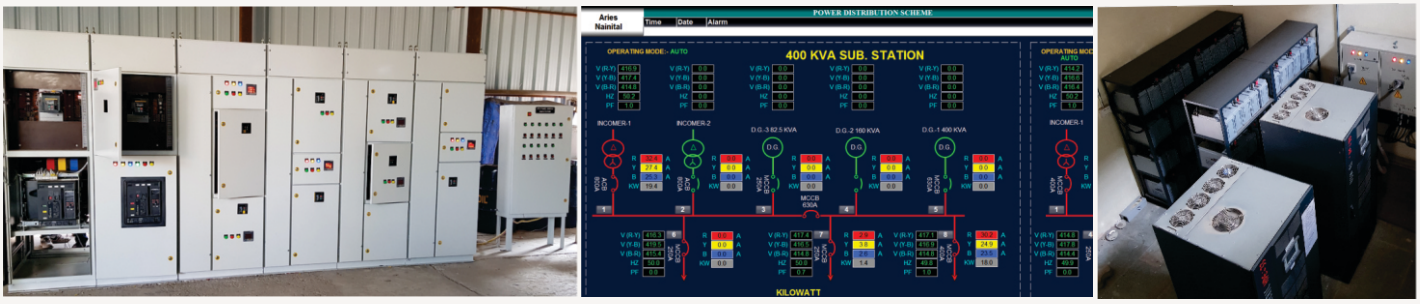


Figure 44. SCADA based power distribution system for Devasthal and high capacity UPS systems

Mechanical Engineering Section

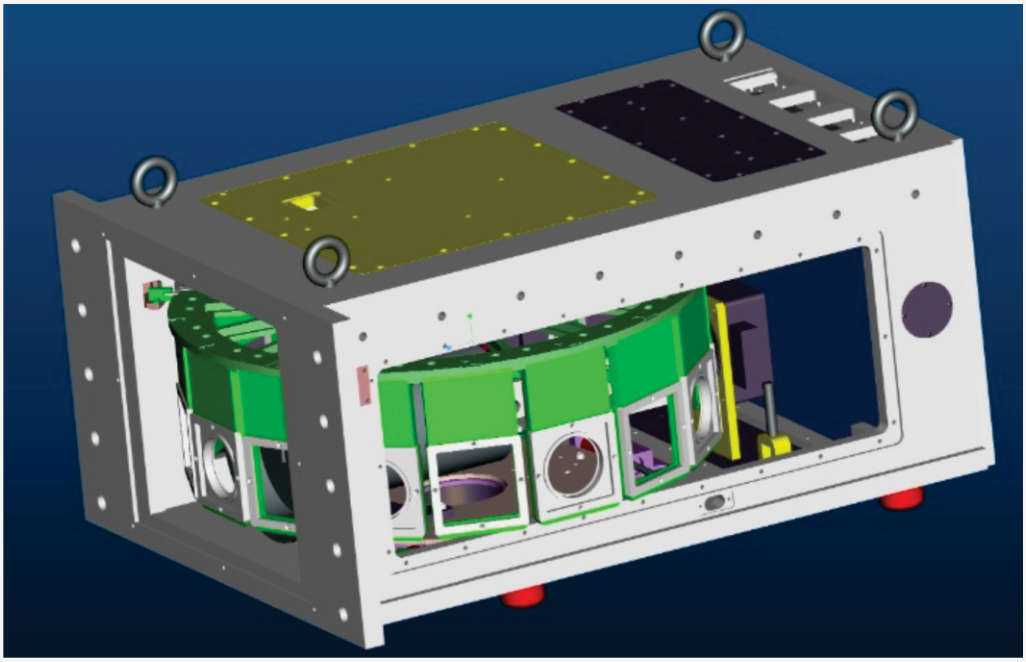
The mechanical section hosts the state-of-the art vertical machining center CNC and numerous conventional machines. A portable CMM is also available to measure the geometry of physical objects. Software such as Pro E, Unigraphics, Auto Cad, Ansys, and Master cam are regularly used for design simulation and computer-aided manufacturing of critical mechanical systems.

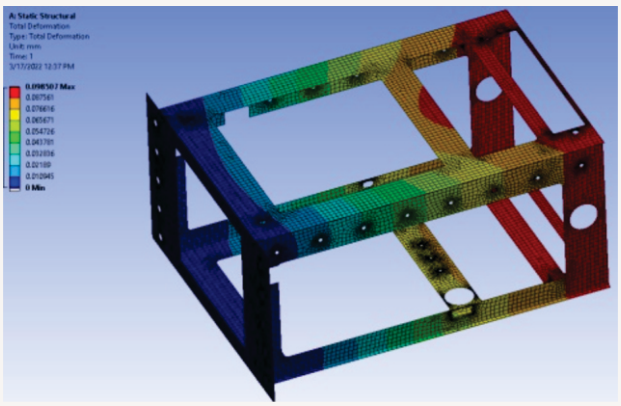
1) Side port imager for DOT

A side port imager is planned to be mounted on DOT. The concept design of the imager was finalized with a full-scale model including the Finite Element Analysis (FEA) and thermal analysis. This imager consists of a non-conventional filter wheel and a turret camera mount which requires crucial fabrication of the main structure in order to meet the requirements of the optical alignment. The main structure has been fabricated and machined in precise planar machines **(Figure 45)**.

2) AGU of DOT and wavefront camera replacement

The existing camera on the DOT AGU has become obsolete and requires replacement. Mounting the new camera demands a few design changes. Considering the space and size available for the new camera, spacer adaptor and support brackets were designed without changing mounting configurations in the AGU axis **(Figure 46)**. The AGU axis unit was successfully dismantled and replaced by the camera support using a CMM machine measurement.





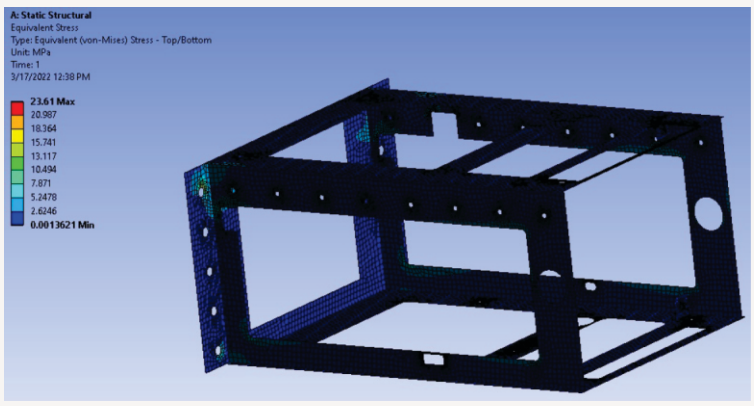


Figure 45. Top: Side port imager assembly on DOT and **Bottom:** FEA of the main structure.

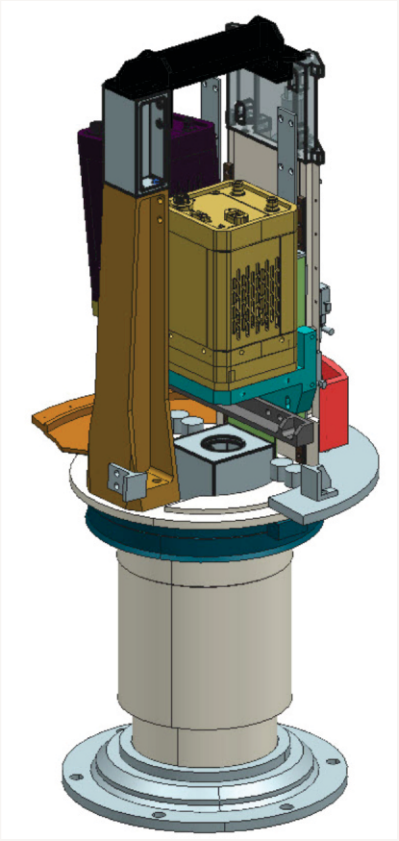


Figure 46. AGU axis with the new camera setup.

Figure 47. Prototype of the TRM unit, power splitter unit and dipole antenna.

3) Prototyping of ASTRAD subsystems

The ASTRAD has several sub-systems whose components will be obsolete in the coming years and will have to be replaced in a phased manner. To address this, the mechanical workshop manufactured the prototypes of the TRM unit, power splitter unit and dipole antenna using aluminium 6061t6 alloy in the CNC machine **(Figure 47)**. Mass production of these units for replacement will be undertaken in future.

Optics Section

The design, development, upgradation and maintenance of critical optical components of different facilities comes under the purview of the optics section. The optics lab is continuously upgraded, critical optical spares and general items are regularly procured.

1) Coating plants

Regular maintenance and health run of the DOT coating plant and the ST coating plant are routinely carried out. Complete servicing of vacuum pumps in both the coating plants was done to increase their life. A new industrial SCADA PC for the DOT coating plant was procured, integrated with the console and tested. The water leakage issue from the chiller unit of the DOT coating plant was attended and resolved. The air compressor was also serviced. New pirani and penning vacuum gauges were procured, installed and tested with the ST coating plant. Some small telescope mirrors were coated using the DOT coating plant.

The cleaning of DFOT primary mirror is carried out every year in the month of September, just before the observing season starts after the monsoon break. This is a complete in-situ cleaning without disturbing the M1 and its cell. The reflectivity log of the present cleaning and its comparison with the previous logs is shown in **figure 48**. The corrector lens and filters were also cleaned annually using distilled water.

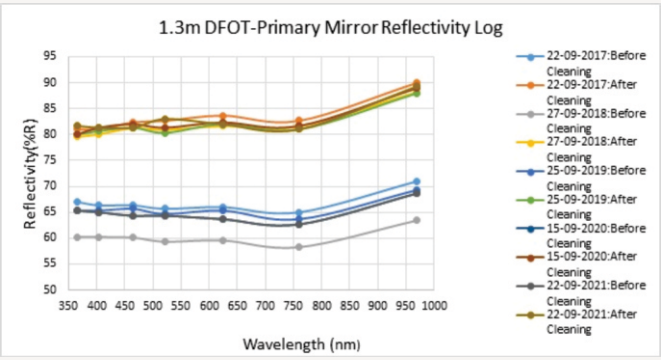


Figure 48. Reflectivity log of DFOT primary mirror.

In-situ CO_2 snow cleaning of the DOT primary mirror was regularly scheduled and carried out. The reflectivity logs were maintained after every cleaning. Five new CO_2 cylinders were procured to increase the frequency of in situ cleaning.

2) Back-end Instruments of DOT

The four primary back-end instruments on DOT were made ready for observations. Routine activities like evacuation of dewar, cooling, helium power lines routing, mounting of filters and mounting/unmounting of instruments on DOT were performed as and when required. Focus checks and generation of pointing model were done in the IVT nights. The cryo cooling/temperature information, cryo compressor pressure and heater power of these back-end instruments are recorded regularly and a common log was maintained.

A new cryo compressor was procured for ADFOSC. For the calibration unit, a new optical substrate was prepared and coated. With the help of the mechanical team, a new mounting was fabricated and assembled with the calibration unit. This has been tested during the observing cycle. For both ADFOSC and TANSPEC, spare spectral calibration lamps and their power supplies were procured and tested in the lab. A new set of UBVRI and SDSS filters were procured for the IMAGER.

3) Upgradation and future activities

Upgrades in ADFOSC

I) Two compound non-deviating prisms were designed for slit less low resolution spectroscopy with ADFOSC and their procurement/ manufacturing was under progress. (ii) To upgrade the capabilities of ADFOSC, it was decided to add the spectro-polarimetric mode which requires a wedged wollaston prism and a quarter waveplate. The final design and simulations of wedged wollstaon prism were completed and the procurement of the same is under process. (iii) Since a new 4kx4k side port imager will be mounted on DOT, its usability with ADFOSC as a backup was worked out. To use this camera with ADFOSC, a separate corrector is needed to match the image quality requirement. Considering the parameters of the new camera, a corrector was designed and optimised without disturbing other optics of ADFOSC.

AGU of DOT

To replace the old AGU camera with the new one, simulations of the optical design were performed using the existing information of guider optics. Dummy cameras, following the new camera dimensions, were manufactured with the help of mechanical team and several issues/challenges were identified and resolved to mount the new camera. It was decided to procure the optical components of the auto guider optics.

Two identical Andor Marana 4.2B-6 cameras have been procured to replace the existing AGU camera and the one used in WFS. A compatible interface flange was also procured along with these cameras to use with the existing guider and WFS optics. Detailed simulations were performed before finalising the interface and camera flanges. The new camera has already been integrated with the AGU and some test images were taken. Extensive testing of both the AGU and WFS with the new cameras will be done in the upcoming observing season.

Computer Section

The computing requirements of the institute are catered by the computer section. The primary goals of the section are (i) maintenance and upgradation of IT resources, (ii) support and development of hardware and software for research facilities, (iii) IT security and network datacentre management, (iv) support and management of web and application software (v) timely user support.

Major Tasks Accomplished

1) The high-end Surya High Performance Computing (HPC) facility (comprising 1 Master + 6 Compute nodes) has been set up at the ARIES datacenter, Haldwani **(Figure 49)**. This facility will handle the scientific and engineering computational requirements. For seamless running of the HPC facility, 2x20 KVA modular UPS system and 2x5 Tr Precision Air Conditioners (PAC) units have been installed. A new generation advanced firewall has also been installed for this facility.

2) Successful migration of ARIES website and database to

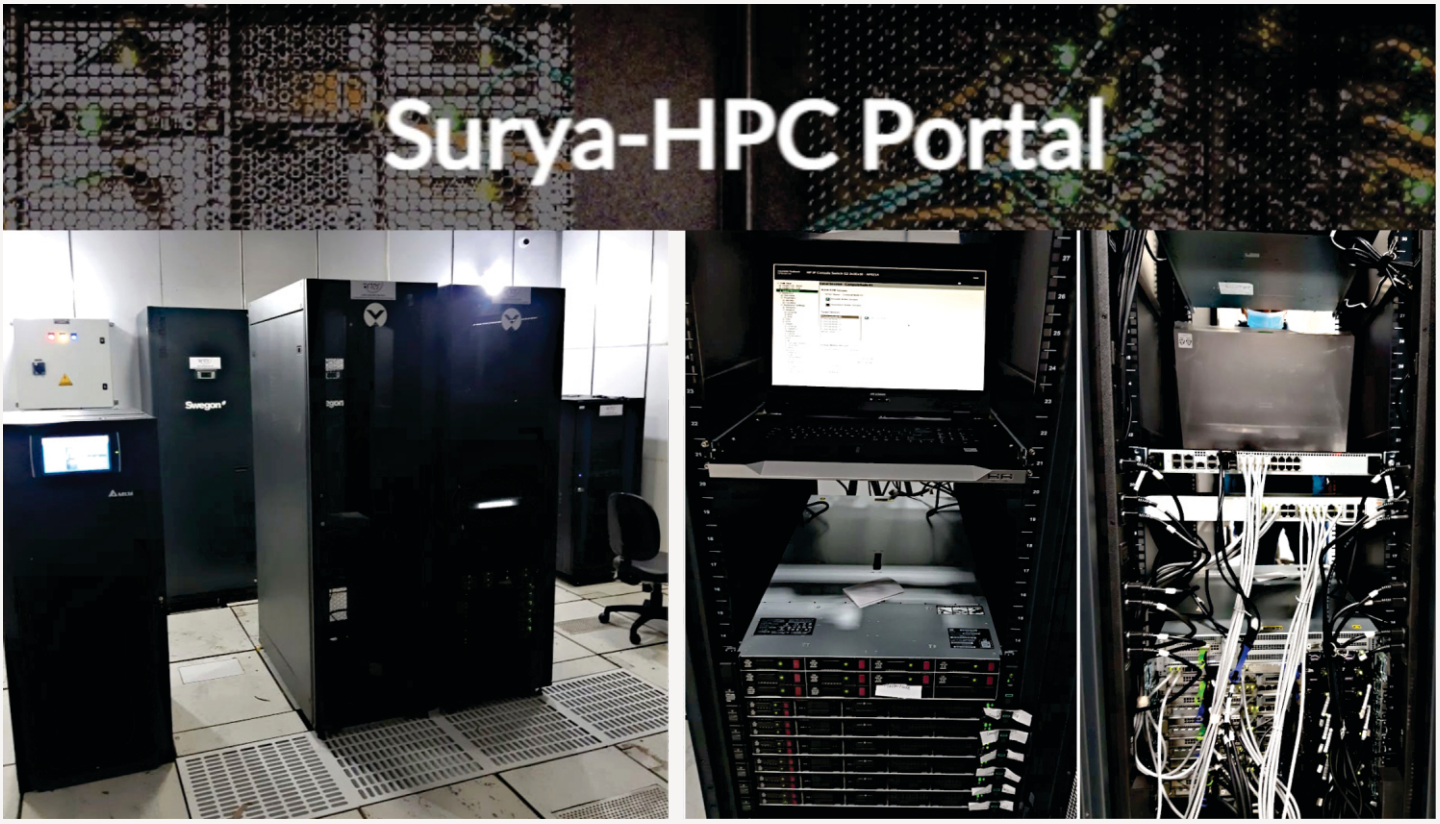


Figure 49. Surya HPC facility installed in the ARIES datacenter at Haldwani.

Amazon Web Services (AWS) cloud infrastructure **(Figure 50)**. The maintenance and upgradation are handled by the computer section.

Figure 50. Migration of ARIES website and database to AWS cloud infrastructure.

3) A Gigabit fibre optic redundant backbone and controller-based secure Wi-Fi network has been set up at the Manora Peak campus which offers a stable and reliable high speed wireless access.

4) Multiple web related activities such as development of online portals **(Figure 51)** and conference web pages were completed.

Figure 51. E-Admin online portal of ARIES.

5) Paperless recruitment portal through webforms and databases was implemented **(Figure 52)**.

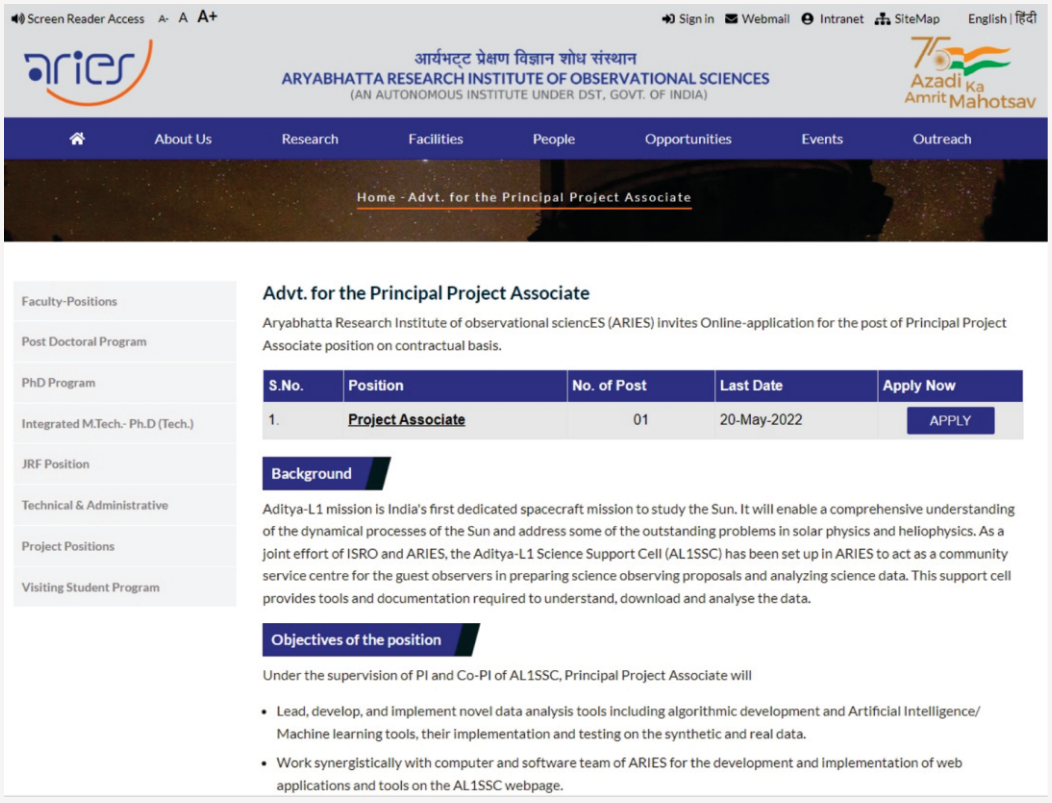


Figure 52. Recruitment portal.

6) The implementation of an Enterprise Resource Planning (ERP) solution was in full swing. This will automate the institute's workflow and reduce the usage of paper.

7) A new 20 Mbps Internet Leased Line has been commissioned successfully at ARIES datacenter, Haldwani.

8) NIC's Kavach App, a two-factor authentication tool was implemented for secure E-mail access.

9) Repair, maintenance, upgradation and deployment of CCTVs.

10) New networking has replaced the old one at several places in the campus.

11) The audio-visual devices and digital displays/panels for hybrid sessions were installed in the meeting rooms.

12) Hardware and software upgradations of the telephone exchange (PBX) system were done and the renovation of the telephone lines and MDFs was in progress.

13) Handling social media platforms of ARIES, recording and processing of seminars/colloquia, live streaming of events, capturing and processing of night sky events images etc.

Involvement in Major Projects

1) Involvement in the ARIES data archival project to develop the web page, design of database and its deployment, and server management.

2) The computer/IT aspects of the HRS which is under development will be worked out by the team.

3) Continuous software development related to the major observational facilities both in astronomy and atmospheric sciences were taken up.

4) A high-precision GPS/GNSS station was established at Devasthal **(Figure 53)**.

Figure 53. Installation of GPS/GNSS station at Devasthal.

Reports form Existing Observing Facilities

3.6 m Devasthal Optical Telescope (DOT)

ARIES operates India's largest 3.6 meter Devasthal Optical Telescope (DOT) at optical and near-infrared wavelengths as a National Facility and hosts a suite of complex instruments, a mirror coating plant, and a control room. The observing time on DOT is shared between India (93%) and Belgium (7%). On average, the night-sky was fully clear for about sixty percent of the time during April 2021 to March 2022 excluding the monsoon period.

The four core teams for the overall functioning and management of DOT are (I) DOT-team executing the day-to-day operation, maintenance and upgradation activities; (ii) Instrument-team accountable for the overall management of existing instruments (IMAGER, ADFOSC, TANSPEC and TIRCAM2) and development of future instruments; (iii) DOT Time Allotment Committee (DTAC) responsible for observing time allocation based on scientific merit of the proposal; (iv) DOT Operation, Maintenance and Upgradation (DOMU) committee to review the operation, maintenance and upgradation of both the telescope and back-end instruments. DOMU also advises ARIES on critical matters of concern.

The DOT activities are summarised below.

1) Observing period from April to May 2021

The TANSPEC was mounted on the main axial port of the telescope during this period. Due to COVID related restrictions, the telescope was mostly operated by instrument teams and internal observers from ARIES. Instrument verification tests and DTAC approved science observations were performed. Both the instrument and telescope worked fine. The TIRCAM2 instrument was mounted on the side-port1 and its functioning with the TANSPEC on the main-port was checked thoroughly for the first time. The cable routing and its movement during night observations and different pointings in the sky for both the instruments were successfully tested. The night sky condition during this period was very poor due to the occurrence of western disturbances and only about 20% of the nights were usable.

2) Non-observing Monsoon period (June to September 2021)

During the monsoon period at Devasthal from June to September, the telescope has to be protected from rain and high humidity and hence the telescope was parked. The monsoon period is extensively used for maintenance and upgradation activities on the telescope and back-end instruments. To maintain a reasonable humidity, de-humidifiers were installed inside the building. The gaps between rotating and non-rotating parts were filled with foams. A few parts of the telescope viz azimuth, altitude, rotator, adapter, sensor arm focus and turntable, M2 hexapod, and M1 mirror need to be moved fortnightly to keep good health of the telescope. The health of the telescope was recorded and checked on about half a dozen occasions. Training to the newly joined observing assistants was imparted on the operations and maintenance activities.

3) Observing cycle DOT-2021-C2 (October to January) and DOT-2022-C1 (February to May)

The science observing proposals on DOT were invited online via DOPSES (an online proposal submission and evaluation system) for the cycles DOT-2021-C2 and DOT-2022-C1 with deadlines of 2nd August 2021 and 01st December 2021, respectively. A total of 78 and 64 proposals were received in the cycles DOT-2021-C2 and DOT-2022-C1, respectively. The over subscription factor of the time demanded by the users was around 3 in both the cycles. The proposals were peer reviewed and the recommendations by DTAC for time allocation were provided to the scheduling team. The observing schedule was prepared by the DOT-team in consultation with the instrument-team. Appropriate time was structured for ICT, DDT, TMT and IVT. The DDT time of 10% was allocated as a quarter for every alternate night. Considering the COVID restrictions, the observations in cycle DOT-2021-C2 were done by ARIES in service mode whereas the restrictions were lifted in cycle DOT-2022-C1 and observations were done in visitor mode. The three main port instruments (IMAGER, ADFOSC, TANSPEC) and one side port instrument (TIRCAM2) were offered in these cycles for scientific observations. TIRCAM2 was available throughout the cycles. In cycle

DOT-2021-C2, the IMAGER was mounted during 1-5 Oct, 7-16 Dec, 27-31 Jan/20 nights, the ADFOSC during 17-26 Dec/10 nights and the TANSPEC during 6 Oct–6 Dec, 27-31 Dec, 1-26 Jan/93 nights on the main axial port. In cycle DOT-2022-C1, the IMAGER was mounted during 1-8 Feb/8 nights, the ADFOSC during 9 Feb–16 Mar/36 nights, the TANSPEC during 17 Mar-15 May/60 nights on the main axial port. Overall, in both the cycles observations were performed successfully with a technical downtime of less than five percent. It was decided to shorten the cycle DOT-2022-C1 by 15 days to accommodate the 4th M1 coating mission. **Figures 54 & 55** depict the various statistics during cycles DOT-2021-C2 and DOT-2022-C1.

4) Maintenance and upgradation work

Guider system of DOT: The guider camera of the telescope developed some technical issues during cycle DOT-2021-C1 and hence it was not available during the observing period from Oct 2021 to May 2022. In order to inspect the AGU, it was necessary to unmount the ARISS from the telescope. The engineering team planned to upgrade the AGU in a phased manner. In addition to the AGU, several other technical activities will be performed, in the following year, including installation of software for TCS, AOS and M2 computers.

The 4th M1 coating mission: The primary mirror (M1) of DOT is coated with bare aluminium and a freshly coated M1 has a typical reflectivity value between 85-88% at visible wavelengths. The M1 loses its reflectivity with time and it has to be coated at regular intervals. For typical dusty and humid sites such as Devasthal, a recoating may be required every alternate year. The current reflectivity of M1 is at the level of 45-50%, implying a sensitivity reduction by 0.75 magnitude. The recoating of M1 is a major task and during the current year a detailed planning for the 4th M1 coating mission was done by the engineering team. It was decided to execute the mission after the completion of cycle DOT-2022 -C1. Several preparatory activities including checks on overhead cranes, and dummy mirror rehearsal, were planned and executed during the period.

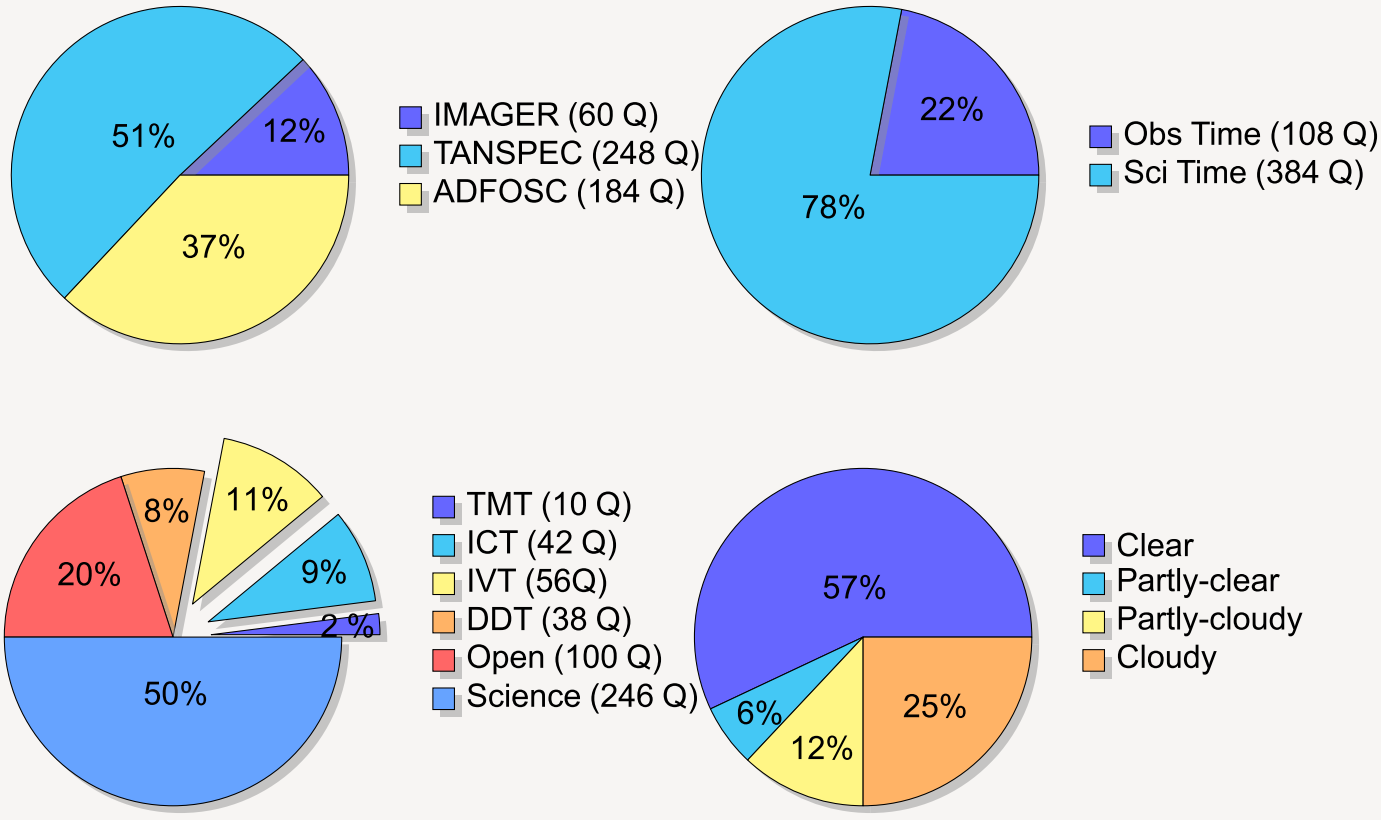


Figure 54. Statistics of main axial port instrument mounting, availability of telescope time, DTAC approved time allocation and sky condition for cycle DOT-2021-C2.

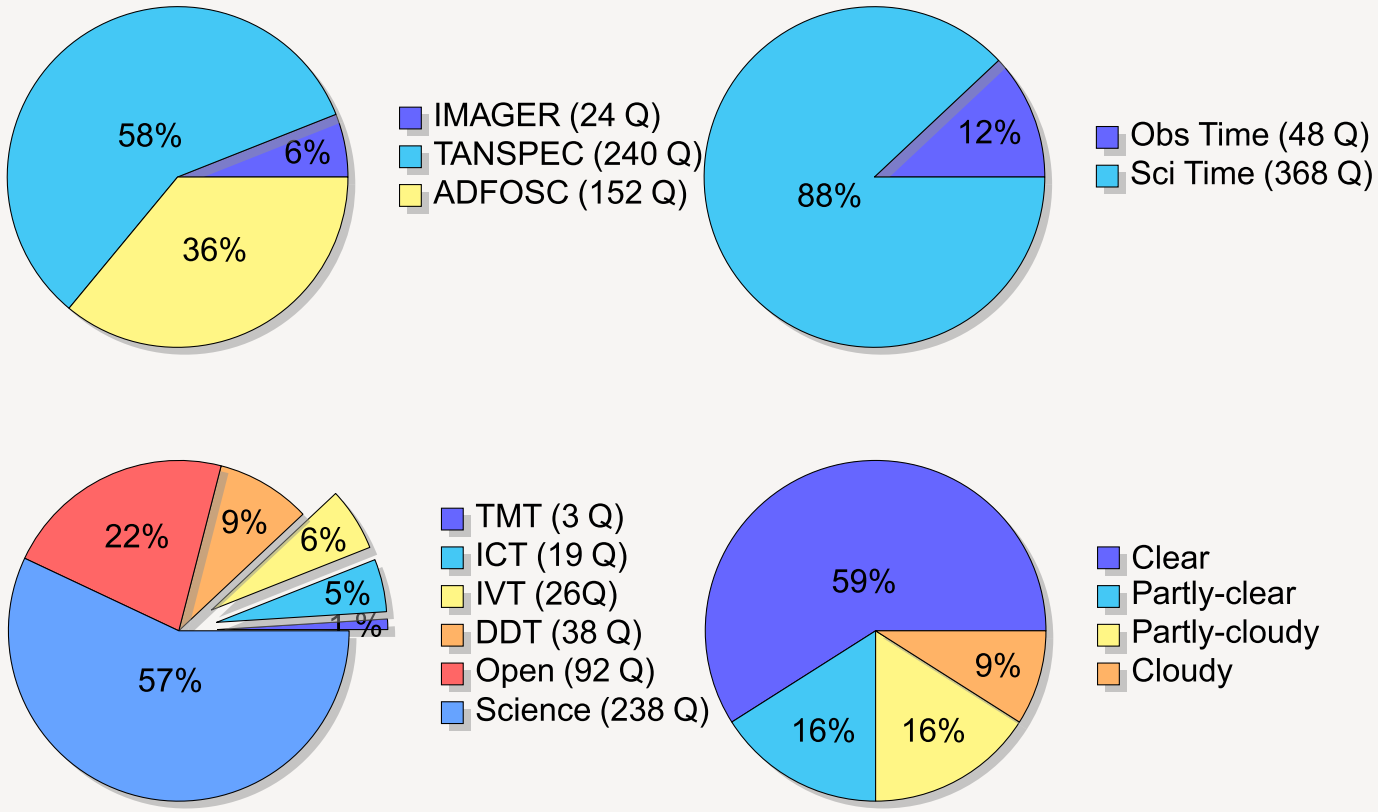


Figure 55. Statistics of main axial port instrument mounting, availability of telescope time, DTAC approved time allocation and sky condition for cycle DOT-2022-C1.

Backend instruments on DOT

4kx4k CCD IMAGER

During the two observing cycles, the 4kx4k CCD IMAGER was mounted on the main axial port and was fully utilised to obtain scientific data. The CCD characterisation and photometric calibration were performed using the data obtained in the IVT

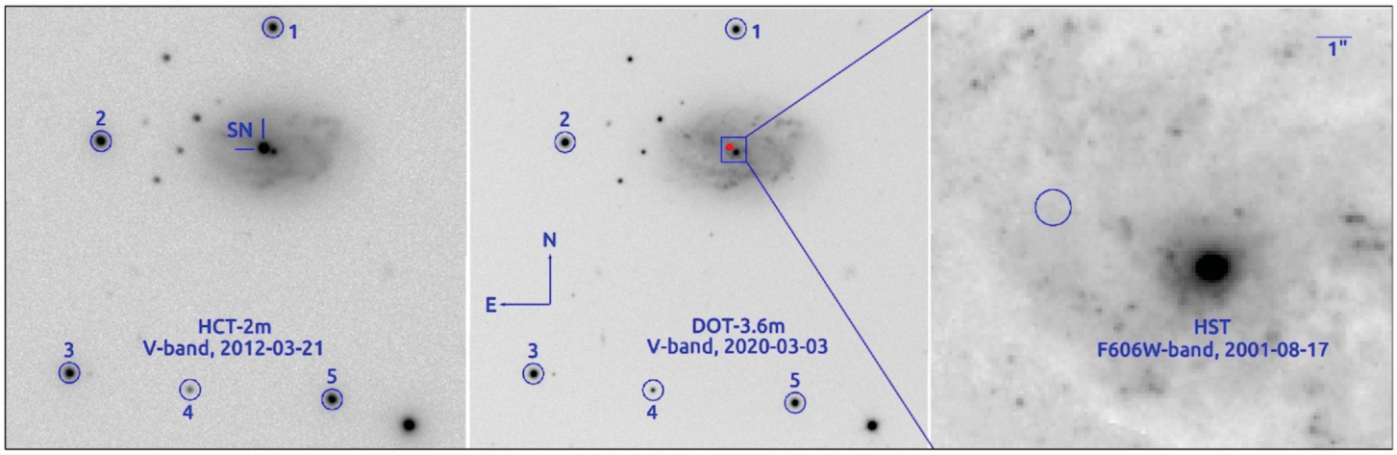


Figure 56. Identification chart of SN 2012au and local secondary stars (IDs 1–5). The V-band images obtained using HCT and DOT taken on 21 March 2012 and 03 March 2020 are shown in the left and middle panels, respectively. The FOV is roughly 3.5'x 3.5' and both images are astrometrically matched. The right panel shows a pre-explosion *HST* image observed on 17 August 2001, zoomed-in near the central region of the host galaxy NGC 4790. The SN 2012au location is marked in the left panel, and the same location is also indicated in the middle panel with a red dot after the SN has faded. The same location is shown with a circle (0.5-arcsec radius) in the pre-explosion *HST* image. North is up, and east is to the left.

nights between 2016-2022. The different combinations of gain and readout noise values, at three readout speeds, were measured and were found to be in agreement with the theoretical values. The extinction coefficients and sky brightness values were estimated at the DOT site using UBVRI observations of several Landolt standard fields. Using colour–colour and colour–magnitude transformation equations, colour coefficients and zero-points were determined. The long time baseline analysis exhibited consistency in the estimated colour coefficient values within 1σ and do not show any noticeable trend with time. The photometric errors and limiting magnitudes computed using this data followed the trends of the earlier estimates obtained using simulated data. The average extinction coefficients, their seasonal variation and zenith night-sky brightness values for the moon-less nights in different filters were found to be comparable with other good astronomical sites. **Figure 56** shows the SN 2012au field observed and calibrated with the IMAGER. The same field observed with the 2.0m HCT and *HST* are also shown. **Figure 57** shows another deep image of a young cluster NGC 1893 observed with the IMAGER where stars below V ~ 24 mag were also detected.

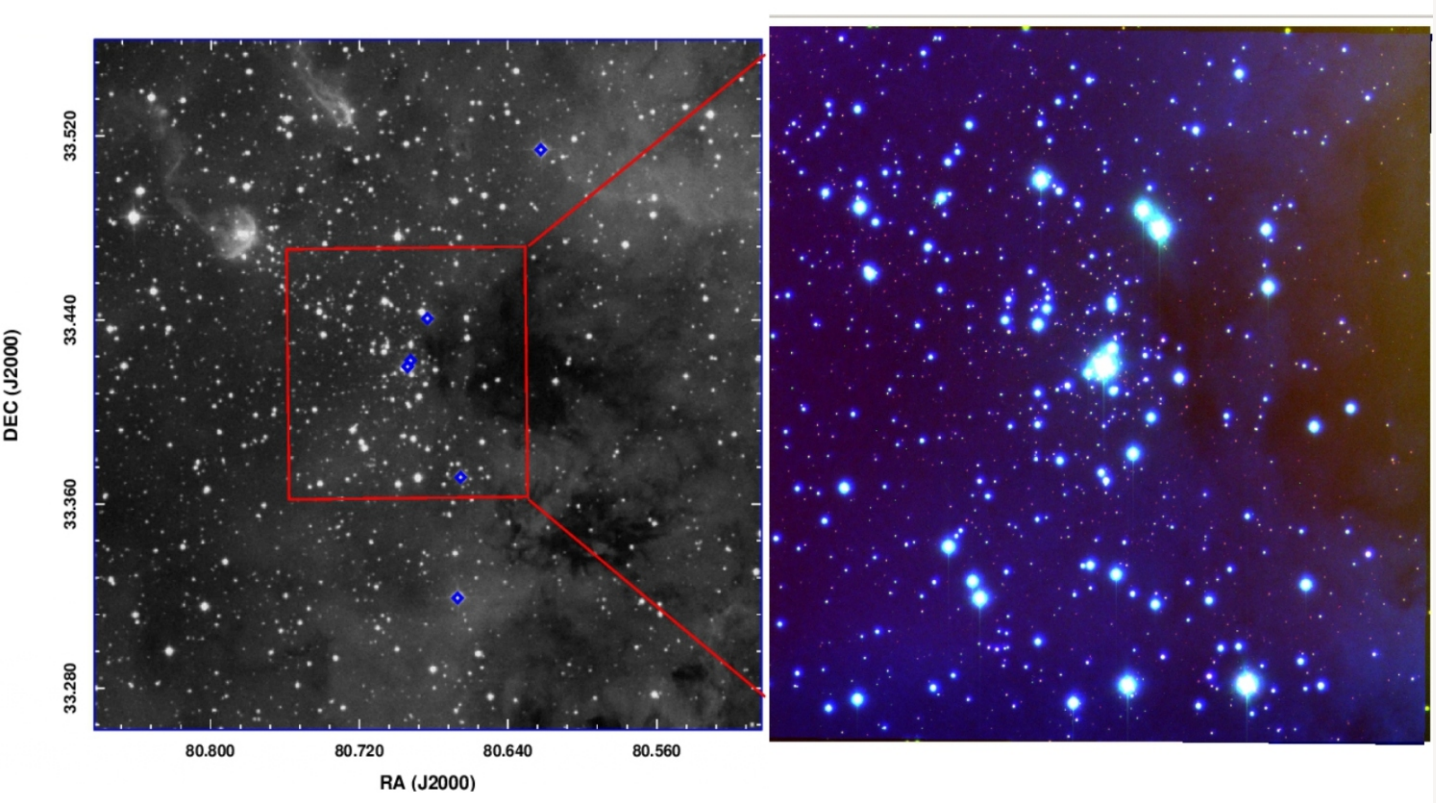


Figure 57. Left: DSS2-R band image of the NGC 1893 complex. Diamond symbols represent the locations of 'O' type stars in the region. **Right:** a colour-composite view of the central portion (1~6.5′×6.5′ FOV) of the cluster constructed using the DSS2-R (blue), 4K×4K CCD IMAGER V-band (green) and I-band (red) images.

ARIES Devasthal Faint Object Spectrograph & Camera (ADFOSC)

ADFOSC, a low resolution (R<2000) optical spectrograph and camera, was used in cycle DOT-2022-C1 for scientific observations as a main port instrument. The present setup of the instrument was planned to be upgraded by adding polarisation and medium dispersion modes of observing. This work was in progress during the year. **Figure 58** shows a deep image recorded, without the telescope guider, using ADFOSC on 14 March, 2022.

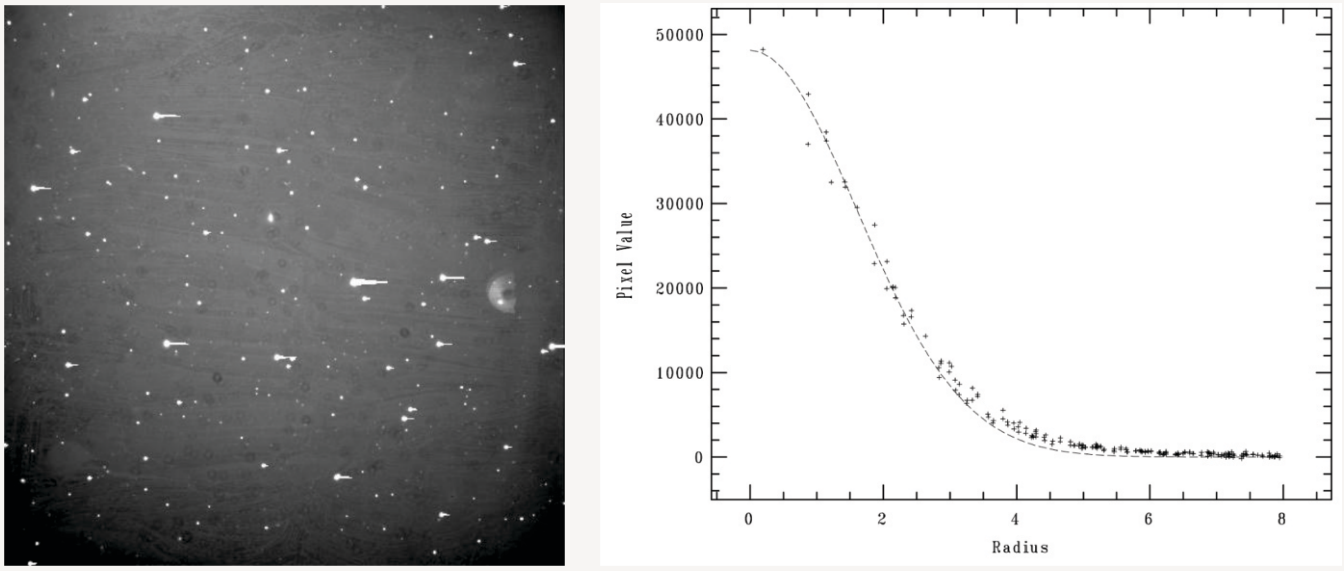


Figure 58. Left: A 15-min r-band image recorded with ADFOSC, without the telescope guider, on 14 March, 2022. The FOV is 13′×13′. **Right:** The PSF FWHM of the stellar profile was measured to be around 3.6 pixels, i.e. 1.4 arcsec.

TIFR-ARIES Near Infrared Spectrometer (TANSPEC)

TANSPEC, a unique spectrograph simultaneously covering the optical and near-infrared bands, has been the primary workhorse in the last two observing cycles of DOT without any down time. TANSPEC as mounted on the main axial port of DOT is shown in **figure 59**. Regular service mode observations were performed by the team for the scheduled observations with TANSPEC. A new pointing model was generated in October 2021 with rms of 1.4 arcsec. The performance of TANSPEC was found to be as per the specifications. Several calibration tests including sensitivity calculations and development of an exposure time calculator were completed. The data reduction pipeline for the cross dispersed (XD) high resolution mode was developed and released on github for use of the scientific community (https://github.com/astrosupriyo/pyTANSPEC). **Figure 60** shows the neon lamp spectra and the spectra of a WR star taken with TANSPEC in XD mode.

Necessary training was imparted to ARIES observers and observing assistance. A set of 5 detailed manuals were prepared and made available to the observers and the technical team. The required spares of the instrument have also been procured.

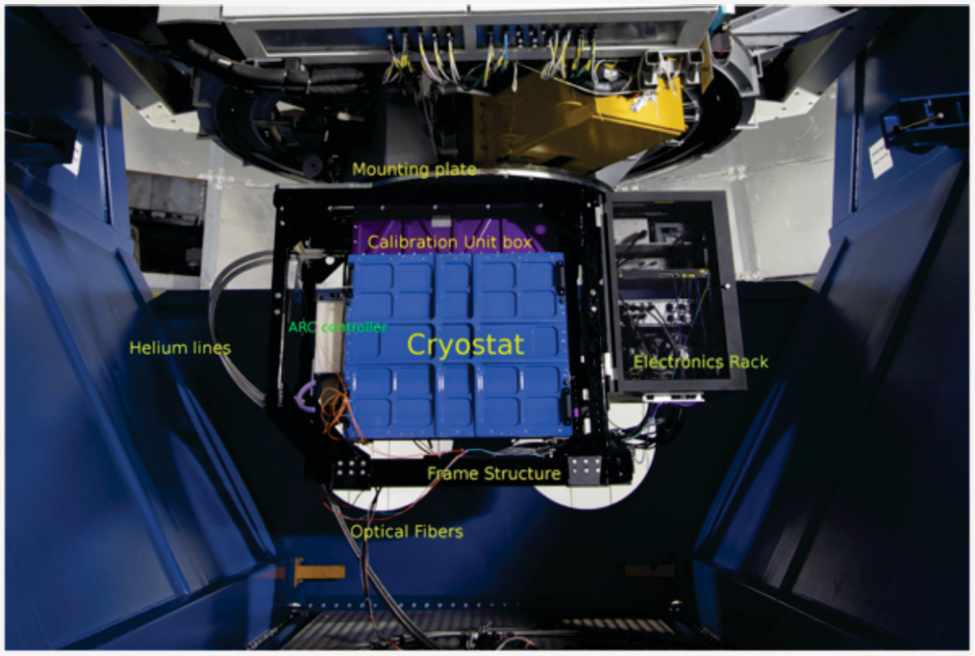


Figure 59. TANSPEC mounted on the main axial port of DOT.

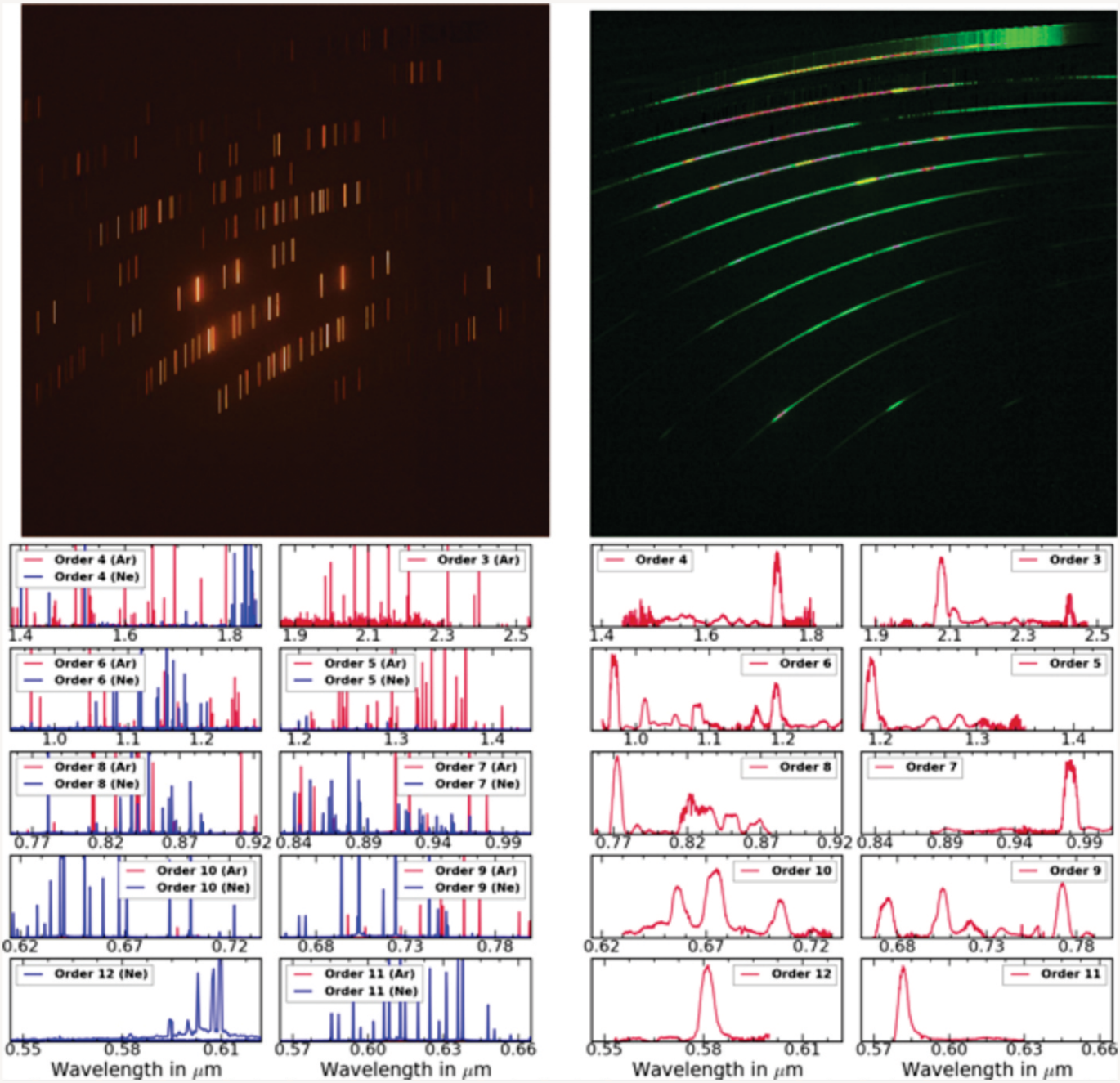


Figure 60. Images of the neon lamp spectra (top left) and the spectra of the WR star "HD 16523" (top right) taken through the TANSPEC in XD mode. The wavelength-calibrated spectra in different orders of the XD mode of the TANSPEC for neon/argon lamps (bottom left) and a WR star (bottom right).

TIFR Near Infrared Imaging Camera-II (TIRCAM2)

TIRCAM2 is an imaging instrument observing in the 1 to 3.7 micron wavelength range. In the last two observing cycles, TIRCAM2 was permanently mounted on the side port1 of DOT. For 6 months continuously it was kept ON (cooling ON) without any major issue. The performance of TIRCAM2 was as per the specifications. Observing and technical support was provided to the observers. Many lunar occultation events were observed with TIRCAM2 due to the newly installed software patch to readout frames at a faster speed of 10 ms.

Maintenance work like trouble shooting of a faulty computer, leakage in helium lines, tripping of TIRCAM2 during power failure etc. were regularly carried out. A complete set of 5 manuals were prepared and made available to the observers and technical team.

1.3m Devasthal Fast Optical Telescope (DFOT)

The 1.3m DFOT at Devasthal, India has been in operation for more than 10 years and is the primary facility for photometric observations of a wide range of scientific programmes carried out at ARIES. It is equipped with a CCD detector, a filter assembly having 8 filters, an auto-guider unit, an all-sky camera and a GPS enabled weather monitoring system to support the observations. A 2kx2k pixels imager or a 512x512 pixels frame transfer imager can be used interchangeably as the back-end instruments. The system is capable of producing sub-millimag photometric stability which has allowed detection of several small scale photometric variations.

The major scientific programmes being carried out with DFOT are monitoring of transients (GRBs, supernovae, extrasolar planets), variability of stars in the Milky-way, star clusters, episodic events such as AGN and X-ray binaries, deep imaging of star clusters, optical study of faint galaxies, etc. Total 211 observing nights were allotted in 2021-22 through observing proposals refereed by the Joint Time Allocation Committee (JTAC). Scientific data was collected in 150 nights whereas 59 nights were lost due to bad weather and only 2 nights were lost due to technical issues. More than 20 research articles and numerous scientific circulars and conference proceedings were published.

Preventive maintenance activities during the monsoon period and observing season were regularly performed. Additionally, to enhance the capabilities of the telescope, some major upgrades like (i) changes in the filter unit to minimize the filter change time between two successive observations, (ii) telescope electronics including the TCS and (iii) mounting of a large format 4kx4k CCD are planned in near future.

1.04m Sampurnanand Telescope (ST)

The 1.04m ST at Manora Peak, Nainital is being used as a major observing facility and will be completing 50 years of successful scientific observations since its inception in 1972. The two primary back-end instruments at the cassegrain focus of the telescope are– 4kx4k CCD imager and ARIES Imaging Polarimeter (AIMPOL) equipped with a PyLon CCD of 1300x1340 pixels.

The major scientific observing programmes were related to the studies of star clusters, young star-forming regions, optical variability in AGNs, optical counterparts of GRBs, supernovae and X-ray sources, and polarimetric study of star-forming regions and late-type stars. Total 196 observing nights were allotted in 2021-22 through observing proposals refereed by the JTAC. Majority of the nights were lost due to bad weather and useful data could be obtained only in 73 nights. About a dozen research articles and numerous scientific circulars and conference proceedings were published.

Preventive maintenance activities during the monsoon period and observing season were regularly performed. From the next observing cycle, an upgrade to the LN2 filling device and mounting/unmounting of the 4kx4k CCD with a vinzax trolley will be implemented.

ARIES Stratosphere Troposphere Radar (ASTRAD)

The ASTRAD fully designed and developed in India has been operational at 206.5 MHz for a significant period of time to achieve different scientific objectives. Despite the pandemic, extensive campaign mode and co-ordinated observations with other similar radars in the country were performed. **Figure 61** depicts the distribution of the observing hours with respect to the months in 2021-22. Some of the observing runs continued for several consecutive days in order to capture the diurnal cycle of specific atmospheric events.

During the activation of ASTRAD, presence of strong central patch in the Doppler spectrum like clutter close to 0 Hz was encountered. It became clear, with several experiment, that the reflected strength of the RF signal in the VHF band is significant due to the mountain terrain. Therefore, it was essential to install a metal fence to minimize the strength and to gain improvement in detectability of the weak backscattered atmospheric signal. A typical topography towards North of the radar site **(Figure 62a)** show that mountain peaks were much above the location of the antenna array. In contrast, the height of the mountain peaks towards south-east **(Figure 62b)** was down below the array location. After a detailed survey of the topography, the height of metal fence was finalised as 4 meters towards north and 3.5 meters in other three directions. The performance of the fence was tested by capturing the spectrum of one Transmit Receive Module (TRM) with one antenna when ~ 400 W peak power was radiated outside and within the fence. The strength of the patch close to 0 Hz was reduced significantly and became negligible with the fence.

ASTRAD observations were used to probe mesoscale dynamics of severe deep convective systems in the pre-

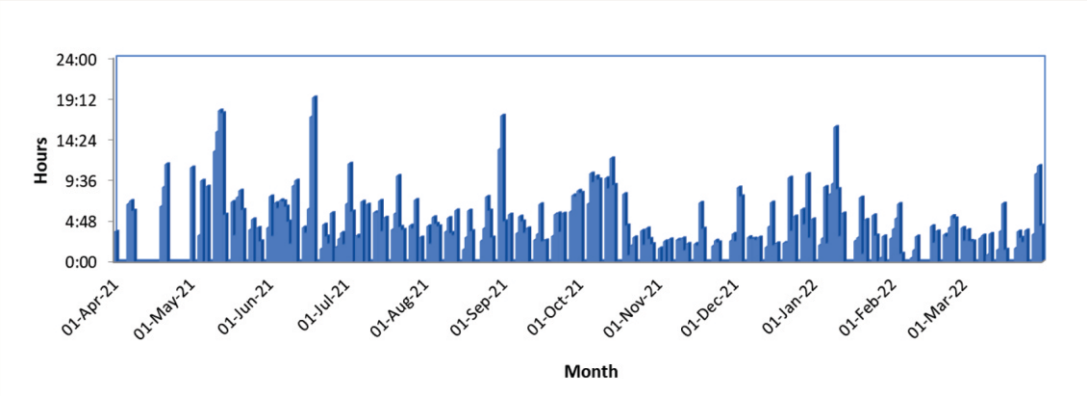


Figure 61. Variations in daily observational hours of ARIES ST Radar (ASTRAD) during 2021-22.

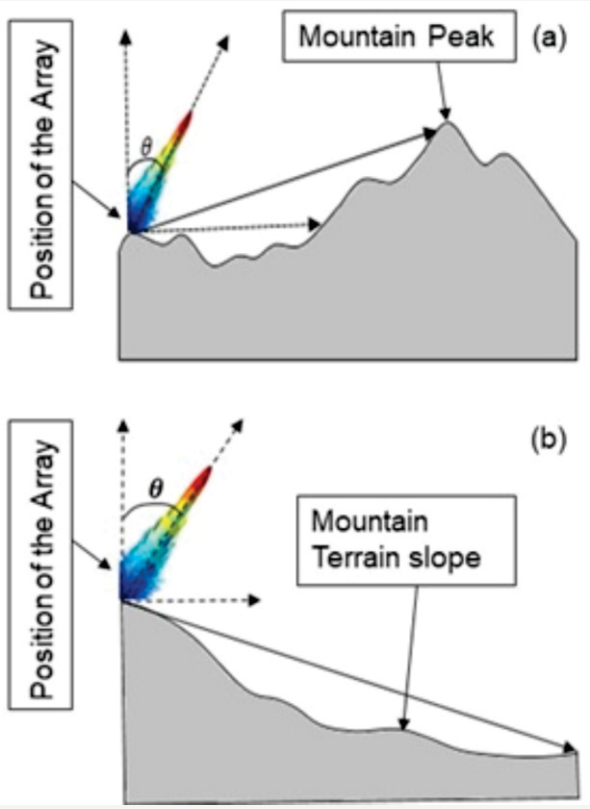


Figure 62. Topographical features at the (a) North and (b) South-East sides of the radar.

monsoon and monsoon season. Vigorous updrafts with maxima of about 15 m/s were observed extending from the mid-troposphere to up to the lower stratosphere region and downdrafts up to about 16 m/s were detected in the lower troposphere within the hailstorm. Momentum flux enhancement of 30-40 times was observed during convection with extremely large values during the hailstorm indicating enhanced flux exchange between troposphere and stratosphere. The findings of this study will aid the forecasting of these storms and improve their simulation in the mesoscale models, particularly over this Himalayan region having complex topography.

Observations from ASTRAD were used for the estimation of C_n^2 and to estimate seasonal and diurnal variation of 'seeing', wavefront coherence time, isoplanatic angle and scintillation rate. The mean C_n^2 over the site varies from $10^{-15.5}$ to 10^{-19} $m^{-2/3}$ with largest values in the monsoon and post monsoon season. The best 'seeing' conditions were observed in the winter and post-monsoon season with median 'seeing' varying from 0.39″ to 0.81″. The largest contribution to the diurnal variation of 'seeing' comes from turbulences at 2 - 5 km height region. Weak correlation of diurnal variation of 'seeing' has been observed with surface temperature and relative humidity. Among astroclimatic parameters largest isoplanatic angle is associated with winter season with median value of 2.57″ and wavefront coherence time of ~4.2 ms. The least scintillation in intensity is observed in the winter season with rate of ~10 % and mostly in monsoon season with ~45% rate. The present study is expected to have a positive impact on the optimization of the operation of adaptive optical techniques, observing time and scheduling of scientific programmes for optical telescope facilities in this region of the central Himalayas.

ARIES has progressed in development and testing of the in-house developed high power amplifier (HPA) for the network of 588 TRMs. A set of seven new amplifier was tested with the new DC power supply unit (PSU) and the result was promising. The procurement of the components for phase wise replacement of the old obsolete HPA and other spare components of the system was initiated.

To maintain the spare of the TRMs and the three element Yagi-Uda antennas of ASTRAD, ARIES initiated to develop them in-house. In this process, a folded dipole for the antenna was developed, fabricated in-house and it met all the basic parameters.

Upcoming Facilities

The 4m International Liquid Mirror Telescope (ILMT)

The ILMT is established at Devasthal observatory in collaboration with the Institute of Astrophysics and Geophysics, University of Liège, Belgium and several Canadian universities and institutes.

The ILMT will perform observations by looking toward the zenith direction in a narrow strip of the sky (about half a degree). The images passing over its FOV will be captured with the help of a highly efficient 4k×4k CCD. The CCD images recorded each night will be used to detect transient and variable stellar sources. The first light of the telescope is expected in spring 2022.

The preparation for the first light was ongoing during this period along with the preventive maintenance activities of the different subsystems of the telescope. Notable amongst these was the insulation of air bearing area which has to be maintained at a temperature of ~19 C. During the harsh Devasthal winters, the temperature drops significantly which can damage the air bearing. The whole system was covered with plexiglass and insulated with nitrile foam which helps to maintain the temperature **(Figure 63)**. The ILMT bowl is periodically cleaned with mercury vacuum cleaner and isopropanol to remove any accumulated dust etc. A movable stainless steel tube was attached to the mercury pumping system in order to safely transfer the mercury from the container to the bowl. Proper safety precautions have to be taken while handling mercury as the vapours are hazardous to health. The mercury vapour counts were recorded on a daily basis. The use of face mask, installation of cartridges, usage of PPE kit and mercury spill cleaning procedure were demonstrated in the safety training provided to the staff **(Figure 64)**.

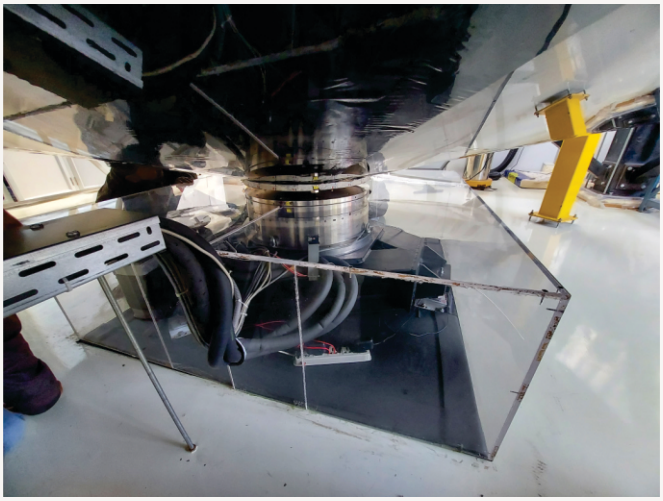


Figure 63. The insulated air-bearing floor area (using nitrile foam cushioning adhesive tape).

Figure 64. Mercury safety demonstration on 05 October, 2021.

Aditya-L1 Support Cell (AL1SC)

Aditya-L1 mission is India's first dedicated spacecraft mission to study the Sun. As a joint effort of ISRO and ARIES, AL1SC is set-up in the transit campus of ARIES located in Haldwani. AL1SC will act as a community service centre for the guest observers in preparing science observing proposals and analysing science data. This support cell provides tools and documentation required to understand, download and analyse the data. It will be regularly updated and will also provide an online help desk with professional researchers and Ph.D. students on-board. The process of equipment procurement such as high-end computational facilities and storage servers has been initiated. The development of AL1SC website was in progress and is expected to be launched in near future **(Figure 65)**. AL1SC will also host several long and short term workshops from next year. Recruitment of JRFs and Project Associates will also be initiated shortly.

Figure 65. Landing page of the AL1SC website.

Thirty Meter Telescope (TMT)

The India TMT consortium primarily has 3 participating institutes- IIA, IUCAA and ARIES along with participation from a few other institutes and universities. The scientists and engineers at ARIES take part in the developmental and administrative activities of TMT. Regular meetings of the Project Management Board (PMB) and Management Advisory Committee (MAC) were held throughout the year. The design of overall electronic scheme and design and development of control electronics for 4 sub-systems of the first light back-end instrument Wide-Field Optical Spectrometer (WFOS) **(Figure 66)** was lead by ARIES. Several team meetings for discussion and optimal design requirements were held. High level reviews with the international team also took place. The activities of WFOS were in full swing and will be continued.

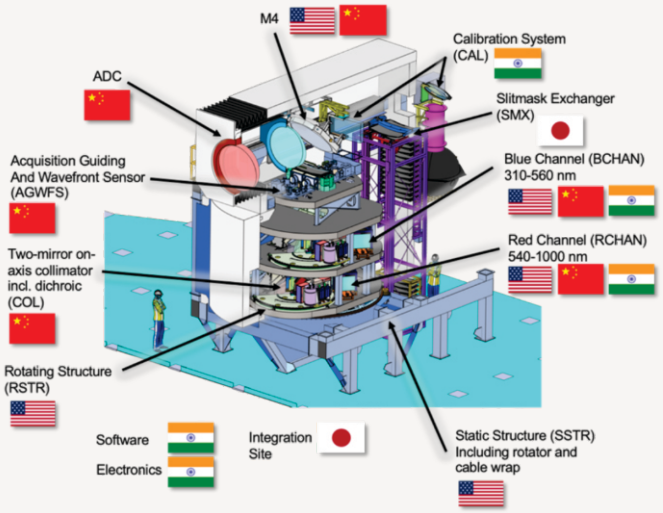


Figure 66. Cutaway of WFOS on the Nasmyth platform showing the contributions from TMT partners *(source:https://www.tmt.org/page/wfos).*

High Resolution Spectrograph

To address the growing demand of high resolution spectroscopy with DOT, a High Resolution Spectrograph (HRS), was conceptualised which is now being built in collaboration with the Australian Astronomical Optics (AAO), Sydney. The main science goals requiring high resolution spectroscopy are asteroseismology, doppler tomography of stellar surface, abundance studies, exoplanets, young stellar object, search for 6Li/7Li in metal-poor halo stars and supernovae. In order to cover a diverse range of scientific objectives, the spectrograph will have two modes of spectral resolution (40,000-low resolution/high efficiency mode and 80,000-high resolution mode) in a wavelength range of 380 - 850 nm with radial velocity stability of < 2m/s. The design of the spectrograph will be similar to other contemporary HRS available in other telescopes and will be based on a modern design using the white pupil concept. It will be a bench mounted fibre-fed spectrograph and located under the pier of DOT. The total time frame for commissioning of HRS is estimated to be 32 months.

Academic Programmes of ARIES

Academic Committee (AC) aims at enhancing the academic environment of the institute by looking after academic affairs of the research students in ARIES. The present members of the committee are:

Dr. Indranil Chattopadhyay (Chair);

Dr. Yogesh C. Joshi (Co-Chair);

Dr. Narendra Singh;

Dr. Saurabh;

Dr. Kuntal Misra;

Dr. Vaibhav Pant

Mr. Ramdayal Bhatt, is secretary to the AC and manages the official files of students, reviews and other matters. In addition Mr. Abhishek Sharma takes care of the fellowship related matter and Mr. V. K. Singh assists the AC with Visiting Student Programme (VSP).

The major activities of the academic committee are:

[A] Preparation of the syllabus and managing the pre-Ph.D. course work of ARIES

AC modifies the course work time to time by keeping the basic structure same.

[B] Reviews of Ph.D. students

AC arranges the reviews of the first year students after the completion of the course work. In 2021, AC conducted the examination and project presentations of the first year batch and following students successfully negotiated the pre-Ph.D. course work, and entered the main Ph.D. programme of ARIES:

(1) Ms. Aayushi Verma (2) Mr. Amit Kumar Ror (3) Mr. Devanand P. U. (4) Ms. Dibya Kirti Mishra (5) Ms. Jyoti Sheoran (6) Mr. Mrinmoy Sarkar (7) Mr. Naveen Dukiya (8) Mr. Sanjit Debnath (9) Ms. Shivangi Pandey and (10) Ms. Upasna Baweja

AC also arranged the reviews of the senior students, including the second year students who got promoted from JRF to SRF. The following students were promoted from JRF to SRF in an open review of their work and a comprehensive examination where they defended two subjects from their pre-Ph.D. course work:

(1) Mr. Arvind Kumar Dattatrey (2) Ms. Bhavya (3) Mr. Gurpreet Singh (4) Mr. Nitin Vashistha (5) Mr. Rahul (6) Mr. Shubham Kishore and (7) Tushar Tripathi.

[C] Joint Entrance Screening Test (JEST)

AC actively participated in the overall planning of the JEST examination on behalf of ARIES. One of the members of AC took the responsibility of conducting JEST 2021 at Nainital centre.

[D] Ph.D. entrance interviews

AC organises interviews every year to select Ph.D. students as JRFs in ARIES. AC members screened the applications and interviews were conducted during 12-16 July 2021 and 24-25 August 2021. Students who are M. Sc in physics/astrophysics and have qualified JEST/ NET/ GATE were invited to appear for the interviews. Inspire qualified students were also considered for the interview provided they fulfilled other general criteria. Candidates who have successfully qualified the interviews were selected as JRFs and inducted in ARIES to undergo a pre-Ph.D. course work. Eleven students joined ARIES.

(1) Ms Ambika Saxena (2) Mr. Athul Dileep (3) Ms. K. Bhageerathi (4) Mr. Karan Dogra (5) Mr. Krishna Kant Sharma (6) Ms. Monalisa Dubey (7) Mr. Priyesh Kumar Tripathi (8) Ms. Srinjana Routh (9) Mr. Srinivas M. Rao (10) Mr. Vikrant Tomar and (11) Mr. Tarak Chand

[E] Integrated M.Tech- Ph.D. (Tech.) programme

The Integrated M.Tech-Ph.D. (Tech.) programme in Astronomical Instrumentation in collaboration with Department of Applied Optics and Photonics, University of Calcutta (CU) was started at ARIES. The degree will be awarded by CU. The duration of M.Tech course work will be of 2 years divided into 4 semesters. After successful completion of the M. Tech course a student can opt for registration for Ph.D. (Tech.) programme, subjected to a selection procedure and minimum cut-off grade. Students with a three years B.Tech. degree (Post BSc Hons) in Optics and Optoelectronics/Radio Physics and Electronics from

CU or B.Tech/BE degree in Electrical/Instrumentation/ Electronics and Communications/Computer Science /Mechanical Engineering from an institution recognised by AICTE were eligible to apply. A candidate with M.Sc. degree in Physics/Electronic Science/Applied Mathematics/ Applied Physics from a UGC recognized institution were also eligible to apply. AC members screened the applications and interviews were conducted during 27-28 July 2021. Candidates who have successfully qualified the interviews were inducted in the programme. Two students joined in this programme.

(1) Mr. Kumar Pranshu (2) Ms. Purvi Udhwani

[F] Summer Project Students

The summer project internship is one of the significant programmes of AC. Short and long term training programmes are offered to the Bachelor/Master level students from various universities/institutes. In this, glimpses of the cutting-edge research and developmental activities of the institute are also highlighted.

[G] Post Doctoral Fellows/Research Associate

11 PDFs/RAs were at ARIES during 2021-2022.

[H] Orientation Programme 2021

Every year AC organises orientation programme to welcome new students, and distributes pre-Ph.D. course certificates to successful outgoing first year students of ARIES. Orientation programme in 2021 was held in a place near Devasthal campus **(Figure 67)**.

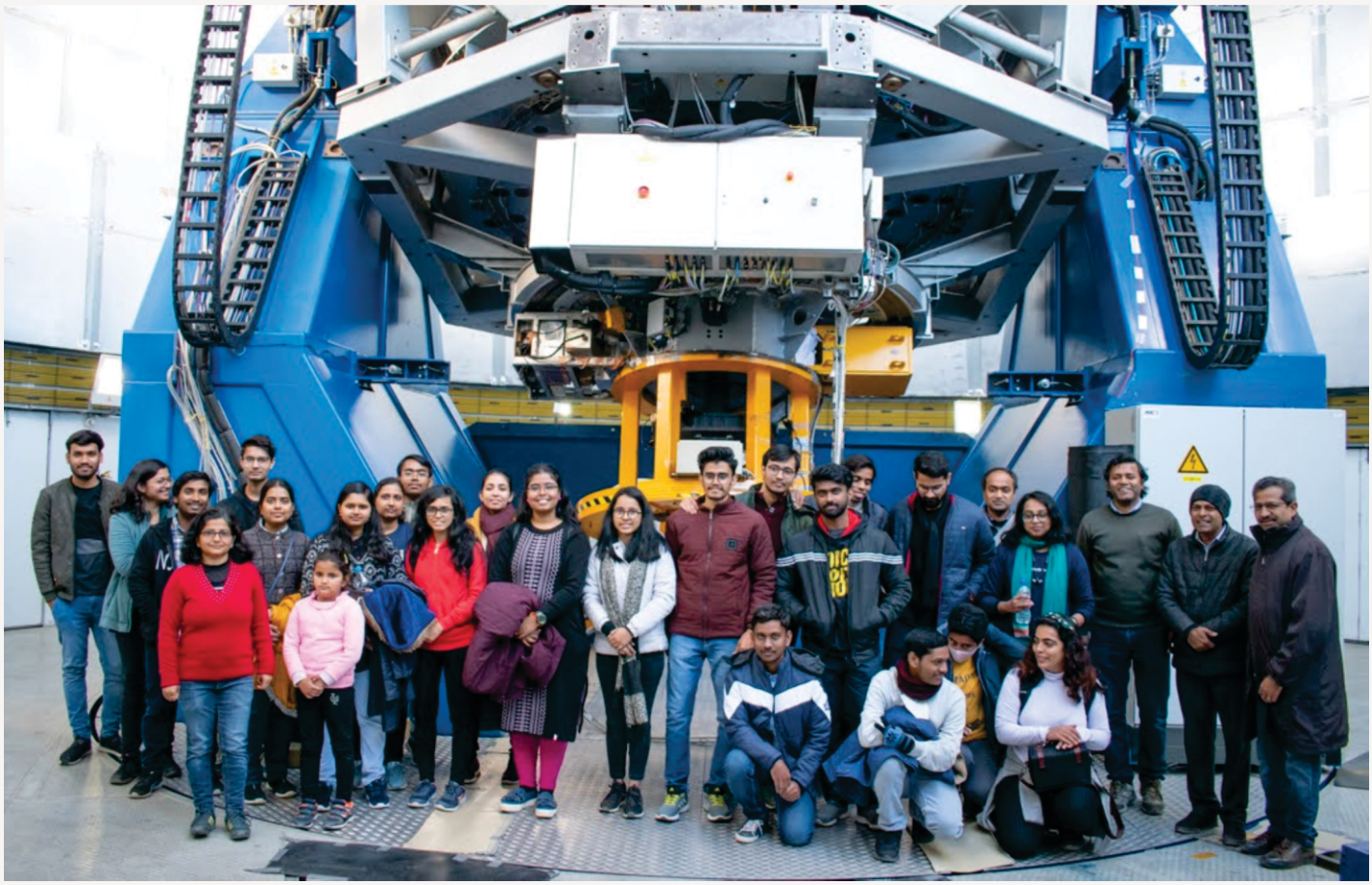
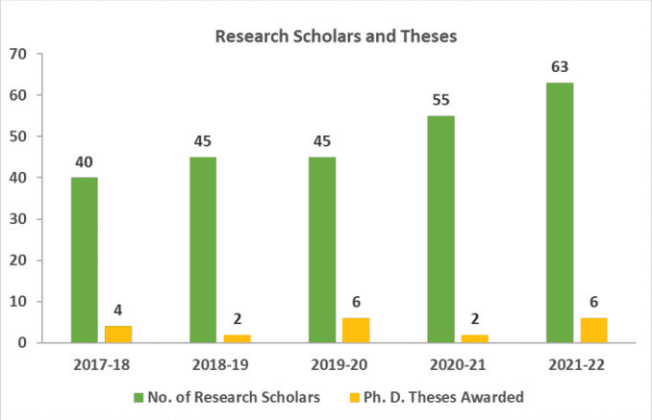


Figure 67. Orientation programme and visit to DOT facility, 2021.

[I] Ph.D. Thesis

6 students of ARIES were awarded/defended their Ph.D. degree and 9 students submitted their thesis during 2021-2022.



Awarded/Defended

Kuldeep Singh was awarded Ph.D. degree in February 2022. His thesis titled "The study of astrophysical magnetized flows" was submitted to the University of Delhi, Delhi. He carried out this work under the supervision of Patrick Das Gupta and **Indranil Chattopadhyay**.

Sapna Mishra was awarded Ph.D. degree in February 2022. Her thesis titled "Probing environment of AGNs based on their feedback processes" was submitted to the University of Delhi, Delhi. She carried out this work under the supervision of T. R. Seshadri and **Hum Chand**.

Raya Dastidar was awarded Ph.D. degree in February 2022. Her thesis titled "Study of core-collapse supernovae and their progenitors" was submitted to the University of Delhi, Delhi. She carried out this work under the supervision of T. R. Seshadri and **Brijesh Kumar.**

Priyanka Jalan was awarded Ph.D. degree in February 2022. Her thesis titled "Probing the physical state of the intergalactic medium and quasar environments" was submitted to the University of Delhi, Delhi. She carried out this work under the supervision of T. R. Seshadri and **Hum Chand**.

Aabha Monga defended her Ph.D. thesis in July 2021. Her thesis titled "Triggering and energy release mechanism in the solar eruptions" was submitted to the Kumaun University, Nainital. She carried out this work under the supervision of **Wahab Uddin** and Ramesh Chandra.

Vineet Ojha defended his Ph.D. thesis in September 2021. His thesis titled "Multi-wavelenght study of narrow-line Seyfert 1 galaxies" was submitted to the Pt. Ravishankar Shukla University, Raipur. He carried out this work under the supervision of **Hum Chand**.

Submitted

Shilpa Sarkar submitted her thesis titled "Two-temperature solution and spectral analysis of flows around compact objects" to the Pt. Ravishankar Shukla University, Raipur in July 2021. The research was done under the supervision of **Indranil Chattopadhyay**.

Bharti Arora submitted her thesis titled "Study of the massive O- and WR-stars and their associated winds" to the Pt. Ravishankar Shukla University, Raipur in July 2021. The research was done under the supervision of **Jeewan Chandra Pandey**.

Ritesh Patel submitted his thesis titled "Characterizing solar eruptions in inner corona using ground and space-based data" to the University of Calcutta, Calcutta in August 2021. The research was done under the supervision of **Dipankar Banerjee**.

Gaurav Singh submitted his thesis titled "Multi-wavelength study of hot stellar population in galactic globular clusters" to the University of Delhi, Delhi in September 2021. The research was done under the supervision of Patrick Das Gupta and **R. K. S. Yadav**.

Jayanand Maurya submitted his thesis titled "Photometric, kinematic, and variability study in the galactic open clusters' to the Pt. Ravishankar Shukla University, Raipur in December 2021. The research was done under the supervision of **Yogesh C. Joshi** and Anubha S. Gour.

Priyanka Srivastava submitted her thesis titled "Study on carbonaceous aerosols over the Central Himalayas" to the University of Delhi, Delhi in February 2022. The research was done under the supervision of T. R. Seshadri and **Manish Naja**.

Bibhuti Kumar Jha submitted his thesis titled "Long-term study of the Sun and its implications to solar dynamo models" to the Pondicherry University, Puducherry in February 2022. The research was done under the supervision of **Dipankar Banerjee**.

Rakesh Pandey submitted his thesis titled "Star formation in Young Star Clusters and H II regions" to the Pt. Ravishankar Shukla University, Raipur in March 2022. The

research was done under the supervision of **Saurabh** and D. P. Bisen.

Tirthendu Sinha submitted his thesis titled "Multi-wavelength study of variable stars and star formation in open star clusters" to the Kumaun University, Nainital in March 2022. The research was done under the supervision of P. S. Bisht and **Saurabh**.

[J] Talk/Poster presentation delivered by research scholars and PDFs

Aayushi Verma

10 May – 11 June, 2021, Refresher Course on Astronomy and Astrophysics, IUCAA, Pune. *(participant)*

31 January – 04 February, 2022, The 21st National Space Science Symposium, IISER, Kolkata (online). *(participant)*

Multiwavelength study of the Galactic mid-infrared bubble [HKS2019] E70, 25-29 March, 2022, The 40th Meeting of the Astronomical Society of India, IIT, Roorkee. *(poster)*

Aditya Jaiswal

Probing the dynamical features of intense pre - monsoon and summer monsoon deep convective system using the ARIES Stratosphere Troposphere Radar (206.5 MHz) over central Himalayan region, 19-30 April, 2021, General Assembly of European Geosciences Union, Vienna (online). *(e-talk)*

A methodical analysis of the dynamic evolution of the active western disturbance over central Himalayas using Stratosphere Troposphere radar, 23-26 November, 2021, International Symposium on Tropical Meteorology, CUSAT, Cochin. *(e -Poster)*

Characterising the layers of enhanced turbulence using VHF radar over central Himalayan site, The 21st National Space Science Symposium, IISER, Kolkata (online). *(e-talk)*

Akanksha Rajput

ARIES ST radar observations and data analysis methodology, 28 December, 2021, Cooperative research on ST/MST radar data analysis workshop, NARL Gadanki. *(e-talk)*

Amar Aryan

Analysis of core-collapse supernovae (CCSNe) using publicly available tools, 05-09 April, 2021, A national perspective on astrophysical jets and observational facilities, ARIES, Nainital (online). *(e-talk)*

Core-collapse Supernovae from very massive stars, 05-09 April, 2021, A national perspective on astrophysical jets and observational facilities, ARIES, Nainital (online).*(e-poster)*

Temporal and spectral modelling of intermediate luminosity type Ib Supernova Sn2015ap, 12-17 April, 2021, The 9th International *Fermi* Symposium (online). *(e-poster)*

14 June, 2021, An Introduction to IFU Spectroscopy (online). *(participants)*

16-20 August, 2019, ZTF summer school, University of Minnesota, USA (online). *(participants)*

13-17 September, 2021, The 16th IMPRS summer School (online). *(participants)*

SN 2016iyc: Pushing the lower limit of the mass of core-collapse supernova progenitor, 25-29 March, 2022, The 40th Meeting of the Astronomical Society of India, IIT, Roorkee. *(e-poster)*

Amit Kumar

GRB 201216C: A TeV detected GRB at redshift z=1.1, 25-29 March, 2022, The 40th Meeting of the Astronomical Society of India, IIT, Roorkee. *(poster)*

Arpit Kumar Shrivastav

Characterizing Spectral Channels of Visible Emission Line Coronagraph of Aditya-L1, 06-10 September, 2021, The 16th European Solar Physics Meeting (ESPM16). *(e-poster)*

24-28 January, 2022, Space Radiation Workshop (online). *(participant)*

Effect of Supra-arcade Downflows on Supra-arcade fan region and loop-tops, 31 January – 04 February, 2022, The 21st National Space Science Symposium, IISER, Kolkata. *(e-poster)*

21-25 February, 2022, STP-15. *(participant)*

Coronal rain : Effect on Transverse Oscillations of Coronal loops, 25-29 March, 2022, The 40th Meeting of the Astronomical Society of India, IIT, Roorkee. *(talk)*

11-12 January, 2022, First Indian Space Weather Conference

(ISWC-2022) (online). *(participant)*

Bhavya

16-20 August, 2021, ZTF summer school, University of Minnesota, United States (online). *(participant)*

15-19 November, 2022, Super Virtual 2021 - From common to exotic transients, ESO, Chile. *(participant)*

Characterisation of the Type II Short Plateau SN 2020jfo, 25-29 March, 2022, The 40th Meeting of the Astronomical Society of India, IIT, Roorkee. *(poster)*

Bibhuti Kumar Jha

A Theoretical Model of the Near-Surface Shear Layer of the Sun, 06-10 September, 2021, The 16th European Solar Physics Meeting (ESPM16). *(e-poster)*

A Theoretical Model of the Near-Surface Shear Layer of the Sun, 21-25 February, 2022, STP-15. *(e-poster)*

A Theoretical Model of the Near-Surface Shear Layer of the Sun, 25-29 March, 2022, The 40th Meeting of the Astronomical Society of India, IIT, Roorkee. *(poster)*

Update on Ca-K data from Kodaikanal Solar Observatory, 25-29 March, 2022, The 40th Meeting of the Astronomical Society of India, IIT, Roorkee. *(talk)*

Dibya Kirti Mishra

24-28 January, 2022, Space Radiation Workshop, ARIES, Nainital. *(participant)*

31 January – 04 February, 2022, The 21st National Space Science Symposium, IISER, Kolkata (online). *(participant)*

Study of Chromospheric Differential Rotation of the Sun using Ca II K Data, 25-29 March, 2022, The 40th Meeting of the Astronomical Society of India, IIT, Roorkee. *(talk)*

Gurpreet Singh

20-26 April, 2021, 7-day winter-end bootcamp on Artificial intelligence and Machine learning. *(participant)*

21-30 June, 2021, Advanced workshop for *AstroSat* data analysis. *(participant)*

24-28 January, 2022, Space Radiation Workshop, ARIES, IISER Pune and NASA (online). *(participant)*

X-Ray Properties of TX Cnc, an Eclipsing Solar-Type Contact Binary of W UMa, 31 January – 04 February, 2022, The 21st National Space Science Symposium, IISER, Kolkata. *(e-Poster)*

07-11 February, 2022, X-ray spectral fitting (XSF) 2022 winter school. *(participant)*

Coronal eclipsing and time-resolved X-Ray spectroscopy of a Semi-Detached Binary DV Psc, 25-29 March, 2022, The 40th Meeting of the Astronomical Society of India, IIT, Roorkee. *(poster)*

Jyoti Sheoran

24-28 January, 2022, Space Radiation Workshop, ARIES, IISER Pune and NASA (online). *(participant)*

31 January – 04 February, 2022, The 21st National Space Science Symposium, IISER, Kolkata (2022). *(participant)*

Thermodynamics of Coronal Mass Ejections in the Inner Corona, 25-29 March, 2022, The 40th Meeting of the Astronomical Society of India, IIT, Roorkee. *(poster)*

Kiran Wani

X-ray Studies of Blazar 1ES 1959+650 using SWIFT and XMM-Newton Satellite, 25-29 March, 2022, The 40th Meeting of the Astronomical Society of India, IIT, Roorkee. *(e-Poster)*

12-15 October 2021, The 3rd Shaw-IAU Workshop on Astronomy for Education (online). *(participant)*

Krishan Chand

Intranight variability of UV emission from powerful blazars, 25-29 March, 2022, The 40th Meeting of the Astronomical Society of India, IIT, Roorkee. *(e-poster)*

Mahendar Chand Rajwar

Observations of light NMHCs over the central Himalayas: Assessment of ozone production potential using a photochemical box model, 12-19 September, 2021, The 16th IGAC Scientific conference (online). *(e-poster)*

Assessment of surface ozone at Dehradun: a valley site in Himalayan and its comparison with other central Himalayan and associated sites, 31 January – 04 February, 2022, The 21st National Space Science Symposium, IISER, Kolkata (online). *(e-poster)*

Mrinmoy Sarkar

Asteroseismic Investigation of delta scuti star HD 118660, 25-29 March, 2022, The 40th Meeting of the Astronomical Society of India, IIT, Roorkee. *(poster)*

Naveen Dukiya

15-11 November, 2021, SuperVirtual 2021 - From common to exotic transients, ESO, Chile. *(participant)*

Identifying Astrometric Calibrators in the Forthcoming ILMT Survey Strip, 25-29 March, 2022, The 40th Meeting of the Astronomical Society of India, IIT, Roorkee. *(talk)*

Nikita Rawat

14 June, 2021, An introduction to IFU Spectroscopy, IAA-CSIC, Spain. *(participant)*

TESS observations of TX Col: rapidly varying accretion flow, 31 January – 04 February, 2022, The 21st National Space Science Symposium, *IISER, Kolkata. (talk)*

TESS Observations of TX Col: Rapidly Varying Accretion Flow, 25-29 March, 2022, The 40th Meeting of the Astronomical Society of India, IIT, Roorkee. *(poster)*

Nitin vashishtha

06-10 September, 2021, ESPM16. *(participant)*

24-28 January, 2022, Space Radiation Workshop, ARIES, IISER Pune and NASA (online). *(participant)*

21-25 February, 2022, STP-15. *(participant)*

Numerical simulations and forward modelling of a breakout CME, 25-29 March, 2022, The 40th Meeting of the Astronomical Society of India, IIT, Roorkee. *(poster)*

11-12 January, 2022, First Indian Space Weather Conference (ISWC-2022). *(participant)*

31 January – 04 February, 2022, The 21st National Space Science Symposium, IISER, Kolkata (online). *(participant)*

Prajjwal Rawat

Lockdown influences on Ozone, NO2, and CO over Asia: Some contrary affects, 12-17, September, 2021, IGAC 2021 (online). *(talk)*

Radiance inter-calibration of INSAT-3D ozone channel with MSG-SEVIRI and successive improvements in ozone optimal/ML retrieval and validation, 13-18 September, 2021, WCRP-WWRP symposium (online). *(talk)*

Assessment of AIRS, IASI, and CrIS ozone retrieval over Central Himalaya, 03-09 October, 2021, Quadrennial Ozone Symposium (QOS) 2021, Yonsei University, Korea (online). *(poster)*

Long-term variations of NO2, SO2, HCHO, and CHOCHO over the Himalayan foothills: Observations from MAX-DOAS, TROPOMI, and GOME-2, 09-11 November, 2021, The 6th International SKYNET Workshop 2021, Japan (online). *(talk)*

Total column ozone from Indian geostationary satellite INSAT-3DR: Improved infrared retrieval and validation, 31 January – 04 February, 2022, The 21st National Space Science Symposium, IISER, Kolkata (online). *(talk)*

Remote Sensing Study of Ozone, NO2, and CO over India: some Contrary Effects of SARS-CoV-2 Lockdown in the Free Troposphere, 23-27 May, 2022, GML 50th Global Monitoring Annual Conference (online). *(talk)*

Priyanka Srivastava

Decadal trend of black carbon aerosols over the Central Himalayas: 17 years of ground observations, 12-17 November, 2021, The 16th IGAC Scientific conference (Online). *(talk and poster)*

Rahul

Source apportionment of TSP in the central Himalayan Region, 09-11 November, 2021, The 6th international SKYNET Workshop, Japan. *(e-Talk)*

Raj Kishor Joshi

Radiatively driven bipolar outflows, 25-29 March, 2022, The 40th Meeting of the Astronomical Society of India, IIT, Roorkee. *(poster)*

Ritesh Patel

Automated detection of accelerating solar eruptions using parabolic hough transform, 09-11 August, 2021, The 2nd PUNCH meeting (online). *(e-poster)*

A statistical study of plasmoids associated with a post-CME current sheet, 06-10 September, 2021, ESPM16 (online). *(e-poster)*

Characterizing spectral channels of visible emission line coronagraph of Aditya-L1, 11-12 January, 2022, Indian Space Weather Conference (online). *(e-talk)*

24-28 January, 2022, Space Radiation Workshop, ARIES, IISER Pune and NASA (online). *(participant)*

Characterising solar wind outflows observed in the varying field of view of WISPR onboard Parker Solar Probe, 21-25 February, 2022, STP-15 (online). *(e-talk)*

A simple radial gradient filter for batch-processing Coronagraph images, 25-29 March, 2022, The 40th Meeting of the Astronomical Society of India, IIT, Roorkee. *(poster)*

Sadhana Singh

Polarimetric Study of Open Clusters toward Galactic Anti-center Direction, 11-14 May, 2021, ISM-2021, Structure, characteristic scales, and star formation, Beirut. *(talk)*

Optical Polarization Study in Open Clusters, 24-28 May, 2021, RoboPol- Looking at the Polarized Universe: Past, Present and Future, University of Crete in Heraklion, Greece. *(talk)*

Polarization, Polarizing Efficiency, and Grain alignment towards the direction of the cluster NGC 2345, 25-29 March, 2022, The 40th Meeting of the Astronomical Society of India, IIT, Roorkee. *(e-Poster)*

Sanjit Debnath

Imprints of spin on the solution and the emission spectrum of accretion flow around the Black hole, 25-29 March, 2022, The 40th Meeting of the Astronomical Society of India, IIT, Roorkee. *(poster)*

Shivangi Pandey

Broad line region and black hole mass of PKS 0736+017, 25-29 March, 2022, The 40th Meeting of the Astronomical Society of India, IIT, Roorkee. *(poster)*

Broad line region and black hole mass of PKS 0736+017, 31 January-04 February, 2022, The 21st National space science symposium, IISER, Kolkata (online). *(flash poster)*

Broad line region and black hole mass of PKS 0736+017, 13-17 September, 2021, Galaxies with Active Nuclei on Scales from Black Hole to Host Galaxy, Crimean observatory, Russia. *(talk)*

12-16 September, 2022, Origin, growth and feedback of black holes in dwarf galaxies, San Sebastian, Spain. *(participant)*

14-16 September, 2022, Panchromatic View of the life cycle of AGN program, ESAC, Madrid. *(participant)*

Sindhu Pandey

13-17 September, 2021, The 16th IMPRS summer School (online). *(participant)*

Upasna Baweja

24-28 January, 2022, Space Radiation Workshop, ARIES, IISER, Pune and NASA (online). *(participant)*

31 January-04 February, 2022, The 21st National Space Science Symposium, IISER, Kolkata (online). *(participant)*

Coronal Magetic field estimation using Bayesian Inference, 25-29 March, 2022, The 40th Meeting of the Astronomical Society of India, IIT, Roorkee. *(poster)*

11-12 January, 2022, First Indian Space Weather Conference (ISWC-2022). *(participant)*

Varun

Introduction to X-ray astronomy, 16-21 May, 2021, ATSOA 2021, ARIES, Nainital. *(e-talk)*

Ground calibration experiment with X-ray polarimeter (POLIX), 24-28 May, 2021, Looking at the polarized universe, University of Crete in Heraklion, Greece. *(e-talk)*

AstroSat detection of a mHz QPO and cyclotron line in IGR J19294+1816 during the 2019 outburst, 25-29 March, 2022, The 40th Meeting of the Astronomical Society of India, IIT, Roorkee. *(poster)*

Vibhore Negi

Optical Flux and Colour Variability of Blazars in the ZTF Survey, 25-29 March, 2022, The 40th Meeting of the Astronomical Society of India, IIT, Roorkee. *(e-poster)*

Vinit Dhiman

Multi-band Variability of the TeV Blazar PG 1553+113 with XMM-Newton, 25-29 March, 2022, The 40th Meeting of the Astronomical Society of India, IIT, Roorkee. *(poster)*

Knowledge Resource Centre/Library

The mark of a progressive institution is judged by the strength of its library, which has been aptly termed "Library is a growing organism" fifth law of library science given by Prof. S. R. Ranganathan, an authority on library science. Ever since the inception of the Observatory in 1954, the library has been steadily building up through the years and is now known to be one of the best libraries amongst those belonging to any similar scientific research institutions in the country. Institute has a well stocked automated library which is named as Knowledge Resource Centre (KRC) (**Figure 68**). It is facilitated with Wi-Fi connectivity. The ARIES KRC acquires books and journals mainly related to Astronomy & Astrophysics and Atmospheric Sciences. The KRC also acquires reference books time to time. The KRC is a member of National Knowledge Resource Consortium (NKRC). NKRC provides free access of subscribed online databases to DST and CSIR institutions.

The KRC is responsible toward providing reports on the activities of the institute time to time. The monthly, quarterly and annual reports along with the KPI data are prepared and submitted to DST and at other places whenever required.

KRC Resource Development

During the period 2021–2022, the following information resources were added:

Subscription to Journals	:74 (Print + Online) + Full Text Databases
Publications in refereed journals	: 129
Theses awarded	: 06

The collection at the end of the period is

Books	: 11,051
Bound volumes of Journals	: 11,205

Apart from books and journals, other materials such as slides, charts, maps, diskettes, CD-ROMs, etc. are also available in the KRC. The user friendly features of Online Catalogue are also available at Web-OPAC in ARIES website. DSpace, an open source software is used for the digital repository of ARIES, where KRC preserves theses, scientific documents, academic reports, photographs of special events, newspaper clippings etc.

In near future several infrastructural modifications and upgrades are planned for the KRC.

Figure 68. KRC main reading hall.

ARIES Science Popularisation & Public Outreach Programme (ASPOP)

ARIES Science Popularization and Outreach Programme (ASPOP) has dedicated telescopes, a mini planetarium, science exhibits/movies, etc. in the ARIES Science Centre through which the institute has been disseminating scientific knowledge, particularly in remote hilly regions, as part of scientific social responsibility. With COVID restrictions easing up, outreach activities in hybrid and in-person modes have been resumed. ARIES actively participated in outreach activities through online platforms such as its website and social media. Major outreach activities were carried out as part of *Azadi ka Amrit Mahotsav* celebrations. Some of the highlights of ASPOP are:

National Science Day

A week-long celebration (22-28 February, 2022) was carried out in hybrid mode. ARIES members gave multiple talks, weather balloon demo and observatory tours to school students. Many offline and online competitions such as painting, slogan writing, science video making and extempore speech were organized. More than 450 students from nearby schools participated in these activities. Painting competitions had participation by students from different states as well. Astrophotography contest was held for general public. ARIES also collaborated with Gurukula Kangri (GU), Haridwar for Vigyan Sarvatra Pujyate during which stargazing and sunspots viewing was arranged for over 400 students and general visitors in their campus during 24-25 February, 2022. The National Science Day celebrations are displayed in **Figures 69 and 70.**

Figure 69. National Science Day celebration at ARIES.

Figure 70. Sunspot viewing on National Science Day.

Exhibitions

ARIES participated in an online exhibition during IAGA IASPEI 2021 Joint Scientific Assembly hosted by CSIR-NGRI during 21-27 August in online mode and three in-person exhibitions – (i) Make in Uttarakhand 2021 during 16-17 September at Ramnagar, (ii) Rise in Uttar Pradesh 2021, during 22-24 December at Ghaziabad, (iii) Ujjwal Uttar Pradesh 2021 during 24-26 December at Gorakhpur. Around 600 students and general public visited the ARIES stalls during the in-person exhibitions **(Figures 71 and 72)**.

Figure 71. Telescope viewing during the in-person exhibition.

Figure 72. Telescope viewing and interaction during the exhibition.

Outreach Talks

Multiple outreach talks, ARIES documentary screening, virtual observatory tours and discussion sessions were conducted which were attended by school and college students. On various special occasions such as Lunar Occultation of Mars, International Day of Light, World Environment Day, National Engineers' Day, World Space Week **(Figure 73)**, International Women's Day etc. ASPOP organized online public talks by outside experts and ARIES members. Leading up to the 75th Independence Day, ARIES organised a week long *Azadi ka Amrit Mahotsav* celebration in online mode during 2-6 August, 2021 **(Figure 74)**. These talks were live streamed on Facebook page and YouTube channel of ARIES. In addition to these, many ARIES members gave several outreach talks in many different institutes and forums in online, offline and hybrid modes.

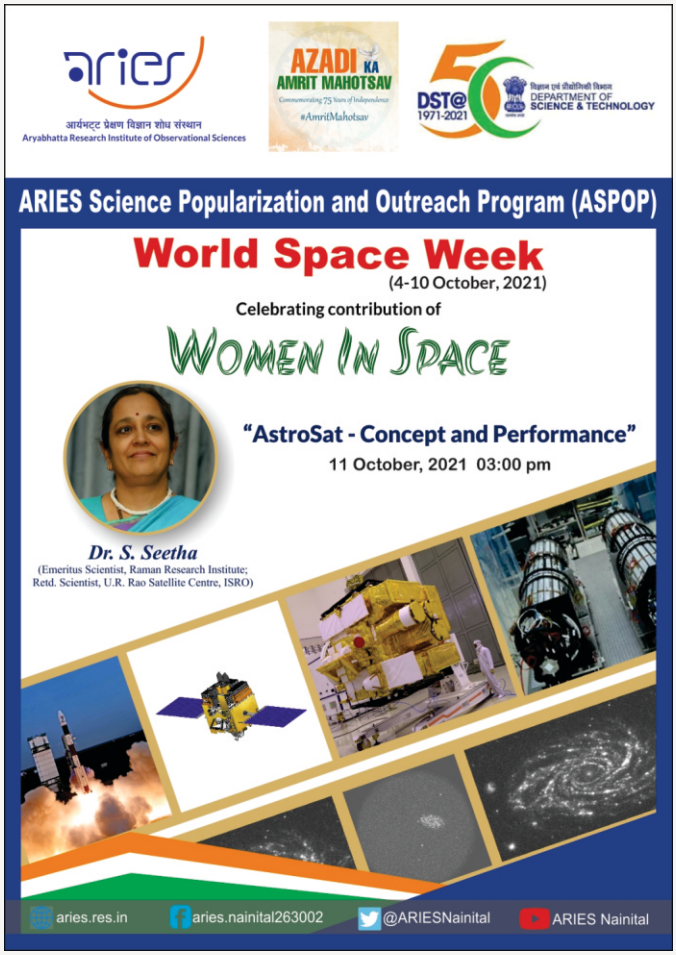


Figure 73. Celebrating World Space Week.

Website & Social Media

Research works by ARIES scientists are summarised in the form of science stories in non-technical language. These stories are featured on ARIES website and shared with DST media cell for wider circulation. During 2021-22, over 20 such science stories were published on ARIES website and DST platforms. Regular updates and activities from ARIES were posted on the social media pages. Many scientific talks as well as outreach talks were live streamed through social

media for wider reach. Important updates from DST and other institutes' social media pages were also re-shared. As a result, the number of followers of ARIES social media pages has increased. The live streamed outreach activities on YouTube and Facebook have 6000+ views till now.

Several upgrades were taken up in the Science Centre. Multiple digital screens have been installed in the visitor area to display audiovisual content and dynamic digital posters. The primary mirror of the science centre telescope has been recoated improving the stargazing experience for the visitors. A modern computerized 14 inch telescope for visitors is being acquired. The planetarium projector set-up has been repaired and the planetarium is again functional. The science centre has been reopened for visitors.

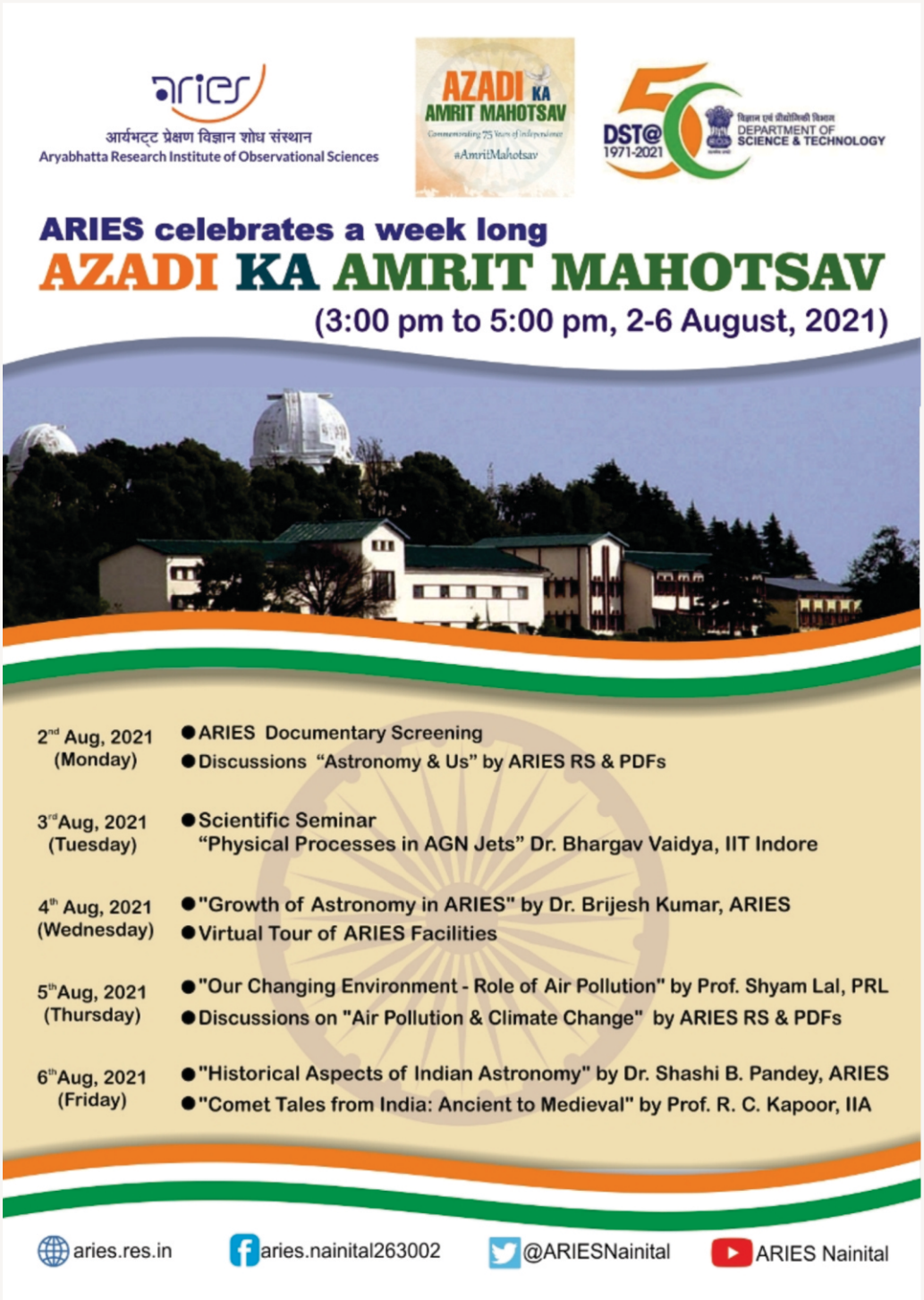


Figure 74. Week long celebration of *Azadi ka Amrit Mahotsav*.

Other Scientific Activities

Meetings/Workshops organised at ARIES

Four meetings/workshops were organised by ARIES in online/in-person/hybrid modes to commemorate *Azadi ka Amrit Mahotsav* and Golden Jubilee Commemoration Year of the DST (1971-2021).

Astrophysical jets and observational facilities: National perspective (5 - 9 April, 2021)

In this workshop about 200 scientists and young researchers from more than 30 institutes/universities from all over India participated to discuss the jets/jetted outflow from various classes of objects, including stars to big galaxies. Brainstorming sessions were held to discuss the contribution from the community to address the long-standing scientific problems utilising the existing and upcoming Indian observational facilities. The 5-day workshop was organised in online mode by ARIES along with TIFR, BARC, Mumbai; IIA, RRI, ISRO, Bengaluru; NCRA, IUCAA, Pune; SINP, Kolkata and PRL, Ahmedabad **(Figure 75)**.

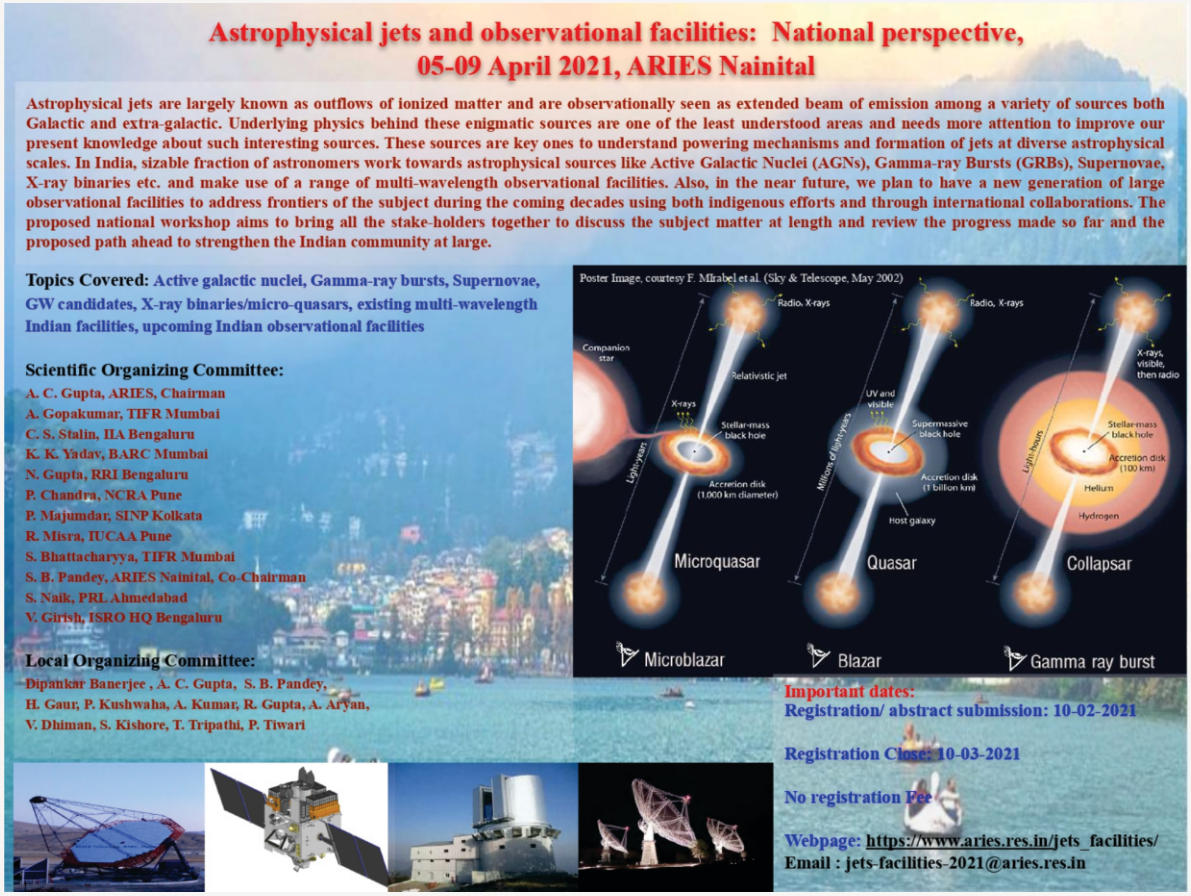


Figure 75. Poster announcing the "Astrophysical jets and observational facilities: National perspective" workshop.

ARIES Training School in Observational Astronomy (ATSOA) (17-24 May, 2021)

Nearly 100 students from more than 25 universities from all over India were introduced to various topics related to astronomy in an online training programme (ATSOA) to develop capacity in the subject **(Figure 76)**. This 8 days training programme for post-graduate students included pedagogical talks in astronomy and hands-on/demonstration sessions on various astronomical data processing techniques such as photometry, spectroscopy, polarimetry, and machine learning every day. By conducting training schools annually, ARIES aims to develop an expertise/skill in astronomical data-analysis in optical wavelengths among young students and create a talent pool in the country.

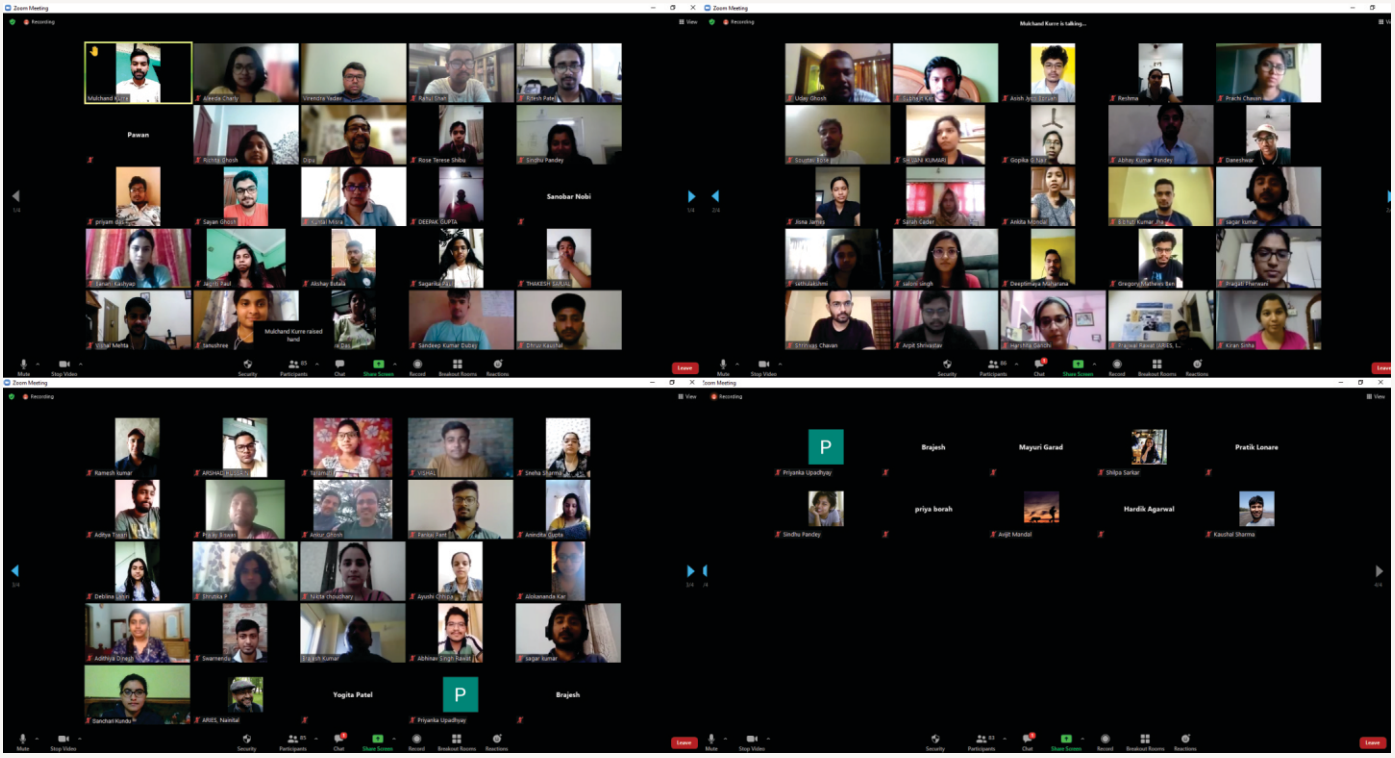


Figure 76. Snapshots from ATSOA 2021.

Space Radiation Workshop (24-28 January, 2022)

This workshop of 5 days held in online mode was attended by more than 200 participants. World leading experts from India and the USA gave enlightening lectures in the workshops. The workshop was aimed to create a unique forum to explore next generation space radiation research and the development of joint NASA-ISRO-IISER- ARIES mission in terms of technology, proposals and programmes **(Figure 77)**.

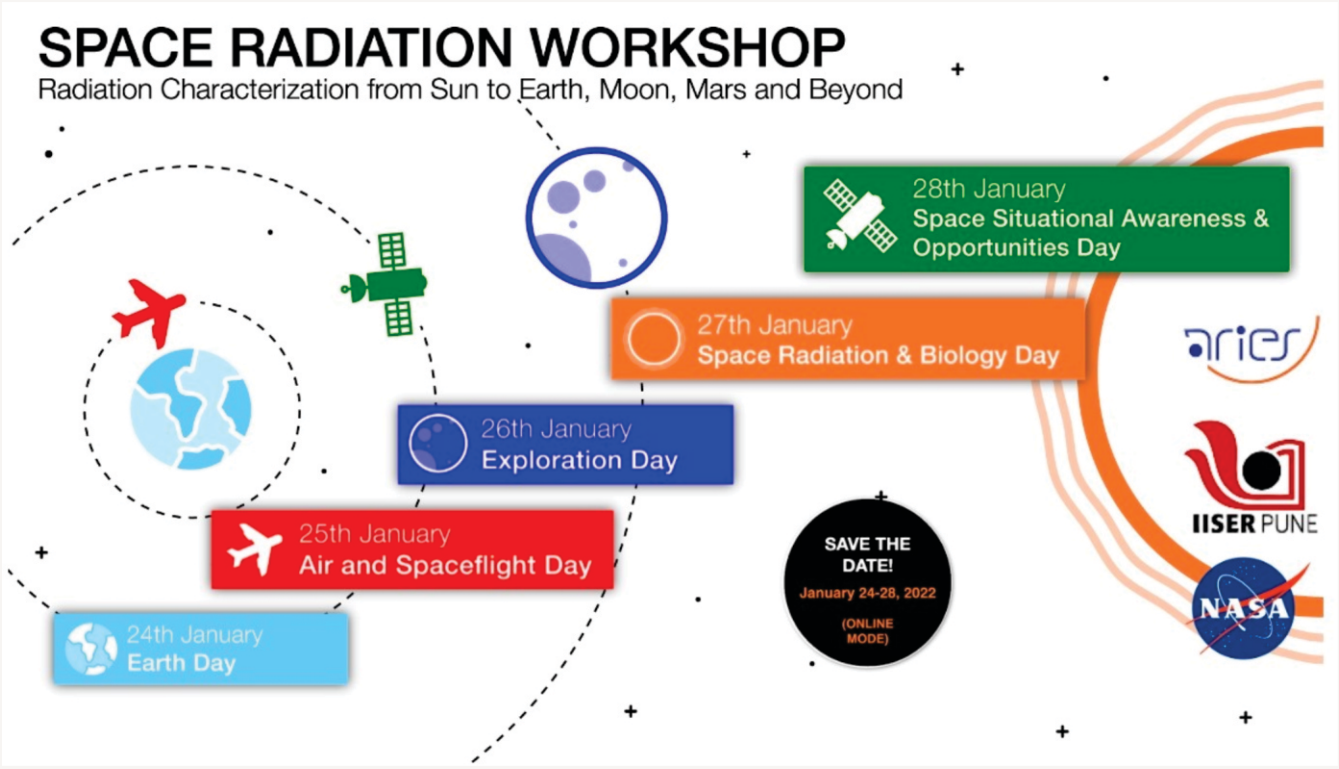


Figure 77. Agenda of the 5 days space radiation workshop.

The 40th annual meeting of the Astronomical Society of India (ASI) (25-29 March, 2022)

The 40th annual meeting of ASI was jointly hosted by IIT, Roorkee and ARIES in hybrid mode at the IIT, Roorkee campus. The meeting was inaugurated by Prof. Vijay Raghavan, Principal Scientific Advisor of Government of India, who stressed on the importance of astronomy in a data-driven age. He highlighted the need for development of major centres for undergraduate education focousing on observation and analysis of data with planetariums connected to them. New and upcoming trends in major areas of astronomy research like galactic astronomy, solar system, instrumentation and techniques, general relativity and cosmology, as well as astronomy and data science, were discussed in the meeting. The ASI also announced several awards on the occasion organised commemorating 75 years of India's independence. The meeting had an in-person gathering of about 300 astronomers from all across India, and more than 400 astronomers joining virtually. There were over 140 scientific talks and 360 posters presented in the meeting. There were special sessions organised by the ASI's Public Outreach and Education Committee (POEC) and the Working Group on Gender Equity (WGGE). This being the 50th year of ASI, special sessions were organised looking back on the development of astronomy in India in the past five decades and making plans for the future. Glimpses of ASI 2022 are shown in **figures 78, 79** and **80.**

Figure 78. Inaugural ceremony of ASI 2022 and address by Prof. K. Vijay Raghavan, PSA, Govt. of India.

Figure 79. Proceedings of the ASI 2022 meeting.

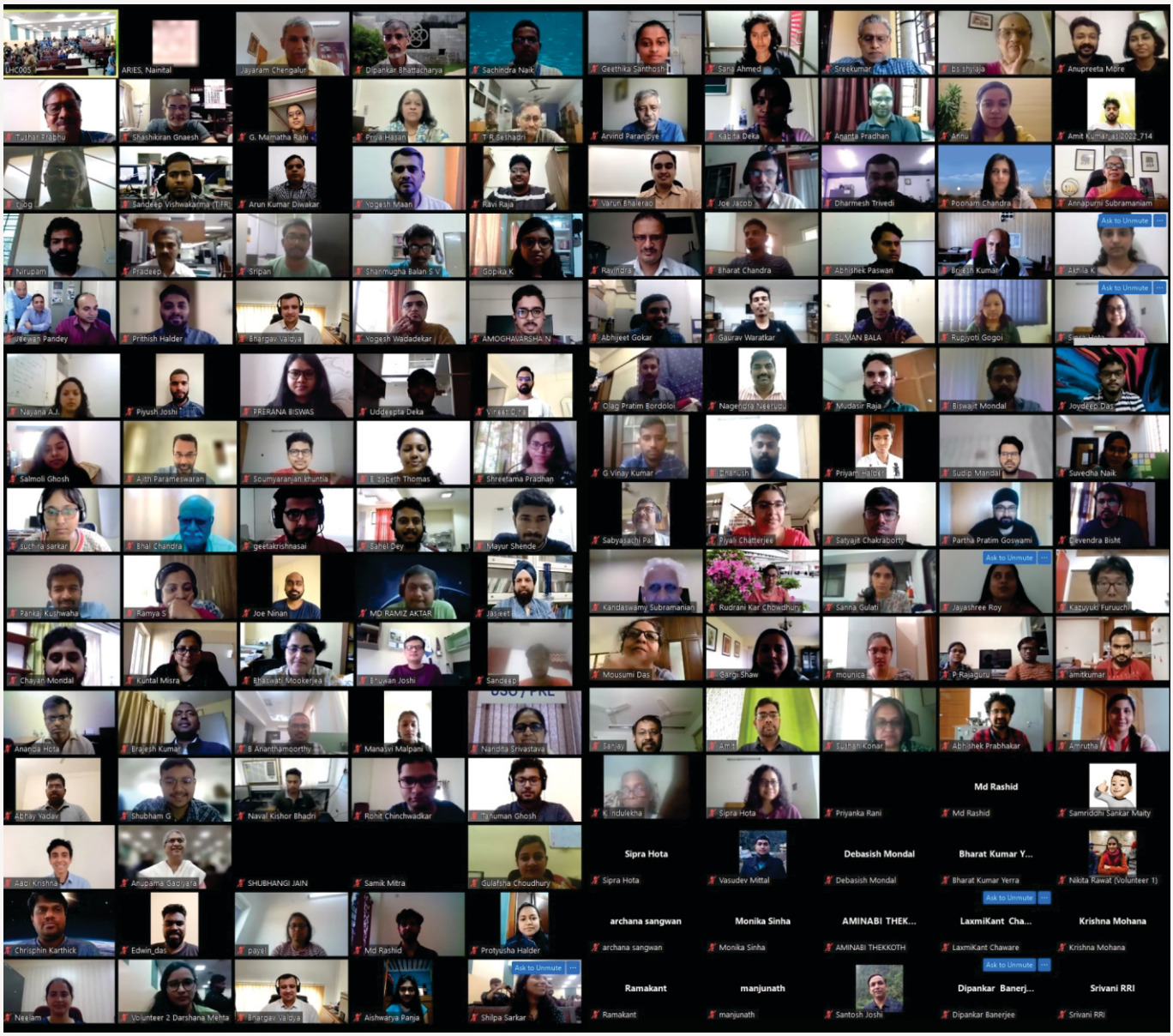


Figure 80. Group photo of in-person (top) and online (bottom) participants in ASI 2022.

Talk/Poster presentation delivered by ARIES members

Brajesh Kumar

Present status of the upcoming 4m ILMT and science cases, 05-09 April, 2021, A national perspective on astrophysical jets and observational facilities, ARIES, Nainital (online). *(talk)*

The 4m ILMT observing facility, 17-24 May, 2021, ATSOA 2021, ARIES, Nainital. *(talk)*

Type Ib supernova SN 2017iro: A moderately luminous event with a possible binary progenitor, 25-29 March, 2022, The 40th Meeting of the Astronomical Society of India, IIT, Roorkee. *(talk)*

Indranil Chattopadhyay

What is astronomy: a brief history, 17-24, May 2021, ATSOA, 2021, ARIES, Nainital. *(talk)*

Theoretical astrophysics, 17-24, May 2021, ATSOA, 2021, ARIES, Nainital. *(talk)*

31 January – 04 February, 2022, The 21st National Space Science Symposium, IISER, Kolkata (online). *(participant and Chair of a session)*

25-29 March, 2022, The 40th Meeting of the Astronomical Society of India, IIT, Roorkee. *(LOC and organizer of a workshop)*

Jeewan Chandra Pandey

05-09 April, 2021, A national perspective on astrophysical jets and observational facilities, ARIES, Nainital (online). *(participant)*

Stellar structure and evolution, 17-24 May, 2021, ATSOA 2021, ARIES, Nainital. *(talk)*

24-26 August, 2021, *Chandra* data workshop, CfA, Havard, USA. *(participant)*

24-28 January, 2022, Space Radiation Workshop, ARIES, Nainital. *(participant)*

TESS observations of TX Col: rapidly varying accretion flow, 31 January – 04 February, 2022, The 21st National Space Science Symposium (NSSS 2022), IISER Kolkata (online). *(talk)*

Star, ISM and Galaxy-I, 25-29 March, 2022, The 40th Meeting of the Astronomical Society of India, IIT, Roorkee. (participant and chair of a session)

Kuntal Misra

Afterglow modelling and energetics of Gamma Ray Bursts (GRBs), 05-09 April, 2021, A national perspective on astrophysical jets and observational facilities, ARIES, Nainital. *(talk)*

Final stages of stars – energetic cosmic explosions, 17-24 May, 2021, ATSOA 2021, ARIES, Nainital. *(talk)*

IAU NAEC Telescope Network, 20-22 July, 2021, The IAU offices family meeting organized by the IAU Office of Astronomy and Education, European Continent. *(participant and organiser of a session)*

02-04 August, 2021, Public engagement in astronomy in the era of pandemic, IIA, Bengaluru. *(participant)*

04-05 October, 2021, Celebrating 20 years of GMRT, NCRA, Pune. *(participant)*

12-15 October, 2021, The 3rd Shaw-IAU Workshop on Astronomy Education organized by the IAU Office of Astronomy and Education, European Continent. *(participant)*

Gamma Ray Bursts: The enigmatic cosmic explosions, 13 November, 2021, Ask an astronomer, ASI POEC, India. *(talk)*

15-19 November, 2021, Super Virtual 2021 – From common to exotic transients. *(participant)*

31 January – 04 February, 2022, The 21st National Space Science Symposium (NSSS 2022), IISER Kolkata (online). *(participant and co-chair of a session)*

25-29 March, 2022, The 40th Meeting of the Astronomical Society of India, IIT, Roorkee. *(participant and chair of a session)*

Manish Naja

Atmospheric Research at ARIES, 17-24 May, 2021, ATSOA, 2021, ARIES, Nainital. *(talk)*

Air Pollution & Climate Change in Himalayas, 15 June, 2021, World Environment Day, ARIES, Nainital. *(talk)*

Fire and its emissions: IGAC-MANGO perspective, 03-04 December, 2021, International Workshop on Fires in South Asia : Current status and future challenges in monitoring, modeling, predictions and mitigation. *(talk)*

Low altitude ballooning: meteorology, dynamics and ozone, 24-28 January, 2022, Space Radiation Workshop, ARIES, IISER Pune and NASA (online). *(talk)*

Air Pollution and Climate Change: Present and Future Directions, 8-10 March, 2022, International conference on current trends in advanced materials and their applications for societal development, DHSGSU, Sagar. *(talk)*

25-29 March, 2022, The 40th Meeting of the Astronomical Society of India, IIT, Roorkee. *(participant)*

Narendra Singh

Air Pollution and Climate Change: A Himalayan persepective, 09 April, 2021, National Seminar on "Role of science and technology in environmental sustainability", GEHU, Bhimtal, Nainital. *(invited talk)*

Air quality, global warming and Himalayan climate Change, 16-17 July, 2021, National conference on "Advances in Theoretical Physics, Material and Atmospheric Science", Deptt. of Physics, Govt. (P.G.) College Dakpathar, Dehradun. *(invited talk)*

Air Pollution and Climate Change: A Himalayan persepective, 03 September, 2021, Two-week online summer school on "Environment & Sustainable Habitat",Deptt. of Botanical & Environmental Sciences, GND University, Amritsar. *(invited talk)*

India-Nepal collaboration initiatives in atmospheric research, 09 September, 2021, Webinar dedicated for "Azadi ka Amrit Mahotsav", Nepal Astronomical Society (NASO), Kathmandu, Nepal. *(invited talk)*

Project Review Group meeting of the UCOST sponsored R&D project, 20 September, 2021, VIGYAN DHAM, Jhajra, Dehradun. *(talk)*

Are we polluting air?: Himalaya an indicator of Climate Change, 22-28 February 2022, Program on Vigyan Sarvatra pujyate, Gurukula Kangri Vishwavidyalaya, Haridwar, (Uttarakhand). *(invited talk)*

Neelam Panwar

Deep Imaging of a young cluster NGC 1893 with the IMAGER mounted on the 3.6m DOT, 05-09 April, 2021, A national perspective on astrophysical jets and observational facilities, ARIES, Nainital. *(poster)*

Star Formation and Interstellar Medium, 17-24, May 2021, ATSOA, 2021, ARIES, Nainital. *(talk)*

Astronomy & Development, 28 February, 2022, Science Day celebration, Govt. PG College Narendranagar and Gopeshwar, Uttarakhand. *(talk)*

Formation and evolution of low-mass stars in young stars clusters, 25-29 March, 2022, The 40th Meeting of the Astronomical Society of India, IIT, Roorkee. *(poster)*

Samaresh Bhattacharjee

ARIES Wind Profiler: First central Himalayan VHF ST Radar, 31 January – 04 February, 2022, The 21st National Space Science Symposium (NSSS 2022), IISER Kolkata (online). *(talk)*

Saurabh

Initial results of the TIFR-ARIES Near Infrared Spectrometer (TANSPEC) on the 3.6m DOT, 25-29 March, 2022, The 40th Meeting of the Astronomical Society of India, IIT, Roorkee. *(poster and chair of a session)*

Santosh Joshi

New initiatives on Indo-Nepal Joint Collaboration in Astronomy and Astrophysics, 07 September, 2021, Colloquium, Nepal Astronomical Society (NASO), Kathmandu, Nepal. *(talk)*

Optical Astronomy in India and Asteroseismology, 10 January, 2022, Colloquium at Department of Physics, University of Nairobi, Kenya. *(talk)*

Asteroseismology from Ground and Space, 30 March, 2022, Colloquium at Koteb Metropolitan University, Ethipoia. *(talk)*

Snehlata

VI CCD photometric detection of variable stars in young open cluster NGC 6823, 25-29 March, 2022, The 40th Meeting of the Astronomical Society of India, IIT, Roorkee. *(poster)*

Suvendu Rakshit

Supermassive black hole in the Universe, 25-29 March, 2022, The 40th Meeting of the Astronomical Society of India, IIT, Roorkee. *(invited talk)*

Tarun Bangia

Contribution of Mechanical Engineering in the Scientific Research at ARIES, 15 September 2021, The Engineering Behind Science: Webinar and Panel Discussions organized on the occasion of National Engineer's day at ARIES, Nainital. *(talk)*

Flexible Dome seal for DOT, 25-29 March, 2022, The 40th Meeting of the Astronomical Society of India, IIT, Roorkee. *(poster)*

Vaibhav Pant

Forward modelling of MHD waves in solar atmosphere, 14-18 June, 2021, Workshop on the 'Growth of Small Scales in the Corona and Solar Wind 2021', Lorentz centre. *(talk)*

Investigating density filling factor in the solar corona using numerical simulations, 25-29 March, 2022, The 40th Meeting of the Astronomical Society of India, IIT, Roorkee. *(talk)*

Virendra Yadav

Taking astronomy to general public, 17-24 May, 2021, ATSOA, 2021, ARIES, Nainital. *(talk)*

Outreach activities at ARIES during the pandemic, 02-04 August 2021, Public Engagement in Astronomy in the Pandemic Era. *(talk)*

24-28 January 2022, Space Radiation Workshop, ARIES. *(participant)*

Universe as we see it, 02 February, 2022, Regional Science Congress. *(talk)*

Investigation of interactions between MSTIDs and mid-latitude field aligned plasma depletions over geomagnetic low-mid latitude transition region, 21-25 February, 2022, STP-15. *(talk)*

Aryabhatta Research Institute of Observational Sciences, 25-29 March, 2022, The 40th Meeting of the Astronomical Society of India, IIT, Roorkee. *(poster)*

3.6m Devasthal Optical Telescope (DOT), 25-29 March, 2022, The 40th Meeting of the Astronomical Society of India, IIT, Roorkee. *(poster)*

1.3m Devasthal Fast Optical Telescope (DFOT), 25-29 March, 2022, The 40th Meeting of the Astronomical Society of India, IIT, Roorkee. *(poster)*

4m International Liquid Mirror Telescope (ILMT), 25-29 March, 2022, The 40th Meeting of the Astronomical Society of India, IIT, Roorkee. *(poster)*

104cm Sampurnanand Telescope (ST), 25-29 March, 2022, The 40th Meeting of the Astronomical Society of India, IIT, Roorkee. *(poster)*

Yogesh C. Joshi

Search for the new exoplantary systems, 17-24 May, 2021, ATSOA 2021, ARIES, Nainital. *(talk)*

02-03 November, 2021, International Space Weather Initiative Workshop on Space Weather: Science and Applications. *(participant)*

24-28 January, 2022, Space Radiation Workshop, ARIES, Nainital. *(participant)*

Probing the nature of Luminous blue variables, 31 January – 04 February, 2022, The 21st National Space Science Symposium (NSSS 2022), IISER Kolkata (online). *(talk)*

Photometric and Spectroscopic evolution of Luminous Blue Variables in nearby galaxies, 25-29 March, 2022, The 40th Meeting of the Astronomical Society of India, IIT, Roorkee. *(poster)*

Staff Welfare Measure

Medical Facility: The institute has its medical reimbursement system through which bills on expenses of both indoor and outdoor treatment for all employees and their dependent family members are reimbursed as per CGHS rates. ARIES has empanelled multiple hospitals in Haldwani, Nainital on cashless basis through which bills on expenses are reimbursed as per CGHS rates. Two doctor are engaged by ARIES who visit the institute on a regular basis. The dispensary is equipped with generic medicines and commonly used medical instruments.

Group Insurance: A Group Insurance Scheme for the employees of the institute is operating in association with the Life Insurance Corporation of India. All the regular employees of the institute are members of the scheme.

Reservation Policy: The Institute is following post based rosters for affecting the prescribed percentage of reservations to SC/ST/OBC in all its new recruitments as per Government of India rules in this regard.

Official Language Policy: Proactive efforts are being made to ensure successful implementation of the official language. A nodal officer has been nominated for implementation of official language as per rules and directions issued by Govternment of India from time to time.

Implementation of Right to Information Act: The provisions of RTI Act have been implemented.

Prevention of Sexual Harassment of Women at Work Place: ARIES is committed to provide a safe and dignified working environment to all its employees. In this regard, ARIES have constituted the *Internal Complaints Committee against Sexual Harassment* in accordance with the "The Sexual Harassment of Women at Workplace (Prevention, Prohibition and Redressal) Act, 2013" of the Government of India for redressal of complaint made by any employee of ARIES regarding sexual harassment by a co-employee. No complaints have been received during the year. The committee also organises awareness programmes during the year **(Figure 81)**.

Canteen Facility: The institute has a canteen run by ARIES on no loss no benefit basis. In the canteen meals, snacks and beverages are prepared in hygienic condition and are served to employees, students and guests at subsidized rates.

Apart from this, the institute has a departmental store which serves employees and their family members residing in the campus.

Recreational Facilities: The institute has set up recreational facilities at the campus for the use of staff and their family members and the Ph.D. students/PDFs. The club house hosts a TT table and other indoor games. There are two full fledged badminton courts (outdoor and indoor) and a gymnasium in the campus. The welfare committee organises annual sports and cultural events meet on the occasion of Gandhi Jayanti.

Figure 81. Awareness programme on Sexual Harassment Act.

Members of ARIES

Academic (26)

Prof. Dipankar Banerjee *(Director)*

Alok C. Gupta
Brijesh Kumar
Jagdish Chandra Joshi *(from 20-01-22)*
Manish Naja
Pankaj Kushwaha *(from 01-10-21)*
Shashi Bhushan Pandey
Suvendu Rakshit
Vaidehi S. Paliya *(till 31-03-22)*
Yogesh C. Joshi
Amitesh Omar
Haritma Gaur *(Inspire Faculty Fellow)*
Jeewan C. Pandey
Narendra Singh
Ramakant Singh Yadav
Saurabh
Umesh C. Dumka
Virendra Yadav
Brajesh Kumar *(Project Scientist)*
Indranil Chattopadhyay
Kuntal Misra
Neelam Panwar
Santosh Joshi
Sneh Lata
Vaibhav Pant
Wahab Uddin

Engineering (12)

Ashish Kumar
Jayshreekar Pant
Nandish Nanjappa
Shobhit Yadava
B. Krishna Reddy
Mohit K. Joshi
Sanjit Sahu
Tarun Bangia
Chandra Prakash
Mukeshkumar B. Jaiswar
Samaresh Bhattacharjee
Tripurari S. Kumar

Administrative and Support (12)

Ravinder Kumar *(Registrar)*
Abhishek Kumar Sharma
Himanshu Vidhyarthi
Praveen Solanki
Virendra Kumar Singh
Bharat Singh *(Asstt. Registrar)*
Gaurav Meena *(till 23-12-21)*
Mahesh Chandra Pande
Rajeev Kumar Joshi
Hansa Karki
Manjay Yadav
Rajendra Prasad Joshi

Scientific and Technical (28)

Abhijit Misra
Arjun Singh
C. Arjuna Reddy
Hemant Kumar
Kanti Ram Maithani
Naveen Chandra Arya
Pradip Chakarborty
Rajan Pradhan *(till 16-04-21)*
Sanjay Kumar Singh
Vinod Kumar Sah
Anant Ram Shukla
Ashok Kumar Singh
Darwan Singh Negi
Javed Alam
Lalit Mohan Dalakoti
Nitin Pal
Prashant Kumar *(till 26-11-21)*
Rajendra Prasad
Srikant Yadav
Anil Kumar Joshi
Babu Ram
Harish Chandra Tewari
Kanhaiya Prasad
Manoj Kumar Mahto
Pavan Tiwari
Rajdeep Singh
Ravindra Kumar Yadav
Uday Singh

Laboratory Assistant/Attendants (7)

Ashok
Rakesh Kumar
Suresh Chandra Arya
Basant Ballabh Bhatt
Ramdayal Bhatt
Mohan Singh Rana
Shyam Lal

Post Doctoral Fellows/Research Associate (11)

Aarti Fulara *(till 30-11-21)*
Kaushal Sharma *(till 31-05-21)*
Pankaj Kushwaha *(till 30-09-21)*
Anjali J. Kaithkkal *(from 22-10-21)*
M. Syed Ibrahim *(till 30-09-21)*
Rakesh Mazumder *(till 08-01-22)*
Avrajit Bandyopadhyay
Manjunath Hegde
Samrat Sen *(till 14-10-21)*

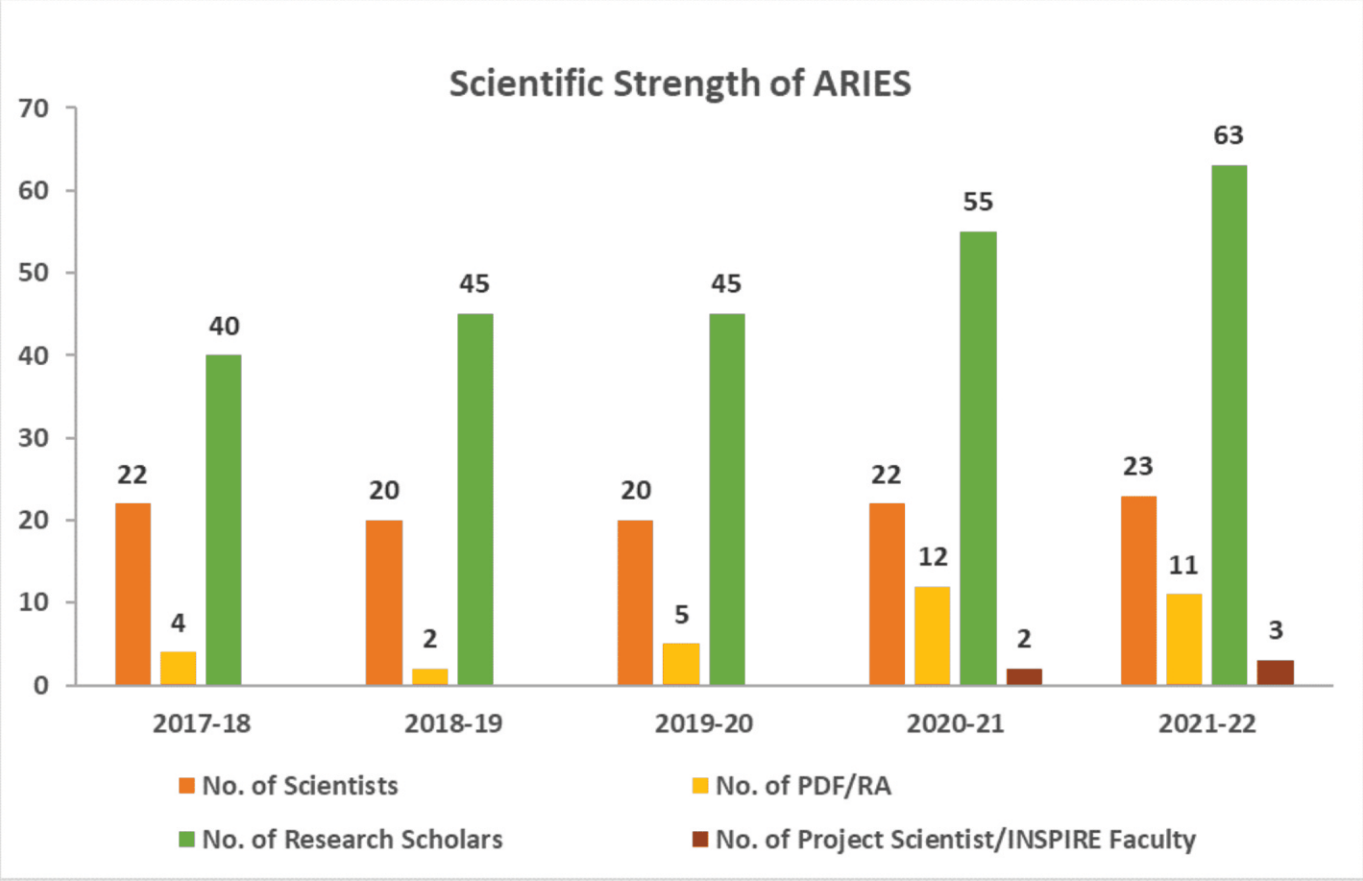
Sindhu Pandey
Varun

Research Scholars (61)

Aayushi Verma
Alaxender Panchal
Amit Kumar
Arpan Ghosh
Athul Dileep
Bibhuti Kumar Jha
Dimple
Jaydeep Singh
Karan Dogra
Kuldeep Singh *(till 11-08-21)*
Mrinmoy Sarkar
Nitin Vashishtha
Priyanka Jalan
Rahul
Raya Dastidar *(till 31-05-21)*
Sanjit Devnath
Shivangi Pandey
Srinjana Routh
Tushar Tripathi
Vikas Rawat
Vinit Dhiman
Aditya Jaiswal
Amar Aryan
Amit Kumar
Arpit Shrivastav
Bharti Arora
Devanand PU
Gurpreet Singh
Jyoti
Krishan Chand
Mahendra C. Rajwar
Naveen Dukiya
Prajjwal Singh Rawat
Priyanka Srivastava
Rahul Gupta
Ritesh Patel
Sapna Mishra *(till 31-07-21)*
Shubham Kishore
Tarak Chand
Upasna Baweja
Vikrant Tomar
Akanksha Rajput
Ambika Saxena
Ankur Ghosh
Arvind Kumar
Bhavya
Dibya Kirti Mishra
Jayanand Maurya
K. Bhageerathi
Krishan Kant Sharma
Monalisa Dubey
Nikita Rawat
Priyesh Kumar Tripathi
Rajkishore Joshi
Rakesh Pandey
Sadhana Singh
Shilpa Sarkar
Srinivas M. Rao
Tirthendu Sinha
Vibhore Negi
Vineet Ojha *(till 10-08-21)*

Integrated M.Tech-Ph.D. (Tech.) (02)

Kumar Pranshu
Purvi Udhwani



New members at ARIES

Dr. Jagdish Chandra Joshi
(Scientist C)

Post Doctoral Fellow

Dr. Anjali Kaithakkal

Integrated M. Tech-Ph.D. Students

Mr. Kumar Pranshu

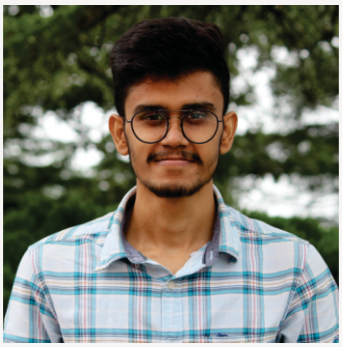
Ms. Purvi

Research Scholars

Ms. Ambika Saxena

Mr. Athul Dileep

Ms. K. Bhageerathi



Mr. Karan Dogra

Mr. Krishan Kant Sharma

Ms. Monalisa Dubey

Mr. Priyesh Kumar Tripathi

Mr. Srinivas M. Rao

Ms. Srinjana Routh

Mr. Tarak Chand

Mr. Vikrant Tomar

Abbreviations

2MASS	Two Micron All-Sky Survey
AC	Academic Committee
ADFOSC	ARIES Devasthal Faint Object Spectrograph & Camera
AGN	Active Galactic Nuclei
AGU	Auto Guider Unit
AL1SC	*Aditya-L1* Support Cell
AOS	Active Optical System
ARISS	Adapter Rotator Instrument Support Structure
ASI	Astronomical Society of India
ASPOP	ARIES Science Popularisation and Public Outreach Programme
ASTRAD	ARIES Stratosphere Troposphere Radar
ATM	Atmosphere
ATSOA	ARIES Training School in Observational Astronomy
AWS	Amazon Web Services
BAL	Broad Absorption Line
BAT	Burst alert telescope
BHI	Beam Horizontal Irradiance
BLSy1	Broad Line Seyfert1
CAD	Computer-Aided Design
CCD	Charged Coupled Device
CCTV	Closed Circuit Television Camera
CGHS	Central Government Health Scheme
CME	Coronal Mass Ejection
CMM	Coordinate Measuring Machine
CNC	Computer Numerical Control
CO	Carbon mono Oxide
CSP	Concentrated Solar Power
DDT	Director's Discretionary Time
DFOT	Devasthal Fast Optical Telescope
DOMU	DOT Operation, Maintenance and Upgradation

DOT	Devasthal Optical Telescope
DTAC	DOT Time Allotment Committee
DST	Department of Science and Technology
eBC	equivalent Black Carbon
EC	Elemental Carbon
ENSO	El Niño–Southern Oscillation
ESC	Extended Solar Cycle
ESD	Electrostatic discharge
EUV	Extreme Ultraviolet
FEA	Finite Element Analysis
FOV	Field Of View
FSRQ	Flat Spectrum Radio Quasar
FWHM	Full Width at Half Maximum
GATE	Graduate Aptitude Test in Engineering
GHI	Global Horizontal Irradiance
GNSS	Global navigation satellite system
GPS	Global Positioning System
GRB	Gamma Ray Burst
GUI	Graphical User Interface
HCT	Himalayan Chandra Telescope
HPA	High Power Amplifier
HPC	High Performance Computer
HRS	High Resolution Spectrograph
HST	Hubble Space Telescope
ILMT	International Liquid Mirror Telescope
INOV	Intra Night Optical Variability
ICT	Instrument Change Time
IR	Infrared
IRAS	Infrared Astronomical Satellite
ISM	Interstellar Medium
IVT	Instrument Verification Time
JEST	Joint Entrance Screening Test

JRF	Junior Research Fellow
JTAC	Joint Time Allocation Committee
KRC	Knowledge Resource Center
LAT	Large Area Telescope
LS	Lower Stratosphere
MAC	Mass Absorption Cross-section
TMT-MAC	TMT-Management Advisory Committee
MESA	Modules for Experiments in Stellar Astrophysics
MHD	Magnetohydrodynamic
MoU	Memorandum of Association
NE	Northeast
NET	National Eligibility Test
NGC	New General Catalog
NIC	National Informatics Centre
NKRC	National Knowledge Resource Consortium
NLSy1	Narrow Line Seyfert1
NSSL	Near-Surface Shear Layer
OPAC	Online Public Access Catalogue
PCB	Printed Circuit Board
PDF	Post Doctoral Fellow
PLC	Programmable Logic Controller
PMB	Project Management Board
PMS	Pre-Main-Sequence
PSF	Point Spread Function
PSU	Power Supply Unit
PWV	Precipitable Water Vapour
QPE	Quasi-Periodic X-ray Eruptions
QPO	Quasi-Periodic Oscillation
RWB	Redder-When-Brighter
sCMOSscientific	Complementary Metal Oxide Semiconductor
SCADA	Supervisory Control and Data Acquisition
SEA	Superposed Epoch Analysis

SFC	Surface
SRF	Senior Research Fellow
SNe	Supernovae
SNEC	Supernova Explosion Code
ST	Sampurnanand Telescope
TANSPEC	TIFR-ARIES Near Infrared Spectrometer
TCS	Telescope Control System
TESS	Transiting Exoplanet Survey Satellite
TIFR	Tata Institute of Fundamental Research
TIRCAM2	TIFR Near Infrared Imaging Camera – II
TMT	Thirty Meter Telescope
TMT	Telescope Maintenance Time
TOA	Top Of the Atmosphere
TRM	Transmit Receive Module
UCoMP	Upgraded Coronal Multi-channel Polarimeter
UPS	Uninterrupted Power Supply
UT	Upper Troposphere
UV	Ultraviolet
VELC	Visible Emission Line Coronagraph
VSP	Visiting Student Programme
WFOS	Wide-Field Optical Spectrometer
WFS	Wave Front Sensor
WISE	Wide-field Infrared Survey Explorer
WR	Wolf-Rayet
XD	Cross Dispersed
XRT	X-ray Telescope
YSO	Young Stellar Object
ZAMS	Zero Age Main Sequence

ARYABHATTA RESEARCH INSTITUTE OF OBSERVATIONAL SCIENCES, (ARIES) MANORA PEAK, NAINITAL-263001(UTTARAKHAND)

AUDITED FINANCIAL STATEMENTS

2021-2022

Audited By:-

C.A. Mukesh Goel, FCA
MUKESH GOEL & CO.
CHARTERED ACCOUNTANTS
"JHURMUT", POLYSHEET, NAINITAL ROAD
HALDWANI- 263 126
(DISTT- NAINITAL, UTTARAKHAND)
Ph: 05946-298920, 9719406671
E-MAIL:mukeshgoel3691@gmail.com

MUKESH GOEL & CO.
CHARTERED ACCOUNTANTS
[CAG Empanelment No – CR2168]

POLYSHEET, NAINITAL ROAD
HALDWANI – 263126 (UK)
PH: (05946) 298920, 9719406671
Email: mukeshgoel3691@gmail.com

FORM NO.10B
[See Rule 17B]
Audit Report under section 12A (b) of the Income Tax Act, 1961 in the case of Charitable or religious or institutions

ARYABHATTA RESEARCH INSTITUTE OF OBSERVATIONAL SCIENCES, MANORA PEAK, NAINITAL

FINANCIAL YEAR 2021-2022
UDIN: 22073335AWIQGG6640

We have examined the Balance Sheet of **ARYABHATTA RESEARCH INSTITUTE OF OBSERVATIONAL SCIENCES, [PAN: AAAAA8701B] as at 31ST March 2022** and the Income and Expenditure Account for the year ended on that date which are in agreement with the books of account maintained by the said Institution.

We have obtained all the information and explanations which of the best of our knowledge and belief were necessary for the purposes of the audit. In our opinion, proper books of account have been kept by the head office and the branches of the above-named institution visited by us so far as appears from our examination of the books, and proper Return adequate for the purposes of audit have been received from branches not visited by us **(the said Institute has no Branch)** subject to the comments given below.
"Observation, Comments, discrepancies and/or inconsistencies, if any, are given on the Statement annexed herewith".

In our opinion and to the best of our information, and according to information given to us **and subject to the *Observation, Comments, discrepancies and/or inconsistencies*** attached herewith, the said accounts give a true and fair view: -

(i) In the case of the Balance Sheet of the state of affairs of the above-named institution as at 31st March 2022.
(ii) In the case of the Income and Expenditure Account, of the surplus/(deficit) of its accounting year ending on 31st March 2022.

The prescribed particulars are annexed hereto.

For MUKESH GOEL & CO.
CHARTERED ACCOUNTANTS

MUKESH GOEL & CO. HALDWANI M.9719406671 Chartered Accountants

CA. MUKESH GOEL, FCA
PROPRIETOR
[FRN - 006150C]
[MRN - 073335]
UDIN: 22073335AWIQGG6640

PLACE: HALDWANI
DATED: September 28, 2022
ENCL: As above

ANNEXURE OF FORM 10B
STATEMENT OF PARTICULARS
FINANCIAL YEAR 2021-2022

I. APPLICATION OF INCOME FOR CHARITABLE OR RELIGIOUS PURPOSES:

1.	Amount of income of the previous year applied to charitable or religious purposes in India during that year.		**Rs. 35,32,80,050.00**
2.	Whether the institution has exercised the option under clause (2) of the Explanation to section 11 (1)? If so, the details of the amount of income deemed to have been applied to charitable or religious purposes in India during the previous year.		**Yes** **Rs. 4,01,74,953.00**
3.	Amount of income Accumulated or set apart for application to charitable or religious purposes, to the extent it does not exceed 15 per cent of the income derived from property held under trust Wholly for such purposes.		**Rs. 5,91,82,935.00**
4.	Amount of income eligible for exemption under section 11 (1)(c) [Give details]		**NIL**
5.	Amount of income, in addition to the amount referred to in item 3 above, accumulated or set apart for specified purposes under section 11 (2)		**Rs. 4,01,74,953.00**
6.	Whether the amount of income of mentioned in item 5 above has been invested or deposited in the manner laid down in section 11(2)(b)? If so, the details there of.		**Yes** **Rs. 4,01,74,953.00**
7.	Whether any part of the income in respect of which an option was exercised under clause (2) of the Explanation to section 11(1) in any earlier year is deemed to be income of the previous year under section 11(B)? If so, the details thereof.		**NA**
8.	Whether, during the previous year, any part of income accumulated or set apart for specified purposes under section11(2) in any earlier year: -		
	a.	has been applied for purposes other than charitable or religious purposes or has ceased to be accumulated or set apart for application there to, or	**NA**
	b.	has ceased to remain invested in any security referred to in section 11(2)(b)(i) or deposited in any account referred to in section 11(2)(b)(ii) or section 11(2) (b) (iii), or	**NA**
	c.	has not been utilized for purposes for which it was accumulated or set apart during the period for which it was to be accumulated or set apart, or in the year immediately following the expiry thereof? If so, the details thereof.	**NA**

Continued to page -2-

MUKESH GOEL & CO. Chartered Accountants HALDWANI M.S.T.No.406671

II. APPLICATION OR USE OF INCOME OF PROPERTY FOR THE BENEFIT OF PERSONS REFERRED TO IN SECTION 13 [3].

1.	Whether any part of the income or property of the institution lent, or continues to be lent, in the previous year to any person referred to in section 13(3) (hereinafter referred to in this Annexure as such person)? If so, give details of the amount, rate of interest charged and the nature of security, if any.	**No**
2.	Whether any part of the income or property of the institution was made, or continued to be made, available for the use of any such person during the previous year? If so, give details of the property and the amount of rent or compensation charged, if any.	**No**
3.	Whether any payment was made to any such person during the previous year by way of salary, allowance or otherwise? If so, give details.	**No**
4.	Whether the services of the institution were made available to any such person during the previous year? If so, give details thereof together with remuneration or compensation received, if any.	**No**
5.	Whether any share, security, or other property was purchased by or on behalf of the institution during the previous year from any such person? If so, give details thereof together with the consideration paid.	**No**
6.	Whether any share, security or other property was sold by or on behalf of the institution during the previous year to any such person? If so, the details thereof together with the consideration received.	**No**
7.	Whether any income or property of the institution was diverted during the previous year in favor of any such person? If so, give details thereof together with the amount of income or value of property so diverted.	**No**
8.	Whether the income or property of the institution was used or applied during the previous year for the benefit of any such person in any other manner? If so, give details.	**No**

III. INVESTMENT HELD AT ANY TIME DURING THE PREVIOUS YEAR(S) IN CONCERNS IN WHICH PERSONS REFERRED TO IN SECTION 13(3) HAVE A SUBSTANTIAL INTEREST.

Sl. No	Name and address of the concern	Where the concern is a company, number and class of shares held	Nominal value of the investment	Income for the investment	Whether the amount in Col. 4 exceeded 5% of the capital of the concern during the previous year-say Yes/No
	----------	----------	----------	NA	----------
	Total				

For MUKESH GOEL & CO.
CHARTERED ACCOUNTANTS

MUKESH GOEL & CO. HALDWANI M.9719406671 Chartered Accountants

CA. MUKESH GOEL, FCA
PROPRIETOR
[FRN - 006150C]
[MRN - 073335]

PLACE: HALDWANI
DATED: September 28, 2022

MUKESH GOEL & CO.
CHARTERED ACCOUNTANTS

POLYSHEET, NAINITAL ROAD
HALDWANI (PO – Kathgodam) - 263126
[District-Nainital, Uttarakhand]
PH: (05946) 298920, 9719406671
Email: mukeshgoel3691@gmail.com

INDEPENDENT ADUITOR'S REPORT

FINANCIAL YEAR - 2020-2021
UDIN: 22073335AWEPIY4002

To,
THE REGISRAR,
ARYABHATTA RESEARCH INSTITUTE OF OBSERVATIONAL SCIENCES (ARIES),
UNDER THE DEPARTMENT OF SCIENCE & TECHNOLOGY (DST),
GOVERNMENT OF INDIA, MANORA PEAK,
NAINITAL – 263001
[District – Nainital, Uttarakhand]

Dated: September 15, 2022

Report on the Audit of the Financial Statements:

(1) Opinion:

We have audited the accompanying Financial Statements of **"ARYABHATTA RESEARCH INSTITUTE OF OBSERVATIONAL SCIENCES (ARIES), NAINITAL, ("The Institute") (PAN: AAAAA8701B),** which comprise the Balance Sheet as at **March 31, 2022**, the Statement of Income & Expenditure and the Statement of Receipt & Payment for the year then ended, and notes to the financial statements, including a summary of significant accounting policies.

In our opinion, and to the best of our information and according to the explanations given to us the accompanying financial statements, give the information required by the applicable laws and regulations to the Institute in the manner so required and give a true and fair view in conformity with the accounting principles generally accepted in India, of the financial position of the Institute as at March 31, 2022 and its financial performance for the year then ended.

(2) Basis for Opinion:

We conducted our audit in accordance with the Standards on Auditing (SAs) issued by ICAI. Our responsibilities under those Standards are further described in the Auditor's Responsibilities for the Audit of the Financial Statements section of our report. We are independent of the Institute in accordance with the code of ethics issued by the Institute of Chartered Accountants of India (ICAI) together with the ethical requirements that are relevant to our audit of the financial statements and we have fulfilled our other ethical responsibilities in accordance with these requirements and the code of ethics.

We believe that the audit evidence we have obtained is sufficient and appropriate to provide a basis for our opinion on the financial statements.

(3) Key Audit Matters:

Key Audit Matters are those matters that, in our professional judgment, were of most significance in our audit of the financial statements of the Institute for the year ended March 31, 2022. These matters were addressed in the context of our audit of the financial statements as a whole, and in forming our opinion thereon, and we do not provide a separate opinion on these matters.

Continued to page -2-

We have determined the matters described below to be the Key Audit Matters to be communicated in our report. We have fulfilled the responsibilities described in "Auditor's Responsibilities for the Audit of the Financial Statements" section of our report, including in relation to these matters.
Accordingly, our audit included the performance of procedures designed to respond to our assessment of the risks of material misstatement of the financial statements. The results of our audit procedures, including the procedures performed to address the matters below, provide the basis for our audit opinion on the accompanying financial statements.

(a) During the financial year under audit i.e. in the financial year 2021-2022, the Institute has made following changes in its Accounting Policies: -

(i) All Project Fund's Accounts are shown as Non-Current Liabilities in the Balance Sheet of the Institute showing balance amount remained to be used in each Project Fund Account. A separate Bank Account is being maintained for each particular Project. The Project Grant received from DST as well as interest earned on the related Project Fund Bank Account is credited in the particular Project Fund Account and all the related Project Expenses are debited in that Project Fund Account.

To implement this change in accounting policy related to the accounting of Project Fund transactions, a sum of Rs. 1,45,42,299.00 is credited to the various Project Fund Accounts after debiting the "Reserves & Surplus A/C" of the Institute by the same amount.

Due to this change in accounting policy balance of Reserves & Surplus has been reduced by Rs. 1,45,42,299.00.
(Annexure – I).

Till the previous financial year i.e. till financial year 2020-2021 all the Grants received for a particular Project as well as interest earned on the related Bank Account were used to show as income of the Institute and all the Project Expenses were used to show as Institute Expenditure.

Due to this change in accounting policy surplus of the Institute has been reduced by Rs. 41,50,874.95.
(Annexure – II)

(ii) Interest earned and accrued on the Saving Bank Accounts and Fixed Deposits accounts maintained for the "Endowment Funds (GPF & Pension)" is shown as Non-Current Liability in the Financial Statements of the Institute as per management's decision.

Till the previous financial year i.e. till financial year 2020-2021 all such interests were used to show as income of the Institute.
Due to this change in accounting policy surplus of the Institute has been reduced by Rs. 33,32,839.00.
(Annexure – III)

(iii) Interest due on GPF during the financial year 2021-2022 is shown as debit balance under the head "Non-Current Liability" in the Financial Statements of the Institute as per management's decision.

Till the previous financial year i.e. till financial year 2020-2021 all such interests were used to show as Expenditure of the Institute.
Due to this change in accounting policy surplus of the Institute has been increased by Rs. 35,12,633.00.
(Annexure – III)

(iv) Interest earned on all Saving Bank Accounts of the Institute run through DST Grants is shown as current liability of the Institute as per management's decision.

Continued to page -3-

MUKESH GOEL & CO. Chartered Accountants
HARIWANI M.97[illegible]6671

Till the previous financial year i.e. till financial year 2020-2021 all such interests were used to show as income of the Institute.
Due to this change in accounting policy surplus of the Institute has been decreased by Rs. 56,51,797.00. (Annexure – IV)

(v) Interest earned on the saving Bank A/C maintained for the "Staff Welfare Fund" is credited directly to this Fund as per management's decision.

In the previous financial year i.e. till financial year 2020-2021 all such interests were used to show as income of the Institute.
Due to this change in accounting policy surplus of the Institute has been decreased by Rs. 6,100.00. (Annexure – IV)

(b) Though the institute is following "ACCRUAL" system of accounting continuously during the year under audit: -

(i) Transactions related to Salary and other establishment expenses as well as various recoveries out of the salary are recorded in the books of accounts on CASH basis as per management's decision;

(ii) Transaction related to re-imbursement of telephone expenses to employees are recorded in the books of accounts on CASH basis as per management's decision;

(iii) Transaction related to GST-TDS are recorded in the books of accounts on CASH basis as per management's decision; and

(iv) Transactions related to Accrual Interest on all the Project Bank accounts are recorded in the books of accounts on CASH basis as per management's decision.

(v) Transactions related to all legal expenses related to court cases are recorded in the books of accounts on CASH basis as per management's decision.

(c) Property, Plant & Equipment (Fixed Assets) of the Institute have not been physically verified by the management of the Institute.

(d) Property, Plant & Equipment (Fixed Asset) Register, as kept by the Institute, does not present Head-wise, Item-wise and year-wise / Date-wise details related to Cost, Depreciation and WDV of Property, Plant & Equipment (Fixed Assets).

We verified the Schedule of Property, Plant & Equipment (Fixed Assets) through accounts of the Institute maintained on Computer using "Tally-ERP-9" software.

(e) During the previous financial year 2020-2021 an addition in the Fixed Assets under the head "Telescope DOT 3.6 Mt" was made by Rs. 314,59,765.00. The payment was arranged through Four Letters of Credit (LC) issued by SBI for the procurement of the said asset. It is found that one such asset amounting Rs. 1,31,32,204.00 has not been procured by the Institute as well as the payment was not released by the Bank in favor of the Supplier till 31st day of March 2022.

Since the said LC bank account had already been closed and transferred to Fixed Assets in FY– 2020-2021, interest earned on this LC Bank Account amounting Rs. 6,69,025.00 has been debited in to the regular bank account (A/C No 253) of the Institute after crediting it in the "Interest earned account".

Further since this asset has not been procured and use of this asset has not been started in the year under audit, no depreciation is charged on this asset.

Continued to page -4-

MUKESH GOEL & CO. Chartered Accountants

(f) A sum of Rs. 2,54,69,905.00, that was shown as "Capital Work-in-progress" in the list of Fixed Assets in FY – 2020-2021, has been transferred to the Asset namely "Building – Telescope – 4Mtr" on the completion of construction work, as on march 31, 2022 and is included in the list of Property, Plant & Machinery. As the use of this asset has not been started in the financial year 2021-2022, no Depreciation is charged on this Asset during the financial year 2021-2022.

(g) A litigation was pending under Arbitration Tribunal regarding one legal claim filed by M/S Vidhyawati Construction Co. against the institute. The said legal claim has been decreed against the institute during the Financial year 2021-2022 creating a demand of Rs. 1,05,65,018.00 + interest by Arbitration Tribunal. The institute has filed an appeal against the order of Arbitration Tribunal in Commercial Court, Dehradun.

The Institute has not made any provision in this regard in the financial year 2021-2022 in its Books of Accounts. All the legal expenses incurred on this claim amounting Rs. 11,31,00000 have been shown as Expenses of the Institute during the financial year 2021-2022.

(h) Some service related legal claims are pending against the institute in the various courts as on March 31, 2022. The Institute has neither shown these claims as contingent liability in its Notes on Accounts (Schedule – 25) nor any provisions are made for any future liability as well as for legal expenses in this regard in the Books of Accounts of the Institute in the financial year 2021-2022.

(i) The Institute has not made any provisions for the following Income Tax Demands shown as contingent liability in the Notes on Accounts (Sch – 25) of financial year 2021-2022 of the Institute.

(j) Statutory liability related to FY- 2021-22 towards NPS (Employer and Employee Share) in case of Mr Jagdish Chandra Joshi, amounting Rs. 29,524.00, has not been deposited to NPS department as "PRAN" had not been allotted to the employee till 31st March 2022.

(k) Statutory liability towards NPS (Employer and Employee Share) in case of "Ravinder Kumar, Registrar, amounting Rs. 15,16,586.00 till 31st March 2022 has not been deposited to NPS department due to pending legal case in this regard.

(l) The Institute has provided and paid Rs. 62,92,053.00 towards Employer's additional NPS contribution of 4% (effective from 1st April 2019 to Oct 2021), to implement DST notification in this regard, during the financial year 2021-2022.

(m) Employer's Additional NPS Contribution of Rs. 62,92,053.00 paid during the financial year 2021-2022 includes Rs. 20,30,533.00 for financial year 2019-2020 and Rs. 23,95,468.00 for financial year 2020-2021.

(n) During the year under audit some accounts are written-off and / or adjusted, after management's approval, to overcome the irregularities and to facilitate true and fair view of the financial statements. As per these adjustments balance of Reserves & Surplus has been increased by Rs. 1,83,867.00. (Annexure – I).

(o) Value of the consumable Stocks has been taken as certified by the management of the Institute.

(p) We could not get a Report on physical verification of Property, Plant & Equipment situated at the Institute as on 31st march 2022.

Our opinion is not modified in respect of these matters.

(4) Responsibilities of Management for the Financial Statements:

The Institute's Management is responsible for the preparation and fair presentation of these financial statements that give a true and fair view of the financial position and financial performance of the Institute in accordance with the accounting principles generally accepted in India and the provisions of Rules & Regulations of the ARIES duly approved by Department of Science & Technology, Government of India.

Continued to page -5-

MUKESH GOEL & CO. Chartered Accountants HALDWANI M.No. 079406671

This responsibility also includes maintenance of adequate accounting records for safeguarding of the assets of the Institute and for preventing and detecting frauds and other irregularities; selection and application of appropriate 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 statements that give a true and fair view and are free from material misstatement, whether due to fraud or error.

In preparing the financial statements, management is responsible for assessing the Institute's ability to continue as a going concern, disclosing, as applicable, matters related to going concern and using the going concern basis of accounting unless management either intends to liquidate the Institute or to cease operations, or has no realistic alternative but to do so.

The management is also responsible for overseeing the Institute's financial reporting process.

(5) Auditor's Responsibilities 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 SAs 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.

As part of an audit in accordance with SAs, we exercise professional judgment and maintain professional skepticism throughout the audit.

We also:

- Identify and assess the risks of material misstatement of the financial statements, whether due to fraud or error, design and perform audit procedures responsive to those risks, and obtain audit evidence that is sufficient and appropriate to provide a basis for our opinion. The risk of not detecting a material misstatement resulting from fraud is higher than for one resulting from error, as fraud may involve collusion, forgery, intentional omissions, misrepresentations, or the override of internal control.
- Evaluate the appropriateness of accounting policies used and the reasonableness of accounting estimates and related disclosures made by management.
- Obtain an understanding of internal control relevant to the audit in order to design audit procedures that are appropriate in the circumstances, but not for the purpose of expressing an opinion on the effectiveness of the Institute's internal control.
- Conclude on the appropriateness of management's use of the going concern basis of accounting and, based on the audit evidence obtained, whether a material uncertainty exists related to events or conditions that may cast significant doubt on the Institute's ability to continue as a going concern. If we conclude that a material uncertainty exists, we are required to draw attention in our auditor's report to the related disclosures in the financial statements or, if such disclosures are inadequate, to modify our opinion. Our conclusions are based on the audit evidence obtained up to the date of our auditor's report. However, future events or conditions may cause the Institute to cease to continue as a going concern.

Continued to page -6-

MUKESH GOEL & CO. HALWANI M.97[illegible]0671 Chartered Accountants

- Evaluate the overall presentation, structure and control of the financial statements, including the disclosures, and whether the financial statements represent the underlying transactions and events in a manner that achieves fair presentation.

Materiality is the magnitude of misstatements of the financial statements that, individually or in aggregate, makes it probable that the economic decisions of the reasonably knowledgeable user of the financial statements may be influenced. We consider quantitative materiality and qualitative factors in (i) planning the scope of our audit work & in evaluating the results of our work; and (ii) to evaluate the effect of any identified misstatements in the financial statements.

We communicate with those charged with governance regarding, among other matters, the planned scope and timing of the audit and significant audit findings, including any significant deficiencies in internal control that we identify during our audit.

We also provide those charged with governance with a statement that we have complied with relevant ethical requirements regarding independence, and to communicate with them all relationships and other matters that may reasonably be thought to bear on our independence and where applicable, related safeguards.

From the matters communicated with those charged with governance, we determine those matters that were of most significance in the audit of the financial statements for the financial year ended March 31, 2022 and are therefore the Key Audit Matters. We describe these matters in our Auditor's Report unless law or regulation precludes public disclosure of these matters.

(6) Other Matter:

Attention is drawn to the fact that the corresponding figures for the year ended March 31, 2021 are based on the previously issued audited financial statements of the Institute.

Our opinion is not modified in respect of these matters.

(7) Report on Other Regulatory Requirements:

Further, we report that: -

a) We have obtained all the information and explanations which to the best of our knowledge and belief were necessary for the purposes of our audit subject to management representation letter;

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 subject to management representation letter & Key Audit Matters as reported in para (3) of this Audit Report; and

c) The Institute's Balance Sheet, the Statement of Income and Expenditure, and the Statement of Receipt & Payment dealt with by this Report are in agreement with the books of account, subject to management representation letter.

For **MUKESH GOEL & CO.**
CHARTERED ACCOUNTANTS

CA. MUKESH GOEL, FCA
PROPRIETOR
[FRN - 006150C]
[MRN - 073335]
UDIN: 22073335AWEPIY4002

PLACE: HALDWANI
DATED: September 28, 2022

ARIES, MANORA PEAK, NAINITAL

ANNEXURE - I:

STATEMENT SHOWING EFFECT OF CHANGE IN ACCOUNTING POLICY
RELATED TO PROJECT FUND A/C
ON THE RESERVES AND SURPLUS ACCOUNT AS ON 31-03-2022

[Amount in Rs.]

Sl. No.	Project Fund A/Cs	Project's Bank Balance as on 31-03-2021	Amount Credited to Project Fund	Amount Debited to Reserves & Surplus A/C
1	BINA - II Project A/C	7,05,368.50	7,05,368.50	7,05,368.50
2	DST - ILTP PROJECT A/C	2,65,496.50	2,65,496.50	2,65,496.50
3	DST/IMRCD/BRICS/PILOTCALL/2017-G PROJECT A/C	6,64,034.00	6,64,034.00	6,64,034.00
4	DST/INSPIRE FACULTY-BATCH - 13/2017 PROJECT A/C	11,74,708.50	11,74,708.50	11,74,708.50
5	DST INSPIRE FACULTY/BATCH - 17/2020 PROJECT A/C	0.00	0.00	0.00
6	DST/INSPIRE/FELLOWSHIP/2019 PROJECT A/C	11,189.00	11,189.00	11,189.00
7	DST/INSPIRE FELLOWSHIP PROJECT A/C	0.00	0.00	0.00
8	DST/INT/THAI/P-15-2019 PROJECT A/C	1,62,270.50	1,62,270.50	1,62,270.50
9	EMR - 2016 - 1723 PROJECT A/C	2,01,149.50	2,01,149.50	2,01,149.50
10	GVAX PROJECT A/C	542.00	542.00	542.00
11	INT/AUSTRIA/BMWF/P-14/2018 PROJECT A/C	3,12,886.50	3,12,886.50	3,12,886.50
12	INT/RUS/RFBR/P-271 PROJECT A/C	4,24,566.50	4,24,566.50	4,24,566.50
13	ISRO - ATCTM PROJECT A/C	49,75,224.50	49,75,224.50	49,75,224.50
14	ISRO - GBP - ABLN & C PROJECT A/C	1,83,095.50	1,83,095.50	1,83,095.50
15	ISRO - GBP (ARFI) PROJECT A/C	11,47,539.50	11,47,539.50	11,47,539.50
16	LC 006871 N 201604 PROJECT A/C	19,28,329.00	19,28,329.00	19,28,329.00
17	SRG/SERB/2021 PROJECT A/C	0.00	0.00	0.00
18	ST-RADAR PROJECT A/C	20,96,728.00	20,96,728.00	20,96,728.00
19	UCOST - PM 2.5 PROJECT A/C	25,122.45	25,122.45	25,122.45
20	DST - INT - POL / P-19/2016 PROJECT A/C	2,64,048.55	2,64,048.55	2,64,048.55
	Total	1,45,42,299.00	1,45,42,299.00	1,45,42,299.00

For and on behalf of ARIES, Nainital

PLACE : HALDWANI
DATED : September 05, 2022

16.9.22
(REGISTRAR)

D. Banerjee
(DIRECTOR)

ARIES, MANORA PEAK, NAINITAL

ANNEXURE - II:

STATEMENT SHOWING EFFECT OF ADJUSTMENTS IN VARIOUS ACCOUNTS ON THE RESERVES AND SURPLUS ACCOUNT AS ON 31-03-2022

[Amount in Rs.]

Sl. No.	Name of Acount Head	Reason of Adjustments	Amount Debited / (Credited) to Adjusted A/C	Amount Credited / (Debited) to Reserves & Surplus A/C
2	Accrued Interest on LC 006871 N 201604 PROJECT A/C as on 3103-2021	Due to Excess Interest credited in FY - 2020-2021 by debiting Accrued Interest	-26806.00	-26806.00
3	Accrued Interest of FY - 2020-21 on Project Bank Accounts	To adjust Accrued interest of FY- 2020-21 on Project Bank Accounts due to change of Accounting Policy for Project Fund Accounts	-32653.00	-32653.00
4	Balance Postage Stamps as on 01-04-2021	To record opening balance of Postage Stamps as on 01/04/2021	6306.00	6306.00
5	Other Incomes (Insurance Receipts)	To record receipts of some Insurance amounts in Bank A/C during FY - 2021-2022	33167.00	33167.00
6	Other Incomes (Advances paid to BRICS Project in earlier years	To adjust refund of Advance given BRICS Project in earlier years and was shown as Expenditure in that year.	180000.00	180000.00
7	Liability of NPS of earlier years	To adjust liability of NPS related to earlier years not required to pay now.	23853.00	23853.00
	Total		183867.00	183867.00

For and on behalf of ARIES, Nainital

PLACE : HALDWANI
DATED : September 05, 2022

16.09.22
(REGISTRAR)

D. Banerjee
(DIRECTOR)

ARIES, MANORA PEAK, NAINITAL

ANNEXURE - III:

STATEMENT SHOWING EFFECT OF CHANGE IN ACCOUNTING POLICY
RELATED TO PROJECT FUND A/C
ON THE FINANCIAL STATEMENTS OF FY - 2021-2022

Amount (Rs.)

Sl. No.	Project Fund A/C	Project Grants & Interests FY - 2021-2022 (Credit balance)	Project Expenses FY - 2021-2022	Net effect (Decrease in Surplus)*
(1)	(2)	(3)	(4)	(5) (3-4)
1	BINA - II PROJECT A/C	1,59,665.00	2,20,733.00	-61,068.00
2	DST - ILTP PROJECT A/C	7,242.00	0.00	7,242.00
3	DST/IMRCD/BRICS/PILOTCALL/2017-G PROJECT A/C	1,73,524.00	6,97,897.00	-5,24,373.00
4	DST/INSPIRE FACULTY-BATCH - 13/2017 PROJECT A/C	14,413.00	11,14,024.00	-10,99,611.00
5	DST INSPIRE FACULTY/BATCH - 17/2020 PROJECT A/C	16,47,308.00	0.00	16,47,308.00
6	DST/INSPIRE/FELLOWSHIP/2019 PROJECT A/C	4,02,359.00	3,72,000.00	30,359.00
7	DST/INSPIRE FELLOWSHIP PROJECT A/C	4,21,760.00	0.00	4,21,760.00
8	DST/INT/THAI/P-15-2019 PROJECT A/C	4,425.00	0.00	4,425.00
9	EMR - 2016 - 1723 PROJECT A/C	5,487.00	0.00	5,487.00
10	GVAX PROJECT A/C	16.00	0.00	16.00
11	INT/AUSTRIA/BMWF/P-14/2018 PROJECT A/C	8,422.00	8,491.00	-69.00
12	INT/RUS/RFBR/P-271 PROJECT A/C	11,579.00	0.00	11,579.00
13	ISRO - ATCTM PROJECT A/C	21,70,479.00	9,78,200.00	11,92,279.00
14	ISRO - GBP - ABLN & C PROJECT A/C	16,02,733.00	5,18,670.50	10,84,062.50
15	ISRO - GBP (ARFI) PROJECT A/C	24,765.00	5,47,593.00	-5,22,828.00
16	LC 006871 N 201604 PROJECT A/C	86,257.00	0.00	86,257.00
17	SRG/SERB/2021 PROJECT A/C	20,58,012.00	0.00	20,58,012.00
18	ST-RADAR PROJECT A/C	57,187.00	0.00	57,187.00
19	UCOST - PM 2.5 PROJECT A/C	90,451.00	73,552.00	16,899.00
20	DST - INT - POL / P-19/2016 PROJECT A/C	3,783.45	2,67,832.00	-2,64,048.55
	TOTAL	89,49,867.45	47,98,992.50	41,50,874.95

* Since Projects Grants & Interest earned are not shown as Income as well as Project Expenses are not shown as Expenditure, the excess of Project Grants & Interest, as aforesaid, will reduce the Surplus of the Institute

For and on behalf of ARIES, Nainital

16.09.22

(REGISTRAR) (DIRECTOR)

PLACE : HALDWANI
DATED : September 05, 2022

ARIES, MANORA PEAK, NAINITAL

ANNEXURE - IV:

STATEMENT SHOWING EFFECT OF CHANGE IN ACCOUNTING POLICY
RELATED TO INTEREST EARNED ON SAVING BANK A/Cs
ON THE FINANCIAL STATEMENTS AS ON 31-03-2022

			Amount (Rs.)
Sl. No.	Particulars	Accounting Treatement	Net effect (Decrease in Surplus)*
A.	Interest earned and accrued on Saving Bank Director's A/C No 253 (SBI)	Interest amount shown as current liability instead os showing as income	56,51,797.00
	(Not shown as Income)		
B.	Interest earned and accrued on Saving Bank A/C of Staff Welfare Fund (SBI)	Interest amount shown as Non-Current liability as a part of the said Fund	6,100.00
	(Not shown as Incomes)		

* Since Interest earned on Saving Bank A/Cs are not shown as Income, this will reduce the surplus of the Institute

For and on behalf of ARIES, Nainital

16.09.22

(REGISTRAR) (DIRECTOR)

PLACE : HALDWANI
DATED : September 05, 2022

ARYABHATTA RESEARCH INSTITUTE OF OBSERVATIONAL SCIENCES (ARIES)
MANORA PEAK, NAINITAL

BALANCE SHEET AS AT 31st MARCH 2022

(Amount in "Rupees")

S. NO	PARTICULARS	Schedule	Current Year	Previous Year
			For the year ended 31st March 2022	For the year ended 31st March 2021
	CORPUS/ CAPITAL FUND AND LIABILITIES			
1	CORPUS/ CAPITAL FUND	1	1,29,00,50,321.28	1,28,83,74,619.08
2	RESERVES AND SURPLUS	2	(23,76,737.05)	1,19,81,694.95
3	NON - CURRENT LIABILITIES:			
	EARMARKED/ ENDOWMENT FUNDS	3	10,81,32,354.06	10,05,17,459.06
	STAFF WELFARE FUND	4	83,567.50	35,570.50
	PROJECT FUND	4A	1,86,93,173.95	-
4	SECURED LOANS AND BORROWINGS	5	-	-
5	UNSECURED LOANS AND BORROWINGS	6	-	-
6	DEFERRED CREDIT LIABILITIES	7	-	-
7	CURENT LIABILITIES AND PROVISIONS	8	1,61,25,938.50	1,58,54,543.50
	TOTAL LIABILITIES		1,43,07,08,618.24	1,41,67,63,887.09
	ASSETS			
9	PROPERTY, PLANT & EQUIPMENT	9	1,08,76,45,024.30	1,12,25,78,812.92
10	INVESTMENTS - FROM ENDOWMENT FUNDS	10	3,09,87,399.00	3,02,13,163.00
11	INVESTMENTS - OTHERS	11	36,23,164.00	34,78,522.00
12	CURRENT ASSETS, LOANS, ADVANCES ETS.	12	30,84,53,030.94	26,04,93,389.17
13	MISCELLANEOUS EXPENDITURE (to the extent not written off or adjusted)		-	-
	TOTAL ASSETS		1,43,07,08,618.24	1,41,67,63,887.09
14	SIGNIFICANT ACCOUNTING POLICIES	24		
15	CONTINGENT LIABILITIES AND NOTES ON ACCOUNTS	25		

As per our separate Audit Report of even date attached.

For MUKESH GOEL & CO.
CHARTERED ACCOUNTANTS

MUKESH GOEL & CO. HALDWANI M.9719406671 Chartered Accountants

CA. MUKESH GOEL, FCA
PROPRIETOR
[FRN - 006150C]
[MRN - 073335]

PLACE : HALDWANI
DATED : September 28, 2022

For and on behalf of ARIES, Nainital

(REGISTRAR) (DIRECTOR)

ARYABHATTA RESEARCH INSTITUTE OF OBSERVATIONAL SCIENCES (ARIES)
MANORA PEAK, NAINITAL

STATEMENT OF INCOME AND EXPENDITURE FOR THE YEAR ENDED 31st MARCH 2022

(Amount in "Rupees")

S. NO	PARTICULARS	SCH	Current Year For the year ended 31st March 2022	Previous Year For the year ended 31st March 2021
	(A) INCOMES:			
1	Income from Sales/Services	13	-	-
2	Grants/Subsidies - Establishment	14	16,10,00,000.00	18,90,00,000.00
	Grants/Subsidies - Other Admin Expenses	14	7,21,00,000.00	6,50,00,000.00
3	Project Grants	14A	-	64,19,005.00
4	Fees/Subscriptions	15	-	-
5	Income from Investments	16	10,93,719.00	17,29,502.00
6	Income from Royalty, Publication etc.	17	-	-
7	Interest Earned	18	25,06,245.00	83,19,351.46
8	Other Income	19	53,87,266.12	73,54,159.36
9	Increase/(decrese) in stock of Finished goods and works-in-progress	20	(15,65,669.71)	3,56,215.62
	TOTAL (A)		24,05,21,560.41	27,81,78,233.44
	(B) EXPENDITURES:			
10	Establishment Expenses	21	16,94,19,832.00	15,37,03,782.00
11	Other Administrative Expenses etc.	22	6,81,73,503.35	6,10,68,030.87
12	Expenditure on Projects	23	-	1,51,76,189.25
13	Interest Expenditures	24	35,12,633.00	1,29,35,782.00
	TOTAL (B)		24,11,05,968.35	24,28,83,784.12
	Balance being excess of Income / (Expenditure) (A - B)		(5,84,407.94)	3,52,94,449.32
14	Depreciation (corresponding to Sch 9)	9	(14,86,39,889.86)	(15,61,19,132.78)
15	Transfer to Special Reserve (Specify each)		-	-
16	Transfer to / from General Reserve		-	-
	BALANCE BEING SURPLUS/(DEFICIT) CARRIED TO CORPUS/ CAPITAL FUND		(14,92,24,297.80)	(12,08,24,683.46)
18	SIGNIFICANT ACCOUNTING POLICIES	24		
19	CONTINGENT LIABILITIES AND NOTES ON ACCOUNTS	25		

As per our separate Audit Report of even date attached.

For MUKESH GOEL & CO.
CHARTERED ACCOUNTANTS

CA. MUKESH GOEL, FCA
PROPRIETOR
[FRN - 006150C]
[MRN - 073335]

PLACE : HALDWANI
DATED : September 28, 2022

MUKESH GOEL & CO. HALDWANI M.9719406671 Chartered Accountants

For and on behalf of ARIES, Nainital

(REGISTRAR) (DIRECTOR)

ARYABHATTA RESEARCH INSTITUTE OF OBSERVATIONAL SCIENCES (ARIES)
MANORA PEAK, NAINITAL

SCHEDULES FORMING PART OF BALANCE SHEET AS AT 31st March 2022

	SCHEDULE 1 - CORPUS/CAPITAL FUND		(Amount in Rupees)
S.NO	PARTICUALRS	Current Year For the year ended 31st March 2022 (Credit)	Previous Year For the year ended 31st March 2021 (Credit)
1	Balance as at the beginning of the year	1,28,83,74,619.08	1,31,58,94,823.10
2	Add : Contributions towards Corpus/Capital Fund	15,09,00,000.00	10,95,00,000.00
3	Add / (Deduct) : Balance of net Income / - (Expenditure) transferred from the Income and Expenditure Account	(14,92,24,297.80)	(12,08,24,683.46)
4	Add / (Deduct) : Unspent Grant	-	-
5	Add / (Deduct) : Adjustment - Excess Interest paid to DST in 2016-17		(1,61,95,520.56)
	BALANCE AS AT THE YEAR - END	1,29,00,50,321.28	1,28,83,74,619.08

	SCHEDULE 2 - RESERVES AND SURPLUS		(Amount in Rupees)
S.NO	PARTICUALRS	Current Year For the year ended 31st March 2022 (Credit)	Previous Year For the year ended 31st March 2021 (Credit)
1	Capital Reserve :		
	As per last Account	-	-
	Addition / (Dedutions) during the year	-	-
2	Revaluation Reserve :		
	As per last Account	-	-
	Addition / (Dedutions) during the year	-	-
3	Special Reserves :		
	As per last Account	-	-
	Addition / (Dedutions) during the year	-	-
4	General Reserve :		
	As per last Account (31.03.2021)	1,19,81,694.95	1,63,76,621.46
	Additions during the year	2,43,326.00	21,89,310.49
	(Dedutions) during the year	(1,46,01,758.00)	(65,84,237.00)
	TOTAL	(23,76,737.05)	1,19,81,694.95

Annexed to the Balance Sheet of even date attached.

For MUKESH GOEL & CO.
CHARTERED ACCOUNTANTS

CA. MUKESH GOEL, FCA
PROPRIETOR
[FRN - 006150C]
[MRN - 073335]

MUKESH GOEL & CO. HALDWANI M.9719406671 Chartered Accountants

PLACE : HALDWANI
DATED : September 28, 2022

For and on behalf of ARIES, Nainital

(REGISTRAR)

D. Banerjee
(DIRECTOR)

ARYABHATTA RESEARCH INSTITUTE OF OBSERVATIONAL SCIENCES (ARIES)
MANORA PEAK, NAINITAL

SCHEDULES FORMING PART OF BALANCE SHEET AS AT 31st March 2022

	SCHEDULE 3 - EARMARKED/ENDOWMENT FUNDS					(Amount in Rupees)	
S.NO	PARTICUALRS	Fund Wise Breakup				Current Year Total	Previous Year Total
						For the year ended 31st March 2022	For the year ended 31st March 2021
		GPF Fund	GPF Reserve	Pension Fund	Pension Reserve	(Credit)	(Credit)
A	Opening Balance of Funds	46110128.00	48,79,418.56	27548640.56	21979271.94	100517459.06	112467190.06
	Total (A)	46110128.00	4879418.56	27548640.56	21979271.94	100517459.06	112467190.06
B	Additions :						
	a) Employee's Contributions	7503000.00	-		-	7503000.00	7296020.00
	b) Interest Accrued	3512633.00	-	-	-	3512633.00	3091061.00
	c) Recoveries of Advances	41425.00	-	-	-	41425.00	177500.00
	d) Transferred from Reserve		-	-	-	0.00	-
	e) Interest Contribution	-	-	-	-	0.00	-
	f) Endowment Surplus	-	-	-	-	0.00	-
	g) Pension Payable	-	-	-	-	0.00	-
	TOTAL (B)	11057058.00	0.00	0.00	0.00	11057058.00	10564581.00
C	Utilisation/Payments:						
	a) Capital Payments:	-		-	-	-	-
	Transferred to GPF Fund	-	-	-	-	-	-
	b) Revenue Payments:	-	-	-	-	-	-
	-Permanent Withdrawls	1790000.00	-	-	-	17,90,000.00	-
	-Recoverable Advances		-	-	-	-	2530000.00
	-Retirement Payment		-	16,52,163.00	-	16,52,163.00	19984312.00
	-Advances of Previous yrs		-	-	-	-	0.00
	-Pension (Last year Prov)	-	-	-		-	0.00
	TOTAL (C)	1790000.00	-	1652163.00	-	3442163.00	22514312.00
	NET BALANCE [A + B - C]	55377186.00	4879418.56	25896477.56	21979271.94	108132354.06	100517459.06

Annexed to the Balance Sheet of even date attached.

For MUKESH GOEL & CO.
CHARTERED ACCOUNTANTS

MUKESH GOEL & CO. HALDWANI M.9719406671 Chartered Accountants

CA. MUKESH GOEL, FCA
PROPRIETOR
[FRN - 006150C]
[MRN - 073335]

PLACE : HALDWANI
DATED : September 28, 2022

For and on behalf of ARIES, Nainital

(REGISTRAR) (DIRECTOR)

ARYABHATTA RESEARCH INSTITUTE OF OBSERVATIONAL SCIENCES (ARIES)
MANORA PEAK, NAINITAL

SCHEDULES FORMING PART OF BALANCE SHEET AS AT 31st March 2022

	SCHEDULE 4 - STAFF WELFARE FUND		(Amount in Rupees)
S.NO	PARTICUALRS	Current Year For the year ended 31st March 2022 (Credit)	Previous Year For the year ended 31st March 2021 (Credit)
1	Balance as at the beginning of the year	35,570.50	-
2	ADD:		
	Staff Contribution Received	99,725.00	64,100.00
	Bank Interest	6,100.00	244.00
3	TOTAL STAFF WELFARE FUND VALUE (1 + 2)	1,41,395.50	64,344.00
4	LESS:		
	Staff Welfare Expenses	57,828.00	28,272.00
	Bank Expenses	0.00	501.50
	TOTAL STAFF WELFARE EXPENSES (4)	57,828.00	28,773.50
	BALANCE AS AT THE YEAR - END [3 - 4]	83,567.50	35,570.50

	SCHEDULE 5 - SECURED LOANS AND BORROWINGS		(Amount in Rupees)
S.NO	PARTICUALRS	Current Year For the year ended 31st March 2022 (Credit)	Previous Year For the year ended 31st March 2021 (Credit)
1	Central Government	-	-
2	State Government	-	-
3	Financial Institutions		
	a) Term Loans	-	-
	b) Interest accrued and due	-	-
4	Banks:		
	a) Term Loans	-	-
	Interest accrued and due	-	-
	b) Other Loans	-	-
	Interest accrued and due	-	-
5	Other Institutions and Agencies	-	-
6	Debentures and Bonds	-	-
7	Others	-	-
	TOTAL	-	-

Annexed to the Balance Sheet of even date attached.

For MUKESH GOEL & CO.
CHARTERED ACCOUNTANTS

MUKESH GOEL & CO. HALDWANI M.9719406871 Chartered Accountants

CA. MUKESH GOEL, FCA
PROPRIETOR
[FRN - 006150C]
[MRN - 073335]

PLACE : HALDWANI
DATED : September 28, 2022

For and on behalf of ARIES, Nainital

(REGISTRAR) (DIRECTOR)

ARYABHATTA RESEARCH INSTITUTE OF OBSERVATIONAL SCIENCES (ARIES)
MANORA PEAK, NAINITAL

SCHEDULES FORMING PART OF BALANCE SHEET AS AT 31st March 2022

	SCHEDULE 4A - PROJECT FUND		(Amount in Rupees)
S.NO	PARTICUALRS	Current Year	Previous Year
		For the year ended 31st March 2022	For the year ended 31st March 2021
		(Credit)	(Credit)
1	ISRO-GBP-ARFI PROJECT	6,24,711.50	-
2	BINA II PROJECT	6,44,300.50	-
3	ISRO - ATCTM PROJECT	61,67,503.50	-
4	ISRO-GBP-ABLN & C PROJECT	12,67,158.00	-
5	LC 006871 N - 2016-04	20,14,586.00	-
6	ST RADAR PROJECT	21,53,915.00	-
7	DST - ILTP PROJECT	2,72,738.50	-
8	EMR-2016-1723 PROJECT	2,06,636.50	-
9	DST/ INSPIRE FACULTY BATCH - 17/2020 PROJECT	16,47,308.00	-
10	DST/ INSPIRE FELLOWHIP PROJECT	4,21,760.00	
11	INT/RUS/RFBR/P-271 PROJECT	4,36,145.50	
12	DST/IMRCD/BRICS/PILOTCALL/2017-G PROJECT	1,39,661.00	-
13	DST/INSPIRE FACULTY BATCH-13/2017 PROJECT	75,097.50	-
14	INT/AUSTRIA/BMWF/P-14/2018 PROJECT	3,12,817.50	-
15	DST/INT/THAI/P-15-2019 PROJECT	1,66,695.50	-
16	DST/INSPIRE FELLOWSHIOP - 2019 PROJECT	41,548.00	-
17	UCOST - PM 2.5 PROJECT	42,021.45	-
18	GVAX PROJECT	558.00	-
19	SRG/SERB/2021 PROJECT	20,58,012.00	-
	TOTAL	1,86,93,173.95	-

Annexed to the Balance Sheet of even date attached.

For MUKESH GOEL & CO.
CHARTERED ACCOUNTANTS

CA. MUKESH GOEL, FCA
PROPRIETOR
[FRN - 006150C]
[MRN - 073335]

PLACE : HALDWANI
DATED : September 28, 2022

MUKESH GOEL & CO. HALDWANI M.9719406671 Chartered Accountants

For and on behalf of ARIES, Nainital

(REGISTRAR) (DIRECTOR)

ARYABHATTA RESEARCH INSTITUTE OF OBSERVATIONAL SCIENCES (ARIES)
MANORA PEAK, NAINITAL

SCHEDULES FORMING PART OF BALANCE SHEET AS AT 31st March 2022

	SCHEDULE 6 - UNSECURED LOANS AND BORROWINGS		(Amount in Rupees)
S.NO	PARTICUALRS	Current Year For the year ended 31st March 2022 (Credit)	Previous Year For the year ended 31st March 2021 (Credit)
1	Central Government	-	-
2	State Government (Specify)	-	-
3	Financial Institutions	-	-
4	Banks:		
	a) Term Loans	-	-
	b) Other Loans (specify)	-	-
5	Other Institutions and Agencies	-	-
6	Debentures and Bonds	-	-
7	Fixed Deposits	-	-
8	Others (Specify)	-	-
	TOTAL	-	-

	SCHEDULE 7 - DEFERRED CREDIT LIABILITIES		(Amount in Rupees)
S.NO	PARTICUALRS	Current Year For the year ended 31st March 2022 (Credit)	Previous Year For the year ended 31st March 2021 (Credit)
1	Acceptances secured by hypothecation of Capital Equipments and other assets	-	-
2	Others	-	-
	TOTAL	-	-

Annexed to the Balance Sheet of even date attached.

For MUKESH GOEL & CO.
CHARTERED ACCOUNTANTS

CA. MUKESH GOEL, FCA
PROPRIETOR
[FRN - 006150C]
[MRN - 073335]

MUKESH GOEL & CO. HALDWANI M.9719406671 Chartered Accountants

For and on behalf of ARIES, Nainital

(REGISTRAR) (DIRECTOR)

PLACE : HALDWANI
DATED : September 28, 2022

ARYABHATTA RESEARCH INSTITUTE OF OBSERVATIONAL SCIENCES (ARIES)
MANORA PEAK, NAINITAL

SCHEDULES FORMING PART OF BALANCE SHEET AS AT 31st March 2022

	SCHEDULE 8 - CURRENT LIABILITIES AND PROVISIONS			(Amount in Rupees)	
S.NO	PARTICUALRS	Current Year For the year ended 31st March 2022		Previous Year For the year ended 31st March 2021	
		(Credit)	(Credit)	(Credit)	(Credit)
	A. CURRENT LIABILITIES:				
1	Acceptances		-		-
2	Sundry Creditors *	-	-	-	-
3	Advances Received - Scientific Meeting		-		-
4	Interest accrued but not due on:				
	a) Secured Loans /borrowings	-		-	
	b) Unsecured Loans/borrowings	-	-	-	-
5	Interest on SBI (Director's) Bank A/C - 253	56,51,797.00	56,51,797.00	-	-
6	Statutory Liabilities:				
	a) GST Reverse Charge	-		-	
	b) GST TDS Payable	1,41,389.00		-	
	c) TDS Payable *	3,80,704.00		3,71,760.00	
	d) Labour Cess (March 2021)	38,013.50		24,948.50	
	e) NPS (Employee's Contribution)*	12,302.00		1,05,220.00	
	f) NPS (Employer's Contribution)*	17,222.00		81,367.00	
	g) NPS of R.Kumar (Employee Contribution)	6,82,046.00		5,40,653.00	
	h) NPS of R.Kumar (Employer Contribution)	8,34,540.00	21,06,216.50	5,40,653.00	16,64,601.50
7	Other Curent Liabilities:				
	a) Earnest Money Deposits*	35,000.00		43,71,000.00	
	b) Performance Security Deposits*	12,49,404.00		8,66,944.00	
	c) Other Securities - RSD -Devakinandan	10,78,208.00		4,18,879.00	
	d) Misc. Project Grant to be transferred (Grants received but neither allocated to project(s) nor transferred to related Bank Account(s)	32,70,884.00		16,29,920.00	
	e) Outstanding Expenses*	26,75,101.00		68,14,925.00	
	f) Group Insurance	240.00		20,715.00	
	g) G. N. Pathak - Pensioner	39,774.00		39,774.00	
	h) L S kanwal - Pensioner	12,071.00		12,071.00	
	i) Shyam Giri - Pensioner	7,243.00		7,243.00	
	k) Ratna Kumar - Fellowship	-	83,67,925.00	8,471.00	1,41,89,942.00
	TOTAL (A)		1,61,25,938.50		1,58,54,543.50
	B. PROVISIONS :				
1	Taxation		-		-
2	Gratuity		-		-
3	Accumulated Leave Encashment		-		-
4	Others (Specify)		-		-
	TOTAL (B)		-		-
	TOTAL (A+B)		1,61,25,938.50		1,58,54,543.50

* Separate List Attached.

Annexed to the Balance Sheet of even date attached.

For MUKESH GOEL & CO.
CHARTERED ACCOUNTANTS

MUKESH GOEL & CO. HALDWANI M.9719406671 Chartered Accountants

CA. MUKESH GOEL, FCA
PROPRIETOR
[FRN - 006150C]
[MRN - 073335]

PLACE : HALDWANI
DATED : September 28, 2022

For and on behalf of ARIES, Nainital

(REGISTRAR) (DIRECTOR)

ARYABHATTA RESEARCH INSTITUTE OF OBSERVATIONAL SCIENCES (ARIES)
MANORA PEAK, NAINITAL
SCHEDULES FORMING PART OF BALANCE SHEET AS AT 31st March 2022

SCHEDULE 9 - PROPERTY, PLANT & EQUIPMENT:

(Amount in Rupees)

S.NO.	DESCRIPTION	Rate	GROSS BLOCK					DEPRECIATION				NET BLOCK	
			Cost/valuation As at beginning of the year (01.04.2021)	Additions During the Year (> 180 days)	Additions During the Year (< 180 days)	Sales/Deductions / W-off during the year	Cost/valuation at the year end (31.03.2022)	As at the beginning of the year (01.04.2021)	On [Op. WDV + Additions - Sale/Ded/W-off (> 180 days) - Deductions]	On Additions During the Year (< 180 days)	Total Depreciation up to the year end (31.03.2022)	As at the Current Year end (31.03.2022)	As at the Previous Year end (31.03.2021)
			(1)	(2)	(3)	(4)	5 (1+2+3-4)	(6)	(7)	(8)	9 (7+8)	10 (5-9)	(11)
1	PROPERTY, PLANT & EQUIPMENT:												
A	LAND:	0%											
	LAND		10,58,50,429.00	-	-	-	10,58,50,429.00	-	-	-	-	10,58,50,429.00	10,58,50,429.00
	TOTAL (A)		10,58,50,429.00	-	-	-	10,58,50,429.00	-	-	-	-	10,58,50,429.00	10,58,50,429.00
B	BUILDINGS & INFRASTRUCTURES	10%											
	Building 3.60 Telescope		3,46,01,869.00	-	-	-	3,46,01,869.00	1,63,15,344.22	18,28,652.48	-	1,81,43,996.70	1,64,57,872.30	1,82,86,524.78
	Building Non-Res (Devsthal)		2,85,27,064.00	-	-	-	2,85,27,064.00	96,95,392.57	18,83,167.14	-	1,15,78,559.71	1,69,48,504.29	1,88,31,671.43
	Building Non-Res (Manora Peak)		11,08,38,703.00	-	44,85,641.00	-	11,53,24,344.00	7,66,98,659.99	34,14,004.30	2,24,282.05	8,03,36,946.34	3,49,87,397.66	3,41,40,043.01
	Building 4MT Telescope*		-	-	2,54,69,905.00	-	2,54,69,905.00	-	-	-	-	2,54,69,905.00	-
	Infrastructure Dev. (Dev Sthal)		5,00,72,786.90	-	-	-	5,00,72,786.90	2,52,39,298.75	24,83,348.81	-	2,77,22,647.57	2,23,50,139.33	2,48,33,488.15
	Infrastructure Dev. (Manora Peak)		1,60,70,946.70	-	-	-	1,60,70,946.70	91,74,104.41	6,89,684.23	-	98,63,788.64	62,07,158.06	68,96,842.29
	Roads at Devsthal		2,28,49,164.00	-	-	-	2,28,49,164.00	1,49,36,869.88	7,91,229.41	-	1,57,28,099.29	71,21,064.71	79,12,294.12
	TOTAL (B)		26,29,60,533.60	-	2,99,55,546.00	-	29,29,16,079.60	15,20,59,669.81	1,10,90,086.38	2,24,282.05	16,33,74,038.24	12,95,42,041.36	11,09,00,863.79
C	Buildings - Residential	5%											
	Guest House (Devsthal)		12,24,022.00	-	-	-	12,24,022.00	6,02,893.33	31,056.43	-	6,33,949.77	5,90,072.23	6,21,128.67
	Building Residential (Manora Peak)		3,07,19,204.60	-	-	-	3,07,19,204.60	1,09,22,099.24	9,89,855.27	-	1,19,11,954.51	1,88,07,250.09	1,97,97,105.36
	TOTAL (C)		3,19,43,226.60	-	-	-	3,19,43,226.60	1,15,24,992.58	10,20,911.70	-	1,25,45,904.28	1,93,97,322.32	2,04,18,234.02
D	VEHICLES	15%											
	Vehicle		56,63,379.10	-	16,22,915.00	-	72,86,294.10	30,74,905.49	3,88,271.04	1,21,718.63	35,84,895.16	37,01,398.94	25,88,473.61
	TOTAL (D)		56,63,379.10	-	16,22,915.00	-	72,86,294.10	30,74,905.49	3,88,271.04	1,21,718.63	35,84,895.16	37,01,398.94	25,88,473.61
E	FURNITURE AND FIXTURES	10%											
	Furniture & Fixture		1,16,07,086.70	20,99,470.00	1,05,04,974.00	-	2,42,11,530.70	65,85,766.47	7,12,079.02	5,25,248.70	78,23,094.19	1,63,88,436.51	50,21,320.23
	TOTAL (E)		1,16,07,086.70	20,99,470.00	1,05,04,974.00	-	2,42,11,530.70	65,85,766.47	7,12,079.02	5,25,248.70	78,23,094.19	1,63,88,436.51	50,21,320.23
F	OFFICE EQUIPMENTS	10%											
	Office Equipment		22,17,236.25	27,828.00	-	-	22,45,064.25	13,33,369.14	91,169.51	-	14,24,538.65	8,20,525.60	8,83,867.11
	TOTAL (F)		22,17,236.25	27,828.00	-	-	22,45,064.25	13,33,369.14	91,169.51	-	14,24,538.65	8,20,525.60	8,83,867.11
G	COMPUTER/PERIPHERALS	40%											
	Computer & Peripherals		5,32,46,418.40	19,32,472.00	68,86,751.00	-	6,20,65,641.40	4,55,92,839.83	38,34,420.23	13,77,350.20	5,08,04,610.26	1,12,61,031.14	76,53,578.57
	Computer Software		41,57,967.00	13,55,689.24	29,14,301.00	-	84,27,957.24	25,79,017.42	11,73,855.53	5,82,860.20	43,35,733.15	40,92,224.09	15,78,949.58
	TOTAL (G)		5,74,04,385.40	32,88,161.24	98,01,052.00	-	7,04,93,598.64	4,81,71,857.26	50,08,275.75	19,60,210.40	5,51,40,343.41	1,53,53,255.23	92,32,528.14
H	ELECTRIC INSTALLATIONS	15%											
	Electrical (Non-Consumable)		74,08,200.00	23,73,210.00	29,75,441.00	-	1,27,56,851.00	11,95,092.90	12,87,947.57	2,23,158.08	27,06,198.54	1,00,50,652.46	62,13,107.10
	Electric Instalation (Devasthal)		43,53,265.00	3471898.00	68,781.00	-	78,93,944.00	29,37,655.40	7,33,126.14	5,158.58	36,75,940.11	42,18,003.89	14,15,609.60
	Electric Instalation (Manora Peak)		1,49,83,909.72	-	40,26,743.00	-	1,90,10,652.72	75,04,827.90	11,21,862.27	3,02,005.73	89,28,695.90	1,00,81,956.82	74,79,081.82
	Electronic Section		91,66,239.55	-	-	-	91,66,239.55	82,00,848.86	1,44,808.60	-	83,45,657.47	8,20,582.08	9,65,390.69
	Electronic Substation-DOT 3.6 Mt		39,38,840.00	77,97,765.00	5,69,667.00	-	1,23,06,272.00	10,93,028.10	15,96,536.54	42,725.03	27,32,289.66	95,73,982.34	28,45,811.90
	Solar Section		6,380.79	-	-	-	6,380.79	6,380.79	-	-	6,380.79	-	-
	TOTAL (H)		3,98,56,835.06	1,36,42,873.00	76,40,632.00	-	6,11,40,340.06	2,09,37,833.95	48,84,281.12	5,73,047.40	2,63,95,162.47	3,47,45,177.59	1,89,19,001.11
I	LIBRARY BOOKS	40%											
	Library Books		5,99,98,076.50	-	37,663.00	-	6,00,35,739.50	5,65,93,141.20	13,61,974.12	7,532.60	5,79,62,647.92	20,73,091.58	34,04,935.30
	TOTAL (I)		5,99,98,076.50	-	37,663.00	-	6,00,35,739.50	5,65,93,141.20	13,61,974.12	7,532.60	5,79,62,647.92	20,73,091.58	34,04,935.30

Continued to page - 2-

MUKESH GOEL & CO. HALDWANI M.97[illegible]6671 Chartered Accountants

S.NO.	DESCRIPTION	Rate	GROSS BLOCK					DEPRECIATION				NET BLOCK	
			Cost/valuation As at beginning of the year (01.04.2021)	Additions During the Year (> 180 days)	Additions During the Year (< 180 days)	Sales/Deductions / W-off during the year	Cost/valuation at the year end (31.03.2022)	As at the beginning of the year (01.04.2021)	On [Op. WDV + Additions - Sale/Ded/W-off (> 180 days) - Deductions]	On Additions During the Year (< 180 days)	Total Depreciation up to the year end (31.03.2022)	As at the Current Year end (31.03.2022)	As at the Previous Year end (31.03.2021)
			(1)	(2)	(3)	(4)	5 (1+2+3-4)	(6)	(7)	(8)	9 (7+8)	10 (5-9)	(11)
J	PLANT MACHINERY & EQUIPMENT	15%											
	Telescope - DOT 3.6 Mt		1,27,78,56,685.00	52,05,816.00	-	-	1,28,30,62,501.00	69,06,33,938.15	8,68,94,453.83	-	77,75,28,391.97	50,55,34,109.03	58,72,22,746.85
	Telescope - 1.3 Mt		9,22,52,249.00	-	-	-	9,22,52,249.00	6,84,67,772.95	35,67,671.41	-	7,20,35,444.36	2,02,16,804.64	2,37,84,476.05
	Telescope		1,60,36,766.55	-	-	-	1,60,36,766.55	63,42,921.39	14,54,076.77	-	77,96,998.16	82,39,768.39	96,93,845.16
	Backend Instrument -Modernization		16,41,75,713.00	4,63,654.00	-	-	16,46,39,367.00	7,30,68,295.35	1,37,35,660.75	-	8,68,03,956.09	7,78,35,410.91	9,11,07,417.65
	Backend Instrumemt - ADFOSC		39,44,215.00	-	7,40,520.00	-	46,84,735.00	27,10,272.85	1,85,091.32	55,539.00	29,50,903.17	17,33,831.83	12,33,942.15
	Instruments		10,85,56,104.67	9,39,280.00	-	-	10,94,95,384.67	8,14,50,669.86	42,06,707.22	-	8,56,57,377.08	2,38,38,007.59	2,71,05,434.81
	Aluminization Plant (Devsthal)		3,95,23,736.00	-	-	-	3,95,23,736.00	2,19,86,844.24	26,30,533.76	-	2,46,17,378.00	1,49,06,358.00	1,75,36,891.76
	LIDAR Project		87,60,465.00	2,30,000.00	-	-	89,90,465.00	73,57,853.23	2,44,891.77	-	76,02,744.99	13,87,720.01	14,02,611.78
	Optics		4,54,597.80	12,999.00	44,64,166.00	-	49,31,762.80	1,66,323.69	45,190.97	3,34,812.45	5,46,327.11	43,85,435.69	2,88,274.11
	High Resolution Spectograph (HRS)		-	-	2,27,19,507.00	-	2,27,19,507.00	-	-	17,03,963.03	17,03,963.03	2,10,15,543.98	-
	CSNOF-09 - 4.2 ILMT Project		-	38,339.00	94,899.00	-	1,33,238.00	-	5,750.85	7,117.43	12,868.28	1,20,369.73	-
	Telecscope (Schmidt)		1,07,38,623.00	-	-	-	1,07,38,623.00	91,86,064.09	2,32,883.84	-	94,18,947.92	13,19,675.08	15,52,558.92
	Planetarium (Public Outreach)		39,18,714.00	-	-	-	39,18,714.00	28,50,901.42	1,60,171.89	-	30,11,073.31	9,07,640.69	10,67,812.58
	Projector (Public Outreach)		1,05,000.00	-	-	-	1,05,000.00	82,503.86	3,374.42	-	85,878.28	19,121.72	22,496.14
	Spectrometer		10,62,951.00	-	-	-	10,62,951.00	5,49,699.38	76,987.74	-	6,26,687.12	4,36,263.88	5,13,251.62
	Telescope (Public Out Reach)		6,07,295.00	-	-	-	6,07,295.00	4,87,733.82	17,934.18	-	5,05,668.00	1,01,627.00	1,19,561.18
	Telescope Solar		13,67,166.00	6,48,979.00	-	-	20,16,145.00	11,93,003.50	1,23,471.23	-	13,16,474.72	6,99,670.28	1,74,162.50
	ST RADAR		18,64,642.00	-	-	-	18,64,642.00	5,17,437.90	2,02,080.62	-	7,19,518.52	11,45,123.49	13,47,204.10
	ASTRAD - CSNOF-05		72,28,762.00	35,99,948.00	50,40,493.00	-	1,58,69,203.00	17,85,651.00	13,56,458.85	3,78,036.98	35,20,146.83	1,23,49,056.18	54,43,111.00
	Telescope Enclosure - 3.6 Mt		1,51,40,307.00	6,65,156.00	5,21,040.00	-	1,63,26,503.00	30,92,087.85	19,07,006.27	39,078.00	50,38,172.12	1,12,88,330.88	1,20,48,219.15
	TOTAL (J)		1,75,35,93,992.02	1,18,04,171.00	3,35,80,625.00	-	1,79,89,78,788.02	97,19,29,974.50	11,70,50,397.68	25,18,546.88	1,09,14,98,919.06	70,74,79,868.96	78,16,64,017.52
K	OTHER FIXED ASSETS	15%											
	Aluminising / Anodising		89,358.67	-	-	-	89,358.67	89,358.67	-	-	89,358.67	-	-
	Atmospheric Science Division (ASD)		-	5,24,692.00	17,56,193.00	-	22,80,885.00	-	78,703.80	1,31,714.48	2,10,418.28	20,70,466.73	-
	Canteen Assets		1,18,437.00	2,08,164.00	1,08,752.00	-	4,35,353.00	19,909.08	46,003.79	8,156.40	74,069.26	3,61,283.74	98,527.93
	CCTV Camera		77,500.00	-	-	-	77,500.00	40,078.56	5,613.22	-	45,691.78	31,808.22	37,421.44
	Gym Assets		-	3,55,458.00	37,704.00	-	3,93,162.00	-	53,318.70	2,827.80	56,146.50	3,37,015.50	-
	Library Instrument		9,500.00	-	-	-	9,500.00	5,284.69	632.30	-	5,916.99	3,583.01	4,215.31
	Workshop Assets		7,04,405.45	6,65,010.00	33,08,390.00	-	46,77,805.45	2,87,249.38	1,62,324.91	2,48,129.25	6,97,703.54	39,80,101.91	4,17,156.07
	Hostel Assets		1,25,830.00	26,261.00	2,53,549.00	-	4,05,640.00	17,007.68	20,262.50	19,016.18	56,286.35	3,49,353.65	1,08,822.33
	Guest House Assets		1,04,685.00	3,668.00	1,57,055.00	-	2,65,408.00	15,432.83	13,938.03	11,779.13	41,149.98	2,24,258.02	89,252.18
	Project Assets		27,62,966.00	-	-	-	27,62,966.00	7,66,723.15	2,99,436.43		10,66,159.58	16,96,806.42	19,96,242.85
	TOTAL (K)		39,92,682.12	17,83,253.00	56,21,643.00	-	1,13,97,578.12	12,41,044.03	6,80,233.66	4,21,623.23	23,42,900.92	90,54,677.20	27,51,638.09
	TOTAL OF CURRENT YEAR (1)		2,33,50,87,862.35	3,26,45,756.24	9,87,65,050.00	-	2,46,64,98,668.59	1,27,34,52,554.43	14,22,87,679.99	63,52,209.88	1,42,20,92,444.29	1,04,44,06,224.30	1,06,16,35,307.92
	TOTAL OF PREVIOUS YEAR (1)		2,27,97,97,410.35	63,25,132.00	4,94,19,873.00	4,54,553.00	2,33,50,87,862.35	1,11,73,33,421.65	15,40,74,729.63	20,44,403.15	1,27,34,52,554.43	1,06,16,35,307.92	1,16,24,63,988.70
2	CAPITAL WORK-IN-PROGRESS												
A	ILMT - 4M		2,54,69,905.00	-	-	2,54,69,905.00	-	-	-	-	-	-	2,54,69,905.00
B	Advance-CWIP (Const Devasthal)		2,94,00,000.00	-	39,69,200.00	-	3,33,69,200.00	-	-	-	-	3,33,69,200.00	2,94,00,000.00
C	Advance Rural Works Department		60,73,600.00	-	37,96,000.00	-	98,69,600.00	-	-	-	-	98,69,600.00	60,73,600.00
	TOTAL (2)		6,09,43,505.00	-	77,65,200.00	2,54,69,905.00	4,32,38,800.00	-	-	-	-	4,32,38,800.00	6,09,43,505.00
	GRAND TOTAL (1 + 2)		2,39,60,31,367.35	3,26,45,756.24	10,65,30,250.00	2,54,69,905.00	2,50,97,37,468.59	1,27,34,52,554.43	14,22,87,679.99	63,52,209.88	1,42,20,92,444.29	1,08,76,45,024.30	1,12,25,78,812.92

NOTE: (1) Telescope DOT 3.6 Mt includes a telescope of Rs. 13132204.00 that had not been received till 31st March 2022, while the said amount has been paid through Bank's LC A/C in FY -2020-21, hence no Depreciation is charged on this amount.

(2) Building 4Mt Telescope includes a Building amounting Rs. 25469905.00 that was added in last days of March 2022 and was not put to use in FY - 2021-22, hence no depreciation is charged on this amount.

Annexed to the Balance Sheet of even date attached.

For MUKESH GOEL & CO.
CHARTERED ACCOUNTANTS

CA. MUKESH GOEL, FCA
PROPRIETOR
[FRN - 006150C]

MUKESH GOEL & CO. HALDWANI M.971940671 Chartered Accountants

For and on behalf of ARIES, Nainital

(REGISTRAR) (DIRECTOR)

ARYABHATTA RESEARCH INSTITUTE OF OBSERVATIONAL SCIENCES (ARIES)
MANORA PEAK, NAINITAL

SCHEDULES FORMING PART OF BALANCE SHEET AS AT 31st March 2022

	SCHEDULE 10 - INVESTMENTS FROM EARMARKED/ENDOWMENT FUNDS		(Amount in Rupees)
S.NO	PARTICUALRS	Current Year For the year ended 31st March 2022 (Debit)	Previous Year For the year ended 31st March 2021 (Debit)
1	In Government Securities	-	-
2	Other approved Securities	-	-
3	Shares	-	-
4	Debentures and Bonds	-	-
5	Subsidiaries and joint Ventures	-	-
6	Others (to be specified):		
	a) FDR (GPF A/C) with Scheduled Bank (SBI)	3,09,87,399.00	3,02,13,163.00
	b) FDR (Pension Fund A/C) with Scheduled Bank (UBI)	-	-
	c) Interest Accrued	-	-
	TOTAL	3,09,87,399.00	3,02,13,163.00

	SCHEDULE 11 - INVESTMENTS - OTHERS		(Amount in Rupees)
S.NO	PARTICUALRS	Current Year For the year ended 31st March 2022 (Debit)	Previous Year For the year ended 31st March 2021 (Debit)
1	In Government Securities	-	-
2	Other approved Securities	-	-
3	Shares	-	-
4	Debentures and Bonds	-	-
5	Subsidiaries and Joint Ventures	-	-
6	Others (to be specified):		
	a) FDR (ST RADAR Project) with Scheduled Bank (SBI)	23,62,596.00	22,71,279.00
	b) FDR (ISRO Project) with Scheduled Bank (SBI)	12,60,568.00	12,07,243.00
	c) Interest Accrued	-	-
	TOTAL	36,23,164.00	34,78,522.00

Annexed to the Balance Sheet of even date attached.

For MUKESH GOEL & CO.
CHARTERED ACCOUNTANTS

MUKESH GOEL & CO. HALDWANI M.9719406671 Chartered Accountants

CA. MUKESH GOEL, FCA
PROPRIETOR
[FRN - 006150C]
[MRN - 073335]

PLACE : HALDWANI
DATED : September 28, 2022

For and on behalf of ARIES, Nainital

(REGISTRAR) (DIRECTOR)

ARYABHATTA RESEARCH INSTITUTE OF OBSERVATIONAL SCIENCES (ARIES)
MANORA PEAK, NAINITAL

SCHEDULES FORMING PART OF BALANCE SHEET AS AT 31st March 2022

	SCHEDULE 12 (A) - CURRENT ASSETS, LOANS, ADVANCES ETC.			(Amount in Rupees)	
S.NO	PARTICUALRS	Current Year For the year ended 31st March 2022		Previous Year For the year ended 31st March 2021	
		(Debit)	(Debit)	(Debit)	(Debit)
	A. CURRENT ASSETS				
1	**Inventories:**				
	a) Finished Goods		-		-
	b) Work in Progress		-		-
	c) Consumables				
	-Stores and Spares	18,47,099.00		27,00,968.39	
	-Stationary	5,08,556.40		6,54,432.61	
	-Computer Accessories	1,90,770.00		14,68,259.62	
	-Postage Stamps	1,582.00		-	
	-Fuel (POL)	9,06,750.00	34,54,757.40	1,96,766.49	50,20,427.11
2	**Sundry Debtors:**				
	a) Debts Outstanding > six months	-		-	
	b) Others	-	-	-	-
3	**Cash balances in hand** (including cheques/drafts)		-		-
4	**Bank Balances:**				
	a) With Scheduled Banks:				
	Current Accounts	-		-	
	Deposit Accounts (LC) *	-		-	
	Savings Account *				
	-Director A/C	18,36,82,672.08		14,27,01,221.55	
	-Pension Fund A/C	6,69,62,564.72		6,53,45,517.72	
	-GPF A/C	1,80,22,708.30		1,18,53,494.30	
	-Canteen A/C	2,04,528.99		1,63,062.99	
	-Staff Welfare Fund A/C	2,75,019.50		35,570.50	
	-Project Bank A/Cs	1,86,93,173.95	28,78,40,667.54	1,45,42,299.00	23,46,41,166.06
	b) With Non-Scheduled Banks:		-		-
5	Post Office-Savings Accounts		-		-
	TOTAL (A)		29,12,95,424.94		23,96,61,593.17

*** Separate List Attached.**

Annexed to the Balance Sheet of even date attached.

For MUKESH GOEL & CO.
CHARTERED ACCOUNTANTS

CA. MUKESH GOEL, FCA
PROPRIETOR
[FRN - 006150C]
[MRN - 073335]

PLACE : HALDWANI
DATED : September 28, 2022

MUKESH GOEL & CO. HALDWANI M.9719406671 Chartered Accountants

For and on behalf of ARIES, Nainital

(REGISTRAR) (DIRECTOR)

ARYABHATTA RESEARCH INSTITUTE OF OBSERVATIONAL SCIENCES (ARIES)
MANORA PEAK, NAINITAL

SCHEDULES FORMING PART OF BALANCE SHEET AS AT 31st March 2022

	SCHEDULE 12 (B) - CURRENT ASSETS, LOANS, ADVANCES ETC.			(Amount in Rupees)	
S.NO	PARTICUALRS	Current Year For the year ended 31st March 2022		Previous Year For the year ended 31st March 2021	
		(Debit)	(Debit)	(Debit)	(Debit)
	B. Loans, Advances & Other Assets				
1	Loans:				
	a) Staff *	28,20,490.00		38,28,215.00	
	b) Others (specify)	-	28,20,490.00	-	38,28,215.00
2	Advances and other amounts (recoverable in cash or in kind)				
	a) On Capital Accounts	-		-	
	b) Pre-paid Expenses *	11,43,081.00		43,13,763.00	
	c) Others *	92,40,698.00	1,03,83,779.00	89,96,043.00	1,33,09,806.00
3	Income Accured On:				
	a) Investments - Endowment Funds			-	
	i) FDR Interest (GPF A/C)	3,08,984.00		2,40,803.00	
	ii) FDR Interest (Pension Fund A/C)	10,30,438.00	13,39,422.00	8,63,933.00	11,04,736.00
	b) Investments - Others			-	
	i) FDR Interest (ST RADAR Project)	37,206.00		36,760.00	
	ii) FDR Interest (ISRO Project)	18,937.00	56,143.00	17,694.00	54,454.00
	c) Loans and Advances	-		-	
	d) Others (Specify):-				
	i) Interest on Project Bank A/Cs	-		59,459.00	
	ii) Interest on Saving Bank A/Cs	25,57,772.00	25,57,772.00	24,75,126.00	25,34,585.00
4	Claims Receivable	-	-	-	-
	TOTAL (B)		1,71,57,606.00		2,08,31,796.00
	TOTAL (A+B)		30,84,53,030.94		26,04,93,389.17

*As Per Separate List Attached

Annexed to the Balance Sheet of even date attached.

For MUKESH GOEL & CO.
CHARTERED ACCOUNTANTS

MUKESH GOEL & CO. HALDWANI M.9719408671 Chartered Accountants

CA. MUKESH GOEL, FCA
PROPRIETOR
[FRN - 006150C]
[MRN - 073335]

PLACE : HALDWANI
DATED : September 28, 2022

For and on behalf of ARIES, Nainital

(REGISTRAR) (DIRECTOR)

ARYABHATTA RESEARCH INSTITUTE OF OBSERVATIONAL SCIENCES (ARIES)
MANORA PEAK, NAINITAL

SCHEDULES FORMING PART OF INCOME & EXPENDITURE FOR THE YEAR ENDED 31st March 2022

	SCHEDULE 13 - INCOME FROM SALES/SERVICES		(Amount in Rupees)
S.NO	PARTICUALRS	Current Year For the year ended 31st March 2022 (Credit)	Previous Year For the year ended 31st March 2021 (Credit)
1	Income from Sales		
	a) Sale of Finished Goods	-	-
	b) Sale of Raw Material	-	-
	c) Sale of Scraps	-	-
2	Income from Services		
	a) Labour and Processing Charges	-	-
	b) Professional/ Consultancy Services	-	-
	c) Agency Commission and Brokerage	-	-
	d)Maintenance Servies (Equipment/ Property)	-	-
	e) Others (Specify)	-	-
	TOTAL	-	-

	SCHEDULE 14 - GRANTS/SUBSIDIES		(Amount in Rupees)
S.NO	PARTICUALRS	Current Year For the year ended 31st March 2022 (Credit)	Previous Year For the year ended 31st March 2021 (Credit)
1	Central Government Grants:		
	-Grant in aid "General"	7,21,00,000.00	6,50,00,000.00
	-Grant in aid "Salary"	16,10,00,000.00	18,90,00,000.00
2	State Government Grants	-	-
3	Government Agencies	-	-
4	Others (specify)	-	-
	TOTAL	23,31,00,000.00	25,40,00,000.00

Annexed to the Statement of Income & Expenditure
of even date attached herewith.

For MUKESH GOEL & CO.
CHARTERED ACCOUNTANTS

CA. MUKESH GOEL, FCA
PROPRIETOR
[FRN - 006150C]
[MRN - 073335]

PLACE : HALDWANI
DATED : September 28, 2022

For and on behalf of ARIES, Nainital

(REGISTRAR) (DIRECTOR)

ARYABHATTA RESEARCH INSTITUTE OF OBSERVATIONAL SCIENCES (ARIES)
MANORA PEAK, NAINITAL

SCHEDULES FORMING PART OF INCOME & EXPENDITURE FOR THE YEAR ENDED 31st March 2022

	SCHEDULE 14A - PROJECTS GRANTS	(Amount in Rupees)	
S.NO	PARTICUALRS	Current Year For the year ended 31st March 2022 (Credit)	Previous Year For the year ended 31st March 2021 (Credit)
1	Central Government Grants:		
	Project Grants Received:-		
	a) Project Grant - DST / IMRCD / BRICS / 2017G		13,83,200.00
	b) Project Grant - DST / INSPIRE FACULTY 13/2017		38,53,333.00
	c) Project Grant - DST / INT / BELG / P-09/2017		8,27,901.00
	d) Project Grant - DST / INSPIRE / FELLOWSHIP		-
	e) Project Grant - DST / INT / POL / P-19 / 2016		-
	f) Project Grant - DST / INT / THAI / P-15		-
	g) Project Grant - EMR / 2016 / 001723		-
	h) Project Grant - INT / AUS / BMWF / P-14		-
	i) Project Grant - ISRO GBP		3,00,000.00
	j) Project Grant - UCOST		-
	k) Other Project Grants		54,571.00
2	State Government Grants	-	-
3	Government Agencies	-	-
4	Others (specify)	-	-
	TOTAL	-	64,19,005.00

Annexed to the Statement of Income & Expenditure
of even date attached herewith.

For MUKESH GOEL & CO.
CHARTERED ACCOUNTANTS

MUKESH GOEL & CO. HALDWANI M.9719406671 Chartered Accountants

CA. MUKESH GOEL, FCA
PROPRIETOR
[FRN - 006150C]
[MRN - 073335]

PLACE : HALDWANI
DATED : September 28, 2022

For and on behalf of ARIES, Nainital

(REGISTRAR) (DIRECTOR)

ARYABHATTA RESEARCH INSTITUTE OF OBSERVATIONAL SCIENCES (ARIES)
MANORA PEAK, NAINITAL

SCHEDULES FORMING PART OF INCOME & EXPENDITURE FOR THE YEAR ENDED 31st March 2022

	SCHEDULE 15 - FEES/SUBSCRIPTIONS		(Amount in Rupees)
S.NO	PARTICUALRS	Current Year For the year ended 31st March 2022 (Credit)	Previous Year For the year ended 31st March 2021 (Credit)
1	Entrance Fees	-	-
2	Annual Fees/ Subscriptions	-	-
3	Seminar/ Programe Fees	-	-
4	Consultancy Fees	-	-
5	Others (Specify)	-	-
	TOTAL	-	-

Annexed to the Statement of Income & Expenditure
of even date attached herewith.

For MUKESH GOEL & CO.
CHARTERED ACCOUNTANTS

MUKESH GOEL & CO. HALDWANI M.9719406671 Chartered Accountants

CA. MUKESH GOEL, FCA
PROPRIETOR
[FRN - 006150C]
[MRN - 073335]

PLACE : HALDWANI
DATED : September 28, 2022

For and on behalf of ARIES, Nainital

D. Banerjee

(REGISTRAR) (DIRECTOR)

ARYABHATTA RESEARCH INSTITUTE OF OBSERVATIONAL SCIENCES (ARIES)
MANORA PEAK, NAINITAL

SCHEDULES FORMING PART OF INCOME & EXPENDITURE FOR THE YEAR ENDED 31st March 2022

	SCHEDULE 16 - INCOME FROM INVESTMENTS						
S.NO	PARTICUALRS	Investment from Earmarked Fund		Investment - Others		Total	
		Current Year	Previous Year	Current Year	Previous Year	Current Year	Previous Year
		For the year ended 31st March 2022	For the year ended 31st March 2021	For the year ended 31st March 2022	For the year ended 31st March 2021	For the year ended 31st March 2022	For the year ended 31st March 2021
		(Credit)	(Credit)	(Credit)	(Credit)	(Credit)	(Credit)
1	Interest	-	-	-	-	-	-
2	Dividends:	-	-	-	-	-	-
3	Rents	-	-	-	-	-	-
4	Others (Specify)					-	-
	-Interest on FDR (GPF A/C)	9,36,021.00	13,99,403.00	-	-	9,36,021.00	13,99,403.00
	-Interest on FDR (Pension Fund A/C)	-	-	-	-	-	-
	-Interest on FDR (ISRO Project A/C)	-	-	54,568.00	76,494.00	54,568.00	76,494.00
	-Interest on FDR (ST RADAR Project)	-	-	1,03,130.00	2,53,605.00	1,03,130.00	2,53,605.00
	TOTAL	9,36,021.00	13,99,403.00	1,57,698.00	3,30,099.00	10,93,719.00	17,29,502.00
	TRANSFFRRED TO INVESTMENTS	9,36,021.00	13,99,403.00	1,57,698.00	3,30,099.00	10,93,719.00	17,29,502.00

Annexed to the Statement of Income & Expenditure
of even date attached herewith.

For MUKESH GOEL & CO.
CHARTERED ACCOUNTANTS

MUKESH GOEL & CO. HALDWANI M.9719406671 Chartered Accountants

CA. MUKESH GOEL, FCA
PROPRIETOR
[FRN - 006150C]
[MRN - 073335]

PLACE : HALDWANI
DATED : September 28, 2022

ARYABHATTA RESEARCH INSTITUTE OF OBSERVATIONAL SCIENCES (ARIES)
MANORA PEAK, NAINITAL

SCHEDULES FORMING PART OF INCOME & EXPENDITURE FOR THE YEAR ENDED 31st March 2022

	SCHEDULE 17 - INCOME FROM ROYALTY, PUBLICATION ETC.			(Amount in Rupees)	
S.NO	PARTICUALRS	Current Year For the year ended 31st March 2022		Previous Year For the year ended 31st March 2021	
1	Income from Royalty	-	-	-	-
2	Income from Publications	-	-	-	-
3	Others (specify)	-	-	-	-
	TOTAL	-	-	-	-

	SCHEDULE 18 - INTEREST EARNED			(Amount in Rupees)	
S.NO	PARTICUALRS	Current Year For the year ended 31st March 2022		Previous Year For the year ended 31st March 2021	
1	On Term Deposits:				
	a) With Scheduled Banks	-		-	
	(Separately shown as Income from Investments)				
	b) With Non-Scheduled Banks	-		-	
	c) Others	-	-	-	-
2	On Savings Accounts:				
	a) With Scheduled Banks				
	-GPF A/C (SBI - 300)	4,17,528.00		3,37,423.00	
	-Pension Fund A/C (SBI - 311)	19,57,582.00		11,65,817.00	
	-Pension Fund A/C (UBI - 535)	21,708.00		21,194.00	
	-Project Bank A/Cs (SBI & UCO Bank)	-		5,77,675.46	
	-Director's Bank A/C (SBI - 253)	-		60,41,409.00	
	-LC Bank A/Cs	-		5,570.00	
	-Canteen Bank A/Cs	5,226.00		6,615.00	
	b) With Non-Scheduled Banks	-		-	
	c) Others	-	24,02,044.00	-	81,55,703.46
3	On Loans:				
	a) Employees/Staff				
	-HBA Interest	76,347.00		72,720.00	
	-Car Advance Interest	15,000.00		52,848.00	
	-Computer Advance Interest	6,716.00		4,500.00	
	-M.Cycle Advance Interest	6,138.00		500.00	
	b) Others - Intt on Income Tax Refund		1,04,201.00	33,080.00	1,63,648.00
	TOTAL		25,06,245.00		83,19,351.46

Annexed to the Statement of Income & Expenditure
of even date attached herewith.

For MUKESH GOEL & CO.
CHARTERED ACCOUNTANTS

CA. MUKESH GOEL, FCA
PROPRIETOR
[FRN - 006150C]
[MRN - 073335]

PLACE : HALDWANI
DATED : September 28, 2022

MUKESH GOEL & CO. HALDWANI M.9719406671 Chartered Accountants

For and on behalf of ARIES, Nainital

(REGISTRAR) (DIRECTOR)

ARYABHATTA RESEARCH INSTITUTE OF OBSERVATIONAL SCIENCES (ARIES)
MANORA PEAK, NAINITAL

SCHEDULES FORMING PART OF INCOME & EXPENDITURE FOR THE YEAR ENDED 31st March 2022

	SCHEDULE 19 - OTHER INCOMES			(Amount in Rupees)	
S.NO	PARTICUALRS	Current Year For the year ended 31st March 2022		Previous Year For the year ended 31st March 2021	
		(Credit)	(Credit)	(Credit)	(Credit)
1	Profit on Sale/disposal of Assets	-	-	6,07,419.00	6,07,419.00
2	Export Incentives realized	-	-	-	-
3	Fees for Miscellaneous Services:				
	a) Electricity Charges	4,49,301.50		4,14,356.25	
	b) Medical Contribution	6,03,350.00		28,93,850.00	
	c) Telephone Charges	-		-	
	d) Water Charges	1,26,656.50		1,09,024.25	
	e) House License Fees	3,69,570.00	15,48,878.00	3,97,622.00	38,14,852.50
4	Miscellaneous Income:				
	a) Guest House rent	-		274.00	
	b) Hostel/Shop rent	3,52,824.00		2,47,704.00	
	c) EMD Security Forfeited	18,000.00		-	
	d) Project Overhead Charges	1,00,000.00		2,40,000.00	
	e) RTI Receipts	292.00		1,404.00	
	f) Notice Period Income	-		-	
	g) Canteen Receipts (Food Bill)	30,19,495.55		19,93,740.86	
	h) ILMT Project (Excess Received)	-		4,40,424.00	
	i) Electrical Penalty	23,201.00		2,400.00	
	j) Other Incomes	3,24,575.57		-	
	k) Recovery of TA Advance	-	38,38,388.12	331.00	29,26,277.86
5	Prior Period Incomes				
	a) Interest on UBI (Pension Fund) Bank A/C		-	5,610.00	5,610.00
	TOTAL		53,87,266.12		73,54,159.36

Annexed to the Statement of Income & Expenditure
of even date attached herewith.

For MUKESH GOEL & CO.
CHARTERED ACCOUNTANTS

MUKESH GOEL & CO. HALDWANI M.9719406671 Chartered Accountants

CA. MUKESH GOEL, FCA
PROPRIETOR
[FRN - 006150C]
[MRN - 073335]

PLACE : HALDWANI
DATED : September 28, 2022

For and on behalf of ARIES, Nainital

(REGISTRAR) (DIRECTOR)

ARYABHATTA RESEARCH INSTITUTE OF OBSERVATIONAL SCIENCES (ARIES)
MANORA PEAK, NAINITAL

SCHEDULES FORMING PART OF INCOME & EXPENDITURE FOR THE YEAR ENDED 31st March 2022

	SCHEDULE 20 - INCREASE/(DECREASE) IN INVENTORIES			(Amount in Rupees)	
S.NO	PARTICUALRS	Current Year For the year ended 31st March 2022		Previous Year For the year ended 31st March 2021	
		(Credit)	(Credit)	(Credit)	(Credit)
1	Closing stock				
	-Finished Goods	-		-	
	-Work-in-progress	-		-	
	-Consumables	34,54,757.40	34,54,757.40	50,20,427.11	50,20,427.11
2	Less: Opening Stock				
	-Finished Goods	-		-	
	-Work-in-progress	-		-	
	-Consumables	50,20,427.11	50,20,427.11	46,64,211.49	46,64,211.49
	NET INCREASE/(DECREASE) [1-2]		(15,65,669.71)		3,56,215.62

Annexed to the Statement of Income & Expenditure
of even date attached herewith.

For MUKESH GOEL & CO.
CHARTERED ACCOUNTANTS

MUKESH GOEL & CO. HALDWANI M.9719406671 Chartered Accountants

CA. MUKESH GOEL, FCA
PROPRIETOR
[FRN - 006150C]
[MRN - 073335]

PLACE : HALDWANI
DATED : September 28, 2022

For and on behalf of ARIES, Nainital

(REGISTRAR) (DIRECTOR)

ARYABHATTA RESEARCH INSTITUTE OF OBSERVATIONAL SCIENCES (ARIES)
MANORA PEAK, NAINITAL

SCHEDULES FORMING PART OF INCOME & EXPENDITURE FOR THE YEAR ENDED 31/03/2022

	SCHEDULE 21 - ESTABLISHMENT EXPENSES*		(Amount in Rupees)
S.NO	PARTICUALRS	Current Year For the year ended 31st March 2022 (Debit)	Previous Year For the year ended 31st March 2021 (Debit)
1	Salaries and Wages	9,98,65,456.00	10,22,14,646.00
2	Allowances and Bonus	2,70,64,207.00	1,77,68,826.00
3	Contribution to NPS	1,44,90,462.00	65,18,669.00
4	Others (specify)		
	-Medical Expenses	37,86,635.00	31,64,924.00
	-Fellowship	2,24,27,245.00	2,03,68,663.00
	-Leave Encashment	-	7,40,493.00
	-Leave Travel Concession	1,65,827.00	83,879.00
	-Special Cash Package Expenses		14,05,487.00
	-Reimbursement of Tuition Fees	16,20,000.00	14,38,195.00
	TOTAL	16,94,19,832.00	15,37,03,782.00

*As per separate list attached.

Annexed to the Statement of Income & Expenditure of even date attached herewith.

For MUKESH GOEL & CO.
CHARTERED ACCOUNTANTS

MUKESH GOEL & CO. HALDWANI M.9719406671 Chartered Accountants

CA. MUKESH GOEL, FCA
PROPRIETOR
[FRN - 006150C]
[MRN - 073335]

PLACE : HALDWANI
DATED : September 28, 2022

For and on behalf of ARIES, Nainital

(REGISTRAR) (DIRECTOR)

ARYABHATTA RESEARCH INSTITUTE OF OBSERVATIONAL SCIENCES (ARIES)
MANORA PEAK, NAINITAL

SCHEDULES FORMING PART OF INCOME & EXPENDITURE FOR THE YEAR ENDED 31st March 2022

	SCHEDULE 22 - OTHER ADMINISTRATIVE EXPENSES		(Amount in Rupees)
S.NO	PARTICUALRS	Current Year For the year ended 31st March 2022 (Debit)	Previous Year For the year ended 31st March 2021 (Debit)
1	Repair & Maintenance (Minor Works) *	57,22,915.00	39,16,783.00
2	Consumable Expenses *	42,49,052.00	32,47,017.50
3	Other Administrative Expenses *	1,14,30,251.00	76,93,070.00
4	Meeting Expenses *	5,07,186.80	2,08,642.00
5	AMC Expenses	9,44,602.00	11,57,471.00
6	Prior Period Expenses	-	9,67,312.00
7	Travelling Expenses	11,18,659.00	31,46,151.00
8	Conveyance Expenses	15,53,924.00	13,02,952.00
9	POL (Fuel) Expenses	40,92,526.00	19,19,300.00
10	Custom Duty / Custom Clearance Charges	4,39,738.23	1,21,253.62
11	Contract Salary (UPNL)	35,95,658.00	42,83,180.00
12	Security Expenses (UPNL)	69,07,404.00	66,57,269.00
13	Electricity Expenses	64,41,110.00	55,55,200.00
14	Legal Fee / Professional Fee/ Consultance Charges	12,54,500.00	13,26,700.00
15	Library Expenses (Journals)	34,90,460.00	47,47,117.81
16	Cleaning Work Expenses	38,13,310.00	32,25,209.00
17	ASTRAD Annual License Fee	6,39,520.00	1,80,250.00
18	Workshop Expenses	3,49,573.00	11,800.00
19	Bank Charges	2,56,285.72	2,49,702.58
20	Office Expenses	4,11,654.00	9,26,463.36
21	Telephone Expenses	3,00,132.00	3,18,796.00
22	Audit Fees	62,500.00	1,25,000.00
23	Printing & Stationary Expenses	1,18,069.00	3,19,969.00
24	Hospitality Expenses	2,50,859.00	1,26,651.00
25	Insurance Charges	1,28,410.60	96,057.00
26	Manpower Expenses	82,96,599.00	69,00,045.00
27	LOGO Expenses	-	7,08,000.00
28	Advertisement Expenses	58,808.00	1,39,494.00
29	Annual Report Translation Fee	33,040.00	55,000.00
30	BSNL Lease Rent	13,84,800.00	8,90,705.00
31	Constitution Day Celeberation Expenses	-	82,653.00
32	Dispensary Expenses	18,700.00	74,802.00
33	Soil Investigation Expenses	-	2,23,800.00
34	Freight & Cartage	31,827.00	19,200.00
35	Registration Expenses	53,124.00	65,003.00
36	Licence Fee Renewal (ILMT)	1,20,000.00	80,012.00
37	Consultancy/IISF Expo/ILMT Hiring / Training	98,306.00	-
	TOTAL	6,81,73,503.35	6,10,68,030.87

*As per separate list attached.

Annexed to the Statement of Income & Expenditure
of even date attached herewith.

For MUKESH GOEL & CO.
CHARTERED ACCOUNTANTS

MUKESH GOEL & CO. HALDWANI M.9719406671 Chartered Accountants

CA. MUKESH GOEL, FCA
PROPRIETOR
[FRN - 006150C]
[MRN - 073335]

PLACE : HALDWANI
DATED : September 28, 2022

For and on behalf of ARIES, Nainital

(REGISTRAR) (DIRECTOR)

ARYABHATTA RESEARCH INSTITUTE OF OBSERVATIONAL SCIENCES (ARIES)
MANORA PEAK, NAINITAL

SCHEDULES FORMING PART OF INCOME & EXPENDITURE FOR THE YEAR ENDED 31st March 2022

	SCHEDULE 23 - EXPENDITURE ON PROJECTS		(Amount in Rupees)
S.NO	PARTICUALRS	Current Year	Previous Year
		For the year ended 31st March 2022	For the year ended 31st March 2021
		(Debit)	(Debit)
1	Project Exp - ISRO - GBP (ABLN & C)	-	6,76,533.00
2	Project Exp - DST/IMRCD/BRICKS/PILOTCALL/2017G	-	7,60,278.50
3	Project Exp - DST/INSPIRE FACULTY-BATCH-13/2017	-	29,93,863.50
4	Project Exp - DST/INSPIRE/FELLOWSHIP/2019	-	2,48,000.00
5	Project Exp - DST / INT / POL / P-19 / 2016	-	43,591.00
6	Project Exp - DST / INT / THAI / P-15	-	48,235.00
7	Project Exp - EMR / 2016 / 001723	-	3,48,902.00
8	Project Exp - ISRO ENVIRONMENTAL - ATCTM	-	56,01,289.50
9	Project Exp - ISRO - GBP (ARFI)	-	6,50,166.00
10	Project Exp - UCOST - R & D - PM	-	1,73,487.25
11	Project Exp - INT / AUS / BMWF / P-14 / 2018	-	8,106.00
12	Project Exp - DST / INT / BELG / P-09 / 2017	-	1,41,265.50
13	Project Exp - DST / INT / BELG / P-02 / 2014	-	7,472.00
14	Project Exp - S. T. RADAR	-	34,75,000.00
15	Project Exp - DST / INSPIRE	-	-
16	Project Exp - ILTP Project	-	-
17	Project Exp - Indo Autria (Dr A.K.Srivastva)	-	-
18	Project Exp - INT / RUS / RFBR / P-271	-	-
19	Project Exp - PDF / 2016 / 003032	-	-
20	Project Exp - PDF / 2016 / 003848	-	-
	TOTAL	-	1,51,76,189.25

	SCHEDULE 24 - INTEREST EXPENDITURES		(Amount in Rupees)
S.NO	PARTICUALRS	Current Year	Previous Year
		For the year ended 31st March 2022	For the year ended 31st March 2021
		(Debit)	(Debit)
1	On Fixed Loans	-	-
2	On Other Loans (including Bank Charges)	-	-
3	Others (specify)	-	
	-Interest returned to DST (2019-2020)	-	37,96,504.00
	-Interest payable to DST (2020-2021)	-	60,41,409.00
	-Interest accrued on GPF A/C	35,12,633.00	30,91,061.00
	- Interest - TDS	-	6,808.00
	TOTAL	35,12,633.00	1,29,35,782.00

Annexed to the Statement of Income & Expenditure
of even date attached herewith.

For MUKESH GOEL & CO.
CHARTERED ACCOUNTANTS

CA. MUKESH GOEL, FCA
PROPRIETOR
[FRN - 006150C]
[MRN - 073335]

PLACE : HALDWANI
DATED : September 28, 2022

For and on behalf of ARIES, Nainital

(REGISTRAR) (DIRECTOR)

ARYABHATTA RESEARCH INSTITUTE OF OBSERVATIONAL SCIENCES (ARIES)
MANORA PEAK, NAINITAL

ANNEXURE OF SCH 12(A)(4): LIST OF BANK ACCOUNTS AS ON 31.03.2022

S. NO.	PARTICULARS	Current Year	Previous Year
		For the year ended 31st March 2022	For the year ended 31st March 2021
		Debit	Debit
1	Director's (SBI) Bank A/C 10860840253	18,36,82,672.08	14,27,01,221.55
2	GPF (SBI) A/C 10860840300	1,80,22,708.30	1,18,53,494.30
3	SBI (Canteen) Bank A/C 32320085086	2,04,528.99	1,63,062.99
4	SBI (Staff Welfare Fund) Bank A/C - 39589660093	2,75,019.50	35,570.50
5	LC No - 2016-04 (SBI) A/C 35822432563	-	-
6	Pension Fund A/Cs:		
	Pension Fund (SBI) A/C - 10860840311	6,62,26,505.70	6,46,30,952.70
	Pension Fund (UBI) A/C - 534702010000535	7,36,059.02	7,14,565.02
	Total (6)	6,69,62,564.72	6,53,45,517.72
7	Project Bank A/Cs		
	SBI (ISRO-GBP-ARFI) Bank A/C 30192927780	6,24,711.50	11,47,539.50
	SBI (BINA II Project) Bank A/C 39216610583	6,44,300.50	7,05,368.50
	SBI (ISRO ATCTM Project) Bank A/C 30310168038	61,67,503.50	49,75,224.50
	SBI (ISRO-GBP-ABLN & C) Bank A/C 30318931302	12,67,158.00	1,83,095.50
	SBI (LC No: 2016-04) Bank A/C 35822432563	20,14,586.00	19,28,329.00
	SBI (ST RADAR Project) Bank A/C 30357703902	21,53,915.00	20,96,728.00
	SBI (DST - ILTP Project) Bank A/C 31286509555	2,72,738.50	2,65,496.50
	SBI (EMR-2016-1723 Project) Bank A/C 37039717963	2,06,636.50	2,01,149.50
	SBI (INT / POL Project) Bank A/C 37039721038	-	2,64,048.55
	SBI Project Bank A/C 372665312845	25,05,213.50	4,24,566.50
	SBI (BRICS Project) Bank A/C 37598108567	1,39,661.00	6,64,034.00
	SBI (INSPIRE Faculty Project) Bank A/C 38098705686	75,097.50	11,74,708.50
	SBI (BMWF Project) Bank A/C 38532163287	3,12,817.50	3,12,886.50
	SBI (Thai Project) Bank A/C 38832273131	1,66,695.50	1,62,270.50
	SBI (INSPIRE Fellowship) Bank A/C 39092267684	41,548.00	11,189.00
	UCO (UCOST Project) BANK A/C 28720110011577	42,021.45	25,122.45
	SBI (GVAX Project) Bank A/C - 31745765543	558.00	542.00
	UBI (SRG/SERB/2021 Project) A/C - 534702010004272	20,58,012.00	-
	SBI PROJECT A/C 36065850402	-	-
	Total (7)	1,86,93,173.95	1,45,42,299.00
	Grand Total (1+2+3+4+5+6)	28,78,40,667.54	23,46,41,166.06

Annexed to Sch 12(A)(4) of the Balance Sheet of even date attached.

For MUKESH GOEL & CO.
CHARTERED ACCOUNTANTS

CA. MUKESH GOEL, FCA
PROPRIETOR
[FRN - 006150C]
[MRN - 073335]

PLACE : HALDWANI
DATED : September 28, 2022

For and on behalf of ARIES,
Nainital

(REGISTRAR) (DIRECTOR)

ARYABHATTA RESEARCH INSTITUTE OF OBSERVATIONAL SCIENCES (ARIES)
MANORA PEAK, NAINITAL

ANNEXURE OF SCH-22 (3): LIST OF OTHER ADMINISTRATIVE EXPENSE FOR THE YEAR ENDED 31.03.2022

S. NO.	PARTICULARS	Current Year For the year ended 31st March 2022	Previous Year For the year ended 31st March 2021
		DEBIT	DEBIT
1	Canteen Expenses	61,00,442.00	49,70,854.00
2	Water Expenses	12,75,397.00	9,42,914.00
3	Pest Control Expenses	1,03,485.00	2,62,524.00
4	Internet Charges	19,28,282.00	6,19,233.00
5	Wages	6,29,078.00	1,74,237.00
6	Return Filing Fees - GST/TDS	1,71,870.00	1,13,493.00
7	NPS Service Charges	1,448.00	9,841.00
8	Gardening Expenses	1,21,171.00	23,695.00
9	Certification Fee	0.00	10,000.00
10	Guest House Expenses	8,922.00	10,277.00
11	Labour / Service Charges	51,640.00	4,200.00
12	Laundry Expenses	12,893.00	3,000.00
13	Ph. D. Registration Expenses	2,23,470.00	5,48,802.00
14	ERP Implementation Expenses	6,90,300.00	-
15	Postage Expenses	16,353.00	-
16	ARIES-IIA-AWSAR Prize	7,000.00	-
17	Testing Expenses	88,500.00	-
	Total	1,14,30,251.00	76,93,070.00

Annexed to Schedule 22 (3) of the Statement of Income & Expenditure of even date attached.

ANNEXURE OF SCH 22 (4): LIST OF MEETING EXPENSES FOR THE YEAR ENDED 31.03.2022

S. NO.	PARTICULARS	Current Year For the year ended 31st March 2022	Previous Year For the year ended 31st March 2021
		DEBIT	DEBIT
1	ATSOA 2020 Meeting Expenses	-	6,974.00
2	Hindi Program Expenses	36,000.00	46,000.00
3	JEST 2022 Meeting Expenses	50,000.00	50,000.00
4	Public Outreach Programme	2,89,490.00	1,03,455.00
5	Scientific Meeting Expenses	-	2,213.00
6	ASI-2020 Meeting Expenses	1,31,696.80	-
7	Asia Solar Physics Meeting Expenses	-	-
8	ESC Meeting Expenses	-	-
9	G.C. Meeting Expenses	-	-
	Total	5,07,186.80	2,08,642.00

Annexed to Schedule 22 (4) of the Statement of Income & Expenditure of even date attached.

For MUKESH GOEL & CO.
CHARTERED ACCOUNTANTS

CA. MUKESH GOEL, FCA
PROPRIETOR
[FRN - 006150C]
[MRN - 073335]

PLACE : HALDWANI
DATED : September 28, 2022

MUKESH GOEL & CO. HALDWANI M.9719406671 Chartered Accountants

For and on behalf of ARIES, Nainital

(REGISTRAR) (DIRECTOR)

ARYABHATTA RESEARCH INSTITUTE OF OBSERVATIONAL SCIENCES (ARIES)
MANORA PEAK, NAINITAL

STATEMENT OF RECEIPT AND PAYMENT FOR THE YEAR ENDED 31ST MARCH 2022

S. No	RECEIPTS	Current Year 2021-2022	Current Year 2021-2022	S. No	PAYMENTS	Current Year 2021-2022	Current Year 2021-2022
I	Opening Balances:			I	Fixed Assets		
	a) Bank Balances	23,46,41,166.06			Buildings & Infrastructures	44,85,641.00	
	b) Cash-in-Hand	0.00	23,46,41,166.06		Vehicles	16,22,915.00	
					Furniture & Fixtures	1,25,90,323.00	
II	Capital Account				Office Equipments	27,828.00	
	Corpus / Capital Fund	15,09,00,000.00			Computers / Peripherals	1,30,89,213.24	
	Reserves & Surplus	2,13,167.00	15,11,13,167.00		Electric Installations	2,12,77,885.00	
					Library Books	37,663.00	
III	Current Liabilities				Plant Machinery & Equipments	4,53,84,796.00	
	Current Liabilities & Provisions	3,01,99,154.00			Other Fixed Assets	73,94,796.00	
	Statutory Liabilities	73,97,916.00	3,75,97,070.00		Capital Work-in-Progress	77,65,200.00	11,36,76,260.24
IV	Non-Current Liabilities:			II	Current Assets		
	Earmarked / Endowment Funds	75,44,425.00			Adv. Chandan Ram	1,000.00	
	Project Funds	89,49,867.45			Loans, Advances & Other Assets	24,22,296.00	24,23,296.00
	Staff Welfare Funds	1,05,702.00	1,65,99,994.45				
				III	Current Liabilities		
V	Current Assets				Current Liabilities & Provisions	3,61,74,991.00	
	Car Advance (ARIES) A/C	1,17,960.00			Statutory Liabilities	71,80,092.00	4,33,55,083.00
	Computer Advance (ARIES) A/C	1,44,000.00					
	HBA (ARIES) A/c	2,87,765.00		IV	Non-Current Liabilities:		
	OMCA Adv, (ARIES)	6,000.00			Earmarked / Endowment Funds	34,42,163.00	
	Loans, Advances & Other Assets	55,41,337.77	60,97,062.77		Project Funds	47,98,992.50	
					Staff Welfare Funds	57,828.00	82,98,983.50
VI	Indirect Incomes						
	Grants / Subsidies	23,31,00,000.00		V	Indirect Expenses		
	Interest Earned	14,62,448.00			Establishment Expenses	16,93,21,967.00	
	Other Incomes	52,41,393.12	23,98,03,841.12		Other Administrative Expenses	6,09,36,044.12	23,02,58,011.12
				V	Closing Balance		
					Bank Balances (Schedule Banks)	28,78,40,667.54	28,78,40,667.54
	Total		68,58,52,301.40		Total		68,58,52,301.40

As per our separate Audit Report of even date attached.

For MUKESH GOEL & CO.
CHARTERED ACCOUNTANTS

CA. MUKESH GOEL, FCA
PROPRIETOR
[FRN - 006150C]
[MRN - 073335]

MUKESH GOEL & CO. HALDWANI M.9719406671 Chartered Accountants

PLACE : HALDWANI
DATED : Sesptember 28, 2022

For and on behalf of ARIES, Nainital

(REGISTRAR) (DIRECTOR)

ARYABHATTA RESEARCH INSTITUTE OF OBSERVATIONAL SCIENCES (ARIES)
MANORA PEAK, NAINITAL

SCHEDULES FORMING PART OF THE ACCOUNTS FOR THE YEAR ENDED 31ST MARCH 2021

SCHEDULE 24 – SIGNIFICANT ACCOUNTING POLICIES:

1. ACCOUNTING CONVENTION & ACCOUNTING POLICIES:

(a) The financial statements are prepared on the basis of historical cost convention, unless otherwise stated, and on the basis of **ACCRUAL method of accounting except for the followings: -**

(i) Transactions related to Salary and other establishment expenses as well as various recoveries out of the salary are recorded in the books of accounts on CASH basis;

(ii) Transaction related to re-imbursement of telephone expenses to employees are recorded in the books of accounts on CASH basis as there is no mechanism to determine the cost of these expenses and the payment is made as and when the claims are submitted by the employees in this regard;

(iii) Transaction related to GST-TDS are recorded in the books of accounts on CASH basis;

(iv) Transactions related to Interest on all the Project Bank accounts are recorded in the books of accounts on CASH basis considering the change in the accounting policy in this regard as explained herein below; and

(v) Transactions related to all legal expenses related to court cases are recorded in the books of accounts on CASH basis.

(b) In the financial year under audit i.e. financial year 2021-2022, the Institute has made following changes in its accounting policies: -

(i) That all Project Fund's Accounts are shown as Non-Current Liability in the Balance Sheet of the Institute showing remaining balance amount to be used for each Project.

A separate Bank Account is being maintained for each particular Project. The Project Grant received from DST as well as interest earned on the related Bank Account is credited in the particular Project Fund Account and all the related Project Expenses are debited in that Project Fund Account. The balance of each Project Fund account is similar to the bank balance of each such Project Fund.

Till the previous financial year i.e. till financial year 2020-2021 all the Grants received for a particular Project as well as interest earned on the related Bank Account were used to show as income of the Institute and all the Project Expenses were used to show as Institute Expenditure resulting thereby transfer of resultant surplus/deficit to Reserves & Surplus A/C of the Institute

To implement this change in accounting policy, a sum of Rs. 1,45,42,299.00, being the total amount equal to the Bank balance of all Project Bank Accounts as on 31st March 2021, is credited to the various Project Fund Accounts after debiting the same amount in the "Reserves & Surplus A/C" of the Institute.

(ii) That the interests earned on all Saving Bank Accounts of the Institute, run through DST Grants, during the financial year 2021-2022, amounting Rs. 56,51,797.00, is shown as current liability of the Institute to follow the GFR Norms of DST, according to that all such interests have to be returned to Bharatkosh.

Till the previous financial year i.e. till financial year 2020-2021 all such interests were used to show as income of the Institute.

(iii) That since the interest earned on the saving Bank A/C maintained for the "Staff Welfare Fund" is a part of the said Fund and is to be used for the purpose of the said Fund, it is credited directly to this Fund and is not shown as income of the Institute.

In the previous financial year i.e. in financial year 2020-2021 all such interests were used to show as income of the Institute.

There is no other change in the Accounting Policy and method of the Institute during the financial year 2021-22.

2. INVENTORY VALUATION:

2.1 As the Institute is engaged in research activities only and is not engaged in any manufacturing, trading and/or business activities, it does not carry any inventory of finished goods, raw materials etc.

2.2 Inventories of the Institute consists "Consumable Items" only and includes the stock of Stores & Spares, Fuel, Stationery, Computer Accessories and Postage Stamps.

2.3 Inventories are valued at Cost as per Accounting Policy of the Institute.

2.4 List of inventory is prepared on the basis of records maintained by the purchase and issue department of the Institute. The inventory is in good condition and is fully usable.

2.5 All inventories owned by the Institute, wherever located, have been recorded.

2.6 The physical verification of the Inventory of the Institute as on 31st March 2022 has been completed and recorded in the office record".

3 INVESTEMNTS:

3.1 Investments of the Institute consists Fixed Deposits in Scheduled Bank only. Amounts of Provident Fund, STRADAR Project Fund and ISRO Project Fund are deposited in Fixed Deposit Schemes of Scheduled Bank and are shown as Investments in the Balance Sheet.

3.2 These Investments are valued at cost as per Institute's accounting policy.

3.3 All the investments, shown in the Balance Sheet, belong to the Institute and they do not include any investments held on behalf of any other persons.

3.4 The Institute has clear title to all of its investments. There are no charges against the investments of the Institute except those appearing in the records of the Institute.

4 PROPERTY, PLANT & EQUIPMENT:

The net book values of Property, Plant & Equipment, at which these are stated in the Balance Sheet of the Institute, are arrived at: -

- After taking into account all capital expenditure, as additions thereto, but no expenditure being chargeable to revenue;
- After eliminating the cost and accumulated depreciation relating to items sold, discarded, demolished or destroyed;
- After providing adequate depreciation as per Income Tax Act, 1961 on all the Property, Plant & Equipment of the Institute as at the year-end;
- After taking into account all capital work-in-progress on completion of the related work; and
- After making necessary adjustments to present a true and fair view of Property, Plant & Equipment.

5 **DEPRECIATION:**

5.1 Depreciation is provided on **"written down value"** method as per rates specifies in the Income-tax Act, 1961 except depreciation on cost adjustments arising on account of conversion of foreign currency liabilities for acquisition of fixed assets, which is amortized over the residual life of the respective assets.

5.2 In respect of additions to/deductions from fixed assets during the year, depreciation is considered as per income tax rules and not on pro-rata basis.

6 **MISCELLANEOUS EXPENDITURE:**

The Institute has the policy to write-off the Deferred Revenue Expenditure over a period of 5 years from the year it is incurred.

7 **GOVERNMENT GRANTS/SUBSIDIES:**

7.1 Institute gets Grants from Central Government to meet out its all financial costs and to complete some related projects.

7.2 Institute gets Government grants to meet out Capital Expenses, Establishment Expenses, General Expenses and to complete some relevant Projects.

7.3 Government grants received to meet out Capital Expenditures are treated as Capital Fund and all the expenditures of capital nature are meet out from this fund.

7.4 Government grants received for Revenue Expenditures e. g. Establishment Expenses and General Expenditures are used to meet out these expenses and the balance of the Grant (Surplus/Deficit) is transferred to Reserves & Surplus A/C.

7.5 Government grants/subsidies are accounted for on realization basis.

8 **FOREIGN CURRENCY TRANSACTIONS:**

8.1 Transactions denominated in foreign currency are accounted at the exchange rate prevailing at the date of the transaction.

8.2 Current asset, foreign currency loans and current liabilities are converted at the exchange rate prevailing as at the year end and the resultant gain/loss is adjusted to cost of fixed assets, if the foreign currency liability relates to fixed assets, and in other cases is considered to revenue.

9 **GENERAL PROVIDENT FUND:**

GPF Rules are applicable to those employees of the Institute who were appointed before 1st Jan 2004. As per the GPF Rules, a minimum subscription of 6% of emolument is deducted from monthly salary of the incumbents. There is no employer contribution in this scheme, it is treated as non-contributory pension scheme of Government applicable for the incumbents appointed prior to 01.01.2004.
A Fund named GPF having the accumulated balance of aforesaid subscription and interest earned thereon at the applicable rates, determined by the Government from time to time, is maintained by a committee of the Institute who keep appropriate records in this regard. The amount of the said Fund is kept in a scheduled bank.

10 NPS (EMPLOYER AND EMPLOYEE SHARE):

ARIES, Nainital is an autonomous institute under Department of Science and Technology and fully funded by the Govt. of India and follows the Govt. norms regarding retirement benefits. New Pension Scheme (NPS) introduced by the Govt. has been adopted by this institute with the approval of competent authority for those employees who was appointed after 01-01-2004. In this scheme, the employee subscription @ 10% of basic + D.A. was deducted and 10% of employer contribution was contributed till 31st March 2019. The Govt. enhanced employer contribution from 10% to 14% vide O.M. No. 1/3/2016-PR dated 31st January, 2019 extended for Autonomous bodies, by making amendment in the previous Gazette Notification No. 5/7/2003-ECB-PR dated 22 December, 2003. ARIES has also implemented the revised scheme of enhanced employer contribution w. e. f. 1st April 2019 onwards.

11 RETIREMENT BENEFITS:

11.1 Liability towards gratuity payable on death/retirement of employees is paid as per Govt. norms at the time of retirement.

11.2 Accumulated leave encashment benefit to the employees is paid as per Govt. norms at the time of retirement.

12 LEASE:

Lease rentals are expensed with reference to lease terms.

PLACE: ARIES, NAINITAL	**REGISTRAR**	**DIRECTOR**
DATED: September 28, 2022	**ARIES, NAINITAL**	**ARIES, NAINITAL**

ARYABHATTA RESEARCH INSTITUTE OF OBSERVATIONAL SCIENCES (ARIES)
MANORA PEAK, NAINITAL

SCHEDULES FORMING PART OF THE ACCOUNTS FOR THE YEAR ENDED 31ST MARCH 2022

SCHEDULE 25 – CONTINGENT LIABILITES AND NOTES ON ACCOUNTS:

Sl. No	Particulars	Current Year	Previous Year
1.	**CONTINGENT LIABILITIES:**		
1.1	Claims against the Institute not acknowledged as debts	Rs. NIL	Rs. NIL
1.2	In respect of: -		
	-Bank guarantees given by/on behalf of the Entity	Rs. NIL	Rs. NIL
	-Letters of Credit opened by Bank on behalf of the Entity	Rs. NIL	Rs. NIL
	-Bills discounted with Banks	Rs. NIL	Rs. NIL
1.3	Disputed demands in respect of:		
	Income Tax	**Rs. 10,29,89,584.00**	**Rs. 10,29,89,584.00**
	Sales Tax/VAT/GST	Rs. NIL	Rs. NIL
	Municipal Taxes	Rs. NIL	Rs. NIL
2.	**CAPITAL COMMITMENTS:**		
	Estimated value of contracts remaining to be executed on capital account and not provided for (Net of advances)	Rs. NIL	Rs. NIL
3.	**LEASE OBLIGATIONS:**		
	Future obligations for rentals (finance lease arrangement)	Rs. NIL	Rs. NIL
	Arrangement for plant and Machinery	Rs. NIL	Rs. NIL

4. **CURRENT ASSETS, LOANS AND ADVANCES:**

In the opinion of the Management, the current assets, loans and advances have a value, on realization in the ordinary course of business, equal at least to the aggregate amount shown in the Balance Sheet.

5. **TAXATION:**

In view of the fact that the income of the Institute is exempt u/s 12 of the Income Tax Act 1961 and thus there being no taxable income under Income-tax Act 1961 for the financial year 2021-2022, the provision for Income tax is not considered necessary and thus has been made as on 31st March 2022.

7. **PAYMENT TO AUDITORS:**	Current Year	Previous Year
A. As Statutory Auditors	**Rs. 62,500.00**	**Rs. 62,500.00**
B. As advisor or in other capacity in respect of:		
i) Taxation matters	NIL	NIL
ii) Management Services	NIL	NIL
iii)Certification	**Rs. 10,000.00**	**Rs. 10,000.00**
C. Any other matter	NIL	NIL

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Sl. No	Particulars	Current Year	Previous Year
6.	**FOREIGN CURRENCY TRANSACTIONS:**		
	6.1 Value of Imports Calculated on C.I.F Basis:		
	-Purchase of Finished Goods	Rs. NIL	Rs. NIL
	-Raw Materials & Components (Including in transit)	Rs. NIL	Rs. NIL
	-Capital Goods	**Rs. 3,38,99,675.00**	**Rs. 53,16,318.94**
	-Stores, Spares and Consumables	**Rs. 24,68,308.00**	**Rs. 40,21,046.28**
	6.2 Expenditure in Foreign Currency:		
	a) Travel	Rs. NIL	Rs. NIL
	b) Remittances and Interest payments	Rs. NIL	Rs. NIL
	c) Royalty	Rs. NIL	Rs. NIL
	d) Know-How Expenses	Rs. NIL	Rs. NIL
	e) Professional Consultancy Fee	Rs. NIL	Rs. NIL
	f) Other Expenditure:		
	-Commission on Sales	Rs. NIL	Rs. NIL
	-Legal and Professional Expenses	Rs. NIL	Rs. NIL
	-Miscellaneous Expenses	Rs. NIL	Rs. NIL
	6.3 Earnings:		
	-Value of Exports on FOB basis	Rs. NIL	Rs. NIL
8.	Contingent Liabilities not provided for	Rs. NIL	Rs. NIL

9. Corresponding figures for the previous year have been regrouped/ rearranged, wherever necessary.

10. Schedules 1 to 25 are annexed to and form an integral part of the Balance Sheet as at 31st March 2022 and the Income and Expenditure Account for the year ended on that date.

D. Banerjee

PLACE: ARIES, NAINITAL
DATED: September 28, 2022

REGISTRAR
ARIES, NAINITAL

DIRECTOR
ARIES, NAINITAL