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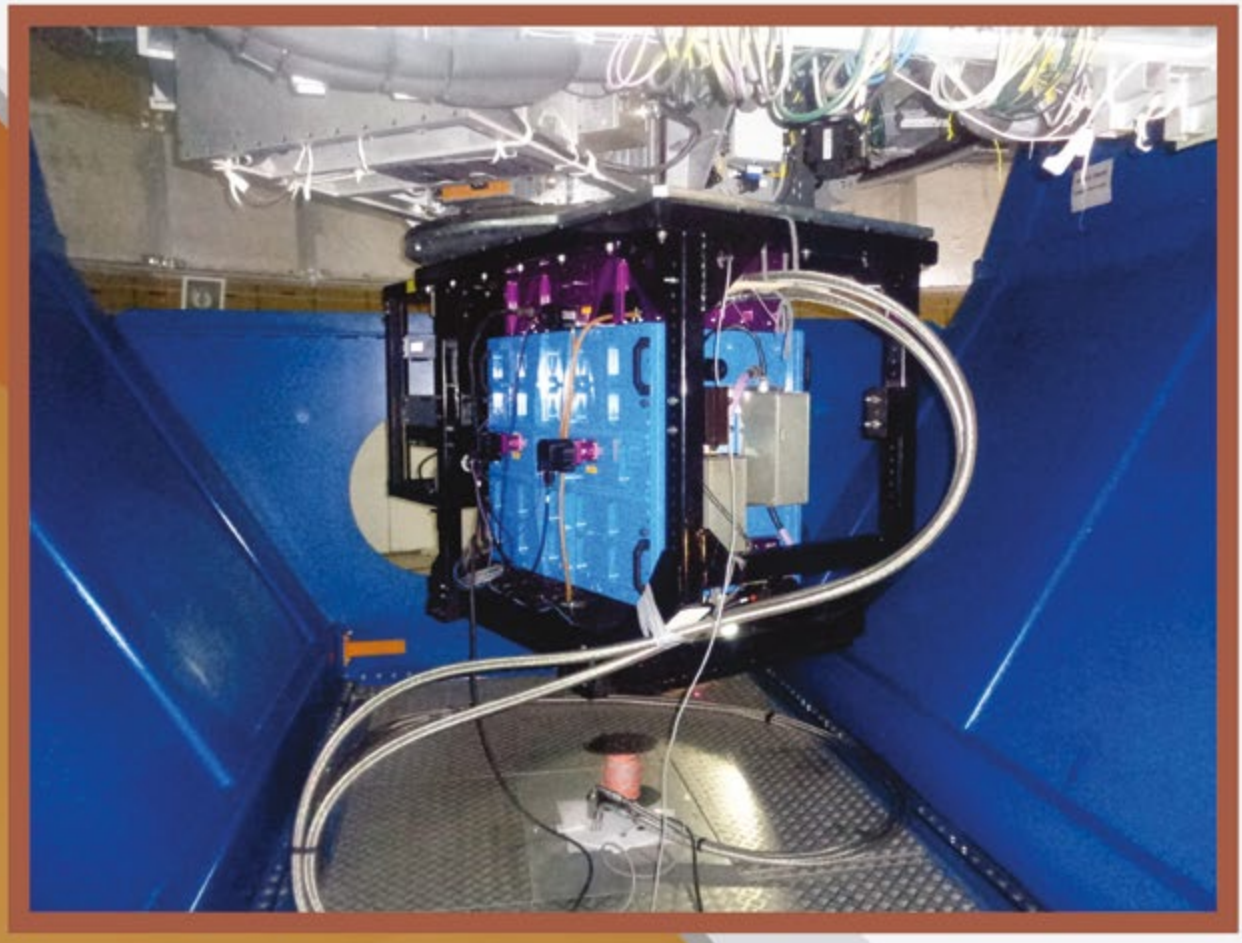

Annual Report 2018-19

ARYABHATTA RESEARCH INSTITUTE OF OBSERVATIONAL SCIENCES

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

Manora Peak, Nainital - 263 001, India

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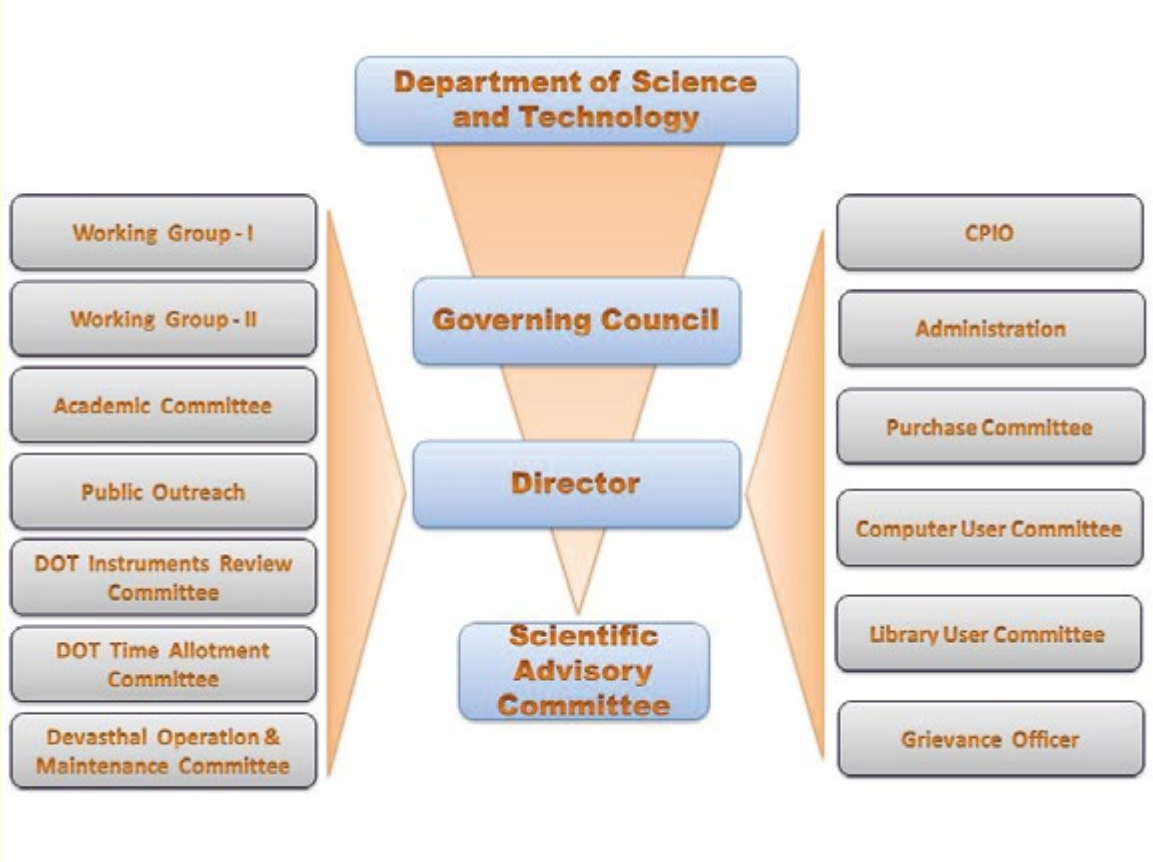
Front Cover: Fully assembled and powered ON TANSPEC on 3.6m DOT.

September, 2019

Contents

Organizational Structure



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From The Director's Desk

I am extremely satisfied and delighted to express that during 2018-2019 all members of ARIES worked as a team and showed significant progress in the scientific and technical activities related to Astronomy & Astrophysics and Atmospheric Sciences.

The largest optical Indian 3.6m Devasthal Optical Telescope (DOT) located in Devasthal is operated by ARIES as a National facility. DOT is equipped with state of the art back-end instruments which provides imaging and spectroscopic capabilities at optical and near-infrared bands. During Cycle 2018A (April-May) science and test observations were carried out with Imager, ADFOSC and TIRCAM2 from a total of 15 proposals submitted by the ARIES users. During the monsoon period (June-September) the regular health run of the telescope was recorded and checked as per the guidelines provided by AMOS. The third aluminisation of the primary mirror took place in September 2018. This was planned and executed solely by the ARIES team and the coating was completed successfully. The freshly coated mirror gave an average reflectivity of 85% in the wavelength range of 360 nm to 960 nm.

TIRCAM2 was successfully tested and commissioned at the main port of 3.6m DOT telescope. Following the encouraging results from TIRCAM2, it was decided to mount this instrument permanently on the sideport-1. After the design and fabrication by ARIES-TIFR team, the instrument was successfully mounted on the sideport-1 in December 2018.

TIFR-ARIES near-infrared Spectrometer (TANSPEC), being built in collaboration with TIFR, ARIES and MKIR (Hawaii) for the 3.6m DOT, is a unique instrument providing simultaneous wavelength coverage from 550 nm to 2540 nm with a resolving power of R~2750. TANSPEC was shipped from MKIR and transported to Devasthal during February-March 2019. Initial ground testing, installation and on-sky testing of TANSPEC on the 3.6m DOT was successfully carried out by MKIR, ARIES and TIFR scientific and engineering teams during March-April 2019. The first light images with TANSPEC were taken on 12 April, 2019 followed by subsequent sky tests upto 15 May, 2019.

I am happy to inform that ARIES Devasthal Faint Object Spectrograph Camera (ADFOSC) was completed at ARIES through in-house research and development activities. Various science and engineering tests were performed when the instrument was mounted on the 3.6m DOT during April 2018.

During 2018-2019, the data taken with the CCD Imager, mounted on the 3.6m DOT, for objects like Globular Clusters, supernovae and host galaxies of GRBs were analysed and submitted for publication in various international journals.

Update on the 3.6m DOT was presented at different forums. Eight contributions related to various aspects of the facility appeared in refereed journals and conference proceedings. The work on 3.6m DOT was also presented during the 2nd Indo-Belgium BINA workshop and 37th meeting of the Astronomical Society of India (ASI 2019).

All the 12 clusters of ARIES Stratosphere Troposphere Radar (ASTRAD) have been set up and tested

successfully at ARIES. Regular observations are taken with ASTRAD and are being compared with balloon borne radiosonde observations.

The scientific studies continued to centre around Earth's atmosphere, Sun, Stars and Galaxies. ARIES scientists contributed results in Galactic and Extra-Galactic astronomy whereas the solar physics studies were focused on transient phenomena such as flares and associated processes.

The lower atmospheric studies related to air pollution and climate change were carried out by the scientists of Atmospheric Science group in ARIES. This group has also contributed towards the observations of trace gases, aerosols and meteorological parameters.

As a part of our academic and outreach activity, we at ARIES regularly conduct public lectures, popular talks and various other scientific activities (workshops/ schools) for school children and general public. We encourage the use of ARIES science centre facilities and motivate the young talents towards a career in Astronomy & Astrophysics and Atmospheric Science.

The technical team in ARIES comprising of engineers and other engineering staff were actively involved in the upkeep of 1.04m Sampurnanand Telescope (ST), 1.3m Devasthal Fast Optical Telescope (DFOT), 3.6m Devasthal Optical Telescope (DOT) and 4.0m International Liquid Mirror Telescope (ILMT), ASTRAD and other instruments related to Atmospheric Science. The technical team were also involved in the research and development activities and maintenance of backend instruments and software.

During the year of this report, ARIES staff constituted of 33 Scientists and Engineers, 13 administrative and support staff, 34 scientific and technical staff, 10 laboratory assistants, 8 post-doctoral fellows and 40 research scholars. In the year 2018, 8 new research scholars joined the institute, while 3 research scholars submitted their theses and 2 research scholars were awarded the Ph.D. degree. ARIES faculty have published 55 papers in refereed journals of high impact factors and 38 papers as conference proceedings. Many visiting students from various national universities/institutes completed their short-term projects under the guidance of ARIES scientists and engineers. Several national/ international collaborative projects were also carried out.

We, at ARIES, have taken several measures to keep our office and premises clean. All efforts are being taken to build an equitable work environment by safeguarding the interests of women, schedule caste and tribes. All important schemes as directed by Government of India and the use of official language in administrative work are being implemented in ARIES. We maintain national integration in the institute.

With the present state of the art and upcoming facilities in ARIES, I strongly believe that our institute will continue to enhance the observational capabilities and excel in the academic activities.

Wahab Uddin
Director In-charge

Research Highlights

The scientists of ARIES carry out research mainly on topics related to Astronomy and Astrophysics, Atmospheric Sciences and Instrumentation. The research activities of the institute are divided into two working groups. The groups are

1. Working Group – I (WG I) – Galactic & Extragalactic Astronomy

2. Working Group – II (WG II) – Solar Physics & Atmospheric Sciences

The working group members are responsible for the annual planning and monitoring of the activities on the academic and technical matters. In this section, a brief highlight of the scientific and instrumentation achievements of the institute, during the period 2018-19, are presented.

Research Working Group – I

All the scientists working on topics related to Galactic and Extragalactic astronomy are the members of WG – I. The group consists of 15 scientists. The group members are actively involved in collaboration with scientists of national and international institutions in the fields of near earth objects, individual stars, star formation, open cluster systems, globular cluster systems, large magellanic cloud (LMC), active galactic nuclei (AGN), quasars, blazars, gamma ray bursts (GRBs), supernovae and numerical simulations. The highlights of the scientific publications by the members are briefly presented below.

Galactic Astronomy

1. Individual Stars

A study of pulsation and rotation in a sample of A-K type stars in the *Kepler* field

The results of time-series photometric analysis of 15106 A-K type stars observed by the *Kepler* space mission was done. 513 new rotational variables were identified and their star spot rotation periods as a function of spectral type were measured and the distribution of their amplitudes was discussed. The well established period-color relationship that applies to stars of spectral types F5-K for all of these rotational variables was examined and interestingly it was found that a similar period-color relationship appears to extend to stars of spectral types A7 to early-F too. This result was not consistent with the very foundation of the period-color relationship. 350 new non-radial pulsating variables such as A- and F-type candidate δ Scuti, γ Doradus and hybrid stars were characterised. This increases the known candidate non radial pulsators in the *Kepler* field significantly by ~20%. The relationship between two recently constructed observables, *Energy* and *Efficiency*, was also studied for the large sample of non-radial pulsators, which shows that the distribution in the logarithm of *Energy* (log(*En*)) can be used as a potential tool to distinguish between the non-radial pulsators, to some extent. Through visual inspection of the light curves and their corresponding frequency spectra, 23 new candidate red giant solar-like oscillators were found that were not previously reported in the literature. The basic physical parameters such as masses, radii and luminosities of these solar-like oscillators were also derived using asteroseismic relations. **[**Chowdhury, S., **Joshi, S.**, Engelbrecht, C. A., Cat, Peter De, **Joshi, Y. C.**, Paul, K. T. (2018). *Astrophy. Space Sci., 363*:260 (18pp)**].**

Stellar magnetic activities on late-type stars

Several main-sequence and pre-main-sequence stars were studied using the data obtained from various ground and space based telescopes. A classical T Tauri star CV Cha in Chamaeleon dark cloud was studied using long term optical, UV and X-ray data. The short-term variability seen in CV Cha could be due to rotational modulation. A rotational period of 3.714 ± 0.001 days was derived for CV Cha. UV light curves obtained from *Swift* also show the variations. X-ray light curves from *XMM-Newton* and *Swift* do not show any significant short as well as long-term variability. However, the light curve from *Chandra* appears to be variable, which could be due to the emergence of small scale flares. X-ray spectra from all observations were explained by a single temperature plasma of 0.95 keV with X-ray luminosity of $10^{30.4}$ erg s^{-1} in the 0.5–7.5 keV energy band. It appears that variability in optical and UV bands could be due to the presence of both hot and cool spots on the surface, while X-ray emission is dominated by magnetic processes **[Pandey, J. C., Karmakar, S., Joshi, A., Sharma, S., Pandey, S. B. & Pandey, A. K.** (2019). *Res. Astron. & Astrophy., 19,* 7(12pp)**].**

Two young stars with planetary systems EPIC 211901114 and K2–33 based on observational data obtained over 70 days with the *Kepler* Space Telescope were also studied. The differential-rotation parameter estimated for K2–33 was $\Delta\Omega$ = 0.004± 0.002 rad/day. The fractional spotted area on the surface of EPIC 211901114 reached upto 5% of its total visible surface. For K2– 33, it was 3.8% of its total visible surface, on an average. The flaring activities on EPIC 211901114 and K2-33 were also studied. A total of 32 flares in EPIC 211901114 and 7 flares in K2– 33 were found. The flare frequencies and amplitudes for EPIC 211901114 and K2–33 have been estimated, together with the time scales for their rise and decay phases. The flare energies were estimated to be $10^{32.1-33.4}$ and $10^{32.2-33.3}$ erg for EPIC 211901114 and K2-33, respectively. Along with this, the differential rotation of 75 cool active dwarfs was also studied using the data obtained from *Kepler* space telescope.**[**Savanov, I. S., Dmitrienko, E. S., **Pandey, J. C. & Karmakar, S.**(2018).*Astrophy. Bull., 73,* 454-462**].**

Compact binaries (Magnetic CVs and X-ray binaries)

A low mass mass X-ray binary MXB 1658-298 was studied using the *Swift*/X-Ray Telescope and Nuclear Spectroscopic Telescope Array *(NuSTAR)* observations made during the outburst phase in 2015–2017. The source showed different spectral states and accretion rates during this outburst. The source was in low/hard state during 2015; and it was in high/soft state during the 2016 *NuSTAR* observations. For the first time a comparison of the soft and hard spectral states during an outburst was reported in MXB 1658–298. The hard state spectrum was described with models consisting of a single-temperature black body component along with comptonized disc emission, or three-component model comprising multicolour disc, single-temperature black body, and thermal comptonization components. The soft state spectrum can be described with black body or disc black body and comptonization component, where the neutron star surface (or boundary layer) is the dominant source for the comptonization seed photons.**[**Sharma, R., Jaleel, A., Jain, C. , **Pandey, J. C.**, Paul, B. and Dutta, A. (2018). *Mon. Not. Roy. Astron. Soc., 481,* 5560-5569**].**

2. Star Clusters

The radial distribution of blue stragglers in galactic globular cluster NGC 6656 – clues to the dynamical status

Using the spatial distribution of blue straggler stars (BSSs), the dynamical status of the Galactic globular cluster NGC 6656 was studied. A combination of multi-wavelength high-resolution space and ground-based data were used to cover a large cluster region. The centre of gravity (C_{grav}) was determined in this study and the projected density profile of the cluster was constructed using the probable cluster members selected from the Hubble Space Telescope *(HST)* and Gaia Data Release 2 proper motion data sets. The projected density profile in the investigated region was nicely reproduced by a single-mass King model, with core (r_c) and tidal (r_t) radii of 75".2 ± 3".1 and 35'.6 ± 1'.1 respectively. In total, 90 BSSs were identified on the basis of proper-motion data in the region of radius 625". The average mass of the BSSs was

determined to be 1.06 ± 0.09 $M_{\odot}$ with an age range of 0.5 to 7 Gyr. The BSS radial distribution showed a bimodal trend, with a peak in the centre, a minimum at $r \sim r_c$ and a rising tendency in the outer region. The BSS radial distribution showed a flat behaviour in the outermost region of the cluster. The A^{+}_{rh} parameter, an alternative indicator of the dynamical status of the cluster, was also found to be 0.038 ± 0.016. Based on the radial distribution and A^{+}_{rh} parameter, this study concludes that NGC 6656 is an intermediate dynamical age cluster. **[Singh, Gaurav & Yadav, R. K. S.** (2019). *Mon. Not. Roy. Astron. Soc.*, *482,* 4874-4882**].**

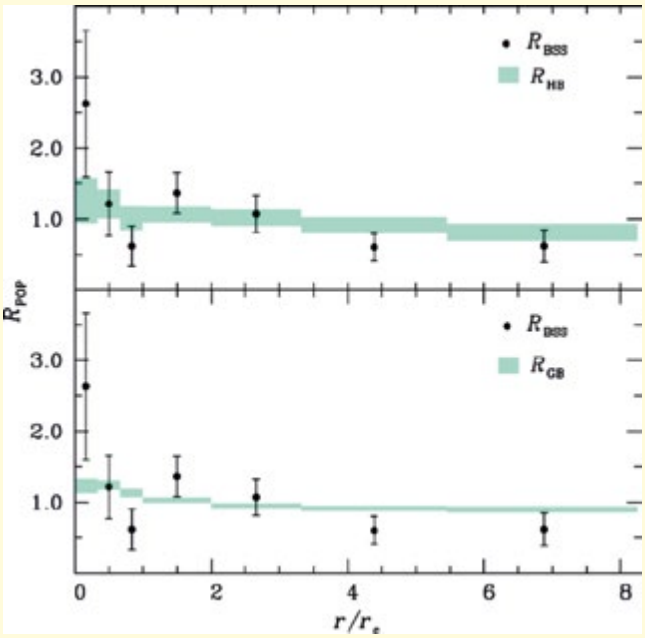

Figure 1. The BSS radial distribution (filled circles) and the reference populations with doubly normalized ratios plotted with respect to the distance from the cluster centre, normalized to rc. The shaded portion in the upper and lower panels shows the distributions of the HB and GB populations respectively, which is almost constant (~ 1). The widths of the shaded regions represent the error bars.

Mass function and dynamical study of the open clusters Berkeley 24 and Czernik 27 using ground based imaging and Gaia astrometry

A *UBVI* photometric study of the open clusters Berkeley 24 (Be 24) and Czernik 27 (Cz 27) was done in this work. The radii of the clusters were determined as 2'.7 and 2'.3 for Be 24 and Cz 27, respectively. The Gaia Data Release 2 (GDR2) catalogue was used to estimate the mean proper motions for the clusters and was found to be 0.35 ± 0.06 mas yr^{-1} and 1.20 ± 0.08 mas yr^{-1} for Be 24 in right ascension and declination and -0.52 ± 0.05 mas yr^{-1} and -1.30 ± 0.05 mas yr^{-1} for Cz 27. Probable cluster members selected from proper motion data was used for the estimation of fundamental parameters. The reddening values *E(B - V)* inferred for Be 24 and Cz 27 were found to be 0.45 ± 0.05 mag and 0.15 ± 0.05 mag respectively. Analysis of extinction curves towards the two clusters show that both have normal interstellar extinction laws in the optical as well as in the near-IR band. From the ultraviolet excess measurement, metallicities for Be 24 and Cz 27 were derived as [Fe/H] = -0.025 ± 0.01 dex and -0.042 ± 0.01 dex respectively. The distances, as determined from main sequence fitting, were 4.4 ± 0.5 kpc and 5.6 ± 0.2 kpc. The comparison of observed CMDs with $Z = 0.01$ isochrones, estimated an age of 2.0 ± 0.2 Gyr and 0.6 ± 0.1 Gyr for Be 24 and Cz 27, respectively. In addition to this, the mass function and dynamical state of these two clusters were also studied for the first time using probable cluster members. The mass function was derived after including the corrections for data incompleteness and field star contamination. The present analysis concludes both clusters to be dynamically relaxed. **[**Bisht, D., **Yadav, R. K. S.,** Ganesh, S., Durgapal, A. K., Rangwal, G. & Fynbo, J. P. U. (2019). *Mon. Not. Roy. Astron. Soc.*, *482,* 1471-1484**].**

A proper motion study of the globular cluster M12 (NGC 6218)

Using astrometric techniques developed by Anderson et al., proper motions (PMs) in the ~ 14.60 x 16.53 $arcmin^2$ area of the kinematically "thick-disk" globular cluster M12 was determined. The cluster's proximity and sparse nature was a suitable target for ground-based telescopes. Archive images with time gap of ~ 11.1 years observed with the wide-field imager (WFI) mosaic camera mounted on the ESO 2.2 m telescope were analysed. The median value of PM error in both components was ~ 0.7 mas yr^{-1} for the stars having V ⩽ 20 mag. PMs were used to determine membership probabilities and to separate

field stars from the cluster sample. An electronic membership catalog of 3725 stars with precise coordinates, PMs and *BVRI* photometry was generated. One of the possible applications of the catalog was demonstrated by gathering the membership information of the variable stars, blue stragglers and X-ray sources reported earlier in the cluster's region. **[**Sariya, D. P., Jiang, Ing-Guey and **Yadav, R. K. S.** (2018). *Res. Astron. Astrophy., 18,* 126 (12pp)**].**

3. Star Formation

Understanding formation of young, distributed low-mass stars and clusters in the W4 cloud complex

It is well known that most of the stars form in rich clusters. However, recent *Spitzer* observations have shown that a significant number of stars also form in the distributed mode whose origin is not well understood. An investigation of clustered and distributed modes of star formation in the W4 complex was done. Identification and characterization of young stellar population associated with the region was done using homogeneous infrared data sets obtained from the Two Micron All Sky Survey, GLIMPSE, MIPS, and Wide-field Infrared Survey Explorer surveys. Stellar surface density and minimum spanning tree maps were made to identify young clusters, and Spitzer images were used to identify irradiated structures, such as elephant-trunk-like structures (ETLSs) and pillars in the region. The surface density distribution of the young stellar objects (YSOs) revealed three new clusterings and ~50% distributed protostars in the HII region. The clusters are of low-mass nature but significantly younger than the central cluster IC 1805. Nearly 38 ETLSs were identified in the region, a majority of which consist of one or a few stars at their tips. These stars were found to be low-mass (<2 M_o) YSOs, located at the outskirts (>17 pc) of the cluster IC 1805 which are part of the scattered distributed population. It was argued that the star formation in the ETLSs of W4 was going on possibly due to the triggering effect of the expanding W4 bubble. Although high-resolution photometric and spectroscopic data would be required to confirm the scenario, nonetheless, the implications of this scenario were discussed for understanding of distributed low-mass star formation in cloud complexes as opposed to other mechanisms such as turbulent fragmentation and dynamical ejection. **[Panwar, N.,** Samal, M. R., **Pandey, A. K.**, Singh, H. P. and **Sharma, S.** (2019). *Astron. Jr., 157*:112 (14pp)**].**

4. GRBs and Supernovae

SN 2015as: a low-luminosity Type IIb supernova without an early light-curve peak

The photometric (from 3 to 509 d post-explosion) and spectroscopic (up to 230 d post-explosion) monitoring campaign of the He-rich Type IIb supernova (SN) 2015as was carried our using several optical telescopes. The (B - V) colour evolution of SN 2015as closely resemble those of SN 2008ax, suggesting that SN 2015as belongs to the SN IIb subgroup that does not show the early, short-

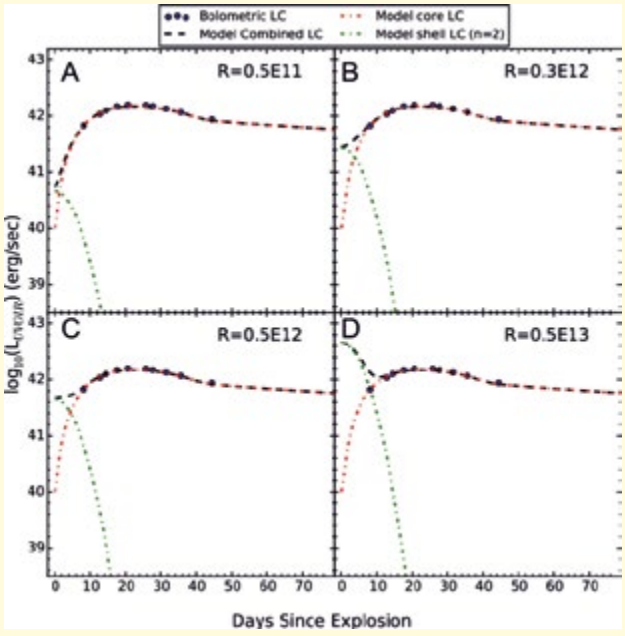

Figure 2. Bolometric light curves at different values of shell radius. The second and third panels show that a small variation in radius incorporates the contribution of the shell to the bolometric light curve.

duration photometric peak. The light curve of SN 2015as reaches the B-band maximum about 22 d after the explosion, at an absolute magnitude of -16.82 ± 0.18 mag. At ~75 d after the explosion, its spectrum transitions from that of a SN II to a SN Ib. P Cygni features due to He I lines appear at around 30 d after explosion, indicating that the progenitor of SN 2015as was partially stripped. The quasi-bolometric analytical light-curve modelling suggests that the progenitor of SN 2015as has a modest mass (~0.1 $M_{\odot}$), a nearly compact ~(0.05×10^{13} cm) H envelope on top of a dense, compact ~(2×10^{11} cm) and a more massive ~(1.2 $M_{\odot}$) He core. The analysis of the nebular phase spectra indicates that ~0.44 $M_{\odot}$ of O was ejected in the explosion. The intensity ratio of the [Ca II]/[O I] nebular lines favours either a main-sequence progenitor mass of ~15 $M_{\odot}$ or a Wolf-Rayet star of 20 $M_{\odot}$. **[Gangopadhyay, A.,** et al. (including **Misra, K., Singh, Mridweeka, Dastidar, R., Kumar, Brijesh & Pandey, S. B.**) (2018). *Mon. Not. Roy. Astron. Soc., 476,* 3611-3630**].**

SN 2015ba: a type IIP supernova with a long plateau

The optical photometric and spectroscopic observations of an atypical Type IIP supernova, SN 2015ba, which exploded in the edge-on galaxy IC 1029, from about a week after explosion to ~272 d were presented. SN 2015ba was a luminous event with an absolute *V*-band magnitude of -17.1 ± 0.2 mag at 50 d since explosion and has a long plateau lasting for ~123 d. The distance to the SN was estimated to be 34.8± 0.7 Mpc using the expanding photosphere and standard candle methods. High-velocity H Balmer components constant with time were observed in the late-plateau phase spectra of SN 2015ba, which suggested a possible role of circumstellar interaction at these phases. Both hydrodynamical and analytical modelling suggest a massive progenitor of SN 2015ba with a pre-explosion mass of 24-26 $M_{\odot}$. However, the nebular spectra of SN 2015ba exhibit insignificant levels of oxygen, which is otherwise expected from a massive progenitor. This might be suggestive of the non-monotonical link between O-core masses and the zero-age main sequence mass of pre-supernova stars and/or uncertainties in the mixing scenario in the ejecta of supernovae. **[Dastidar, R.,** et al. (including **Misra, K., Singh, Mridweeka, Gangopadhyay, A., Kumar, Brijesh & Pandey, S. B**) (2018). *Mon. Not. Roy. Astron. Soc., 479,* 2421-2441**].**

Low-frequency View of GW170817/GRB 170817A with the Giant Metrewave Radio Telescope

The short gamma-ray burst (GRB) 170817A was the first GRB associated with a gravitational-wave event. Due to the exceptionally low luminosity of the prompt γ-ray and afterglow emission, the origin of both radiation components is highly debated. The most discussed models for the burst and the afterglow include a regular GRB jet seen off-axis and the emission from the cocoon encompassing a "choked" jet. The low radio frequency observations at 610 and 1390 MHz obtained with the Giant Metrewave Radio Telescope (GMRT) over a span of 7 to 152 days after the burst were reported. The afterglow started to emerge at these low frequencies about 60 days after the burst. The 1390 MHz light curve barely evolved between 60 and 150 days, but its evolution was also marginally consistent with an $F\nu \propto t^{0.8}$ rise seen in higher frequencies. The radio data and archival X-ray, optical, and high-frequency radio data were modelled using the top-hat and Gaussian structured GRB jet models. A Markov Chain Monte Carlo analysis of the structured-jet parameter space was performed. Though highly degenerate, useful bounds on the posterior probability distributions could be obtained. The bounds obtained for the viewing angle were consistent with that inferred from the gravitational-wave signal. The energy budget in prompt emission was estimated to be an order of magnitude lower than that in the afterglow blast wave. **[**Resmi, L., et al. (including **Misra, K.**) (2018). *Astrophy. Jr., 867:57* (10pp)**]**

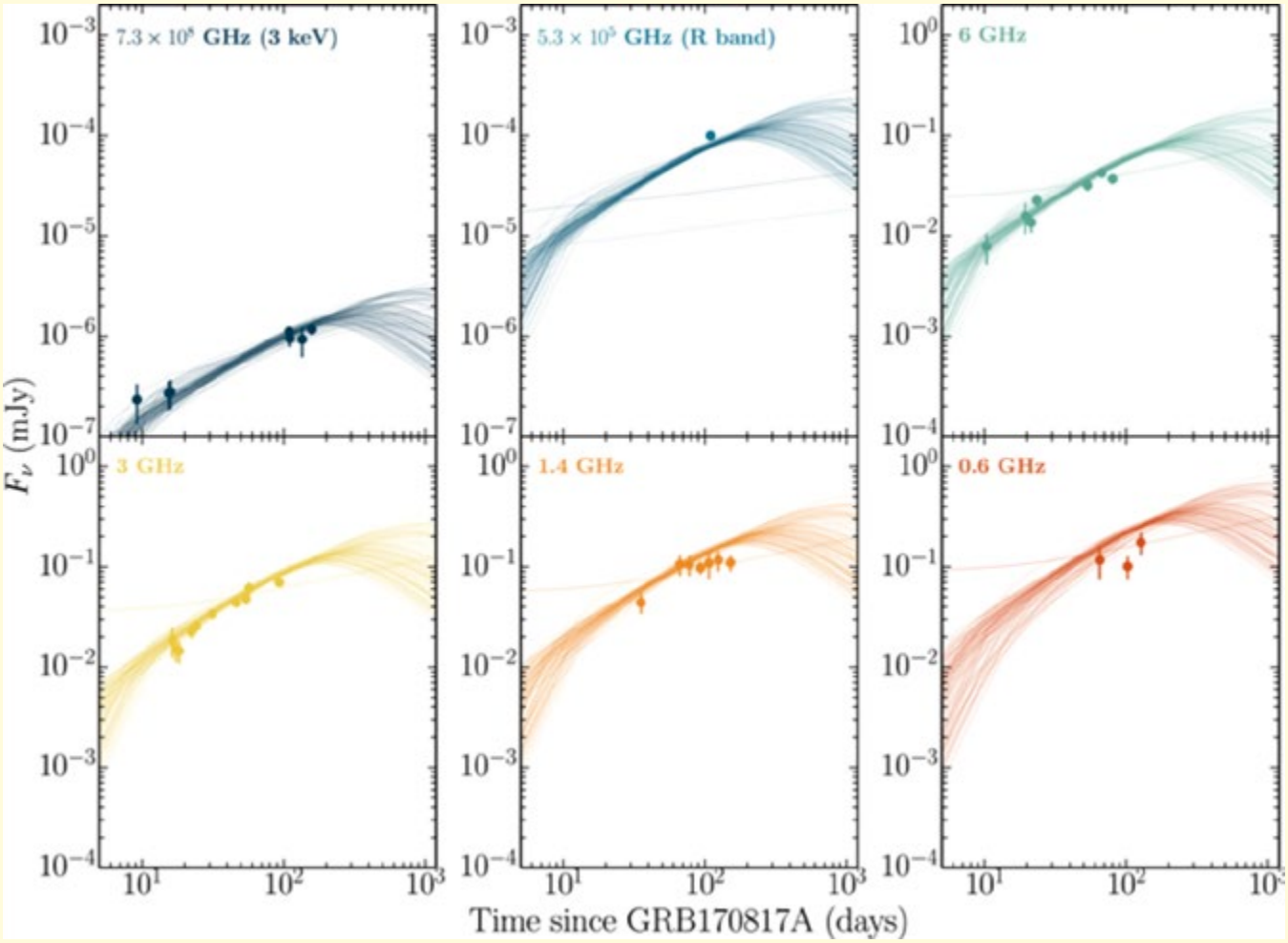

Figure 3. 610 and 1390 MHz GMRT light curves along with higher-frequency data from the literature (detections: circles; upper limits: triangles). Overlaid are 100 random realizations from the posterior chain from the run where energy fractions are restricted to be <0.3. Some light curves show small-scale undulations, due to the limited resolution in polar directions. Since the data are dominated by higher radio frequencies, the flatness of the GMRT 1390 MHz light curve is not well reproduced in the model realizations.

5. External Galaxies, AGN and Quasars

Deceleration of CIV and Si IV broad absorption lines in X-Ray bright quasar SDSS-J092345+512710

In this study a synchronized kinematic shift of C IV and Si IV broad absorption lines (BAL) in a high-ionization, radio-loud, and X-ray bright quasar SDSS-J092345+512710 (at z_{em} ~ 2.1627) is reported. This quasar shows two broad absorption components (blue component at v ~ 14,000 km s^{-1}, and red component at v ~ 4000 km s^{-1} with respect to the quasars systemic redshift). The absorption profiles of C IV and Si IV BAL of the blue component show a decrease in outflow velocity with an average deceleration rate of -1.62$^{\pm 0.05}$ cm s^{-2} and -1.14$^{\pm 0.22}$ cm s^{-2} over a rest-frame time span of 4.15 yr. Any acceleration-like signature in the red component is not seen. This is consistent with dramatic variabilities usually seen at high velocities. During the monitoring period the quasar has shown no strong continuum variability and this study suggests that the observed variability could be related to the time dependent changes in disk wind parameters like launching radius, initial flow velocity, or mass outflow rate. **[Joshi, Ravi** et al. (including **Chand, H.**) (2019). *Astrophy. Jr., 871,* 43-49**].**

Intra-night optical monitoring of three γ-ray detected narrow-line Seyfert 1 galaxies

For three radio-loud gamma-ray detected narrow-line Seyfert 1 (gamma-ray NLSy1) galaxies, optical variability on intra-night and/or week-like time-scales, based on five ⩾ 3 h long monitoring sessions for each galaxy is reported. The radio-loudness factors ($R_{1.4\ GHz}$)[1] for these galaxies, namely 1H 0323+342 (z = 0.0629), PKS J1222+0413 (z = 0.966), and PKS J1505+0326 (z = 0.408) are ~318, ~1534, and ~3364 at 1.4 GHz, respectively. For the most distant gamma-ray NLSy1, PKS J1222+0413, intra-night optical variability (INOV) characterization is presented for the first time. The blazar-like behaviour of the nearest gamma-ray NLSy1, 1H 0323+342, which showed strong INOV on four of the five nights, was unexpected in view of its recent reclassification as radio intermediate ($R_{5\ GHz} \leqslant$ 25). Its particularly violent INOV is manifested by two optical outbursts lasting ~1 h, whose rapid brightening phase is shown to imply a doubling time of ~1 h for the optical synchrotron flux, after (conservatively) deducting the thermal optical emission contributed by the host galaxy and the Seyfert nucleus. A more realistic decontamination could well reduce substantially the flux doubling time, bringing it still closer in rapidity to the ultra-fast VHE (>100 GeV) flares reported for the blazars PKS 1222+216 and PKS 2155-304. A large contamination by thermal optical emission may, in fact, be common for NLSy1s as they are high Eddington rate accretors. This study further suggests that superluminal motion in the radio jet could be a robust diagnostic of INOV. **[Ojha, Vineet,** Gopal-Krishna & **Chand, H.** (2019). *Mon. Not. Roy. Astron. Soc.*, *483,* 3036-3047**].**

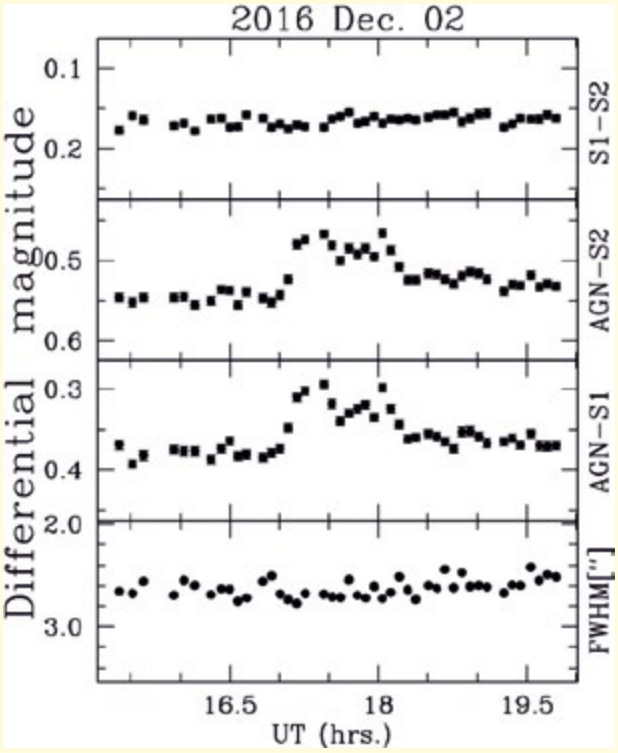

Figure 4. The figure shows the intranight differential light curves (DLCs) observed with 1.3m DFOT for a γ-ray detected narrow-line Seyfert 1 galaxy, viz. 1H 0323+342, revealing an optical flare, likely to be associated with the synchrotron jet.

Investigating kpc-scale radio emission properties of narrow-line Seyfert 1 galaxies

In recent years, several radio-loud narrow-line Seyfert 1 galaxies (RL-NLS1s) possessing relativistic jets have come into attention with their detection in very large baseline array (VLBA) and in gamma-ray observations. In this work an attempt to understand the nature of radio jets in NLS1s by examining the kpc-scale radio properties of, hitherto, the largest sample of 11101 optically selected NLS1s is done. Using 1.4 GHz FIRST, 1.4 GHz NVSS, 327 MHz WENNS, and 150 MHz TGSS catalogues, it is found that the radio-detection of merely ~4.5 per cent (498/11101) NLS1s, with majority (407/498 ~ 81.7 per cent) of them being RL-NLS1s. This study yields the highest number of RL-NLS1s and it can only be a lower limit. Most of the radio-detected NLS1s are compact (<30 kpc), exhibiting both flat as well as steep radio spectra, and are distributed across a wide range of 1.4 GHz radio luminosities (10^{22}-10^{27} W Hz^{-1}). At the high end of radio luminosity our NLS1s often tend to show blazar-like properties such as compact radio size, flat/inverted radio spectrum, radio variability, and polarization. The diagnostic plots based on the mid-IR colours suggest that the radio emission in NLS1s is mostly powered by active galactic nuclei (AGNs), while nuclear star formation may have a significant contribution in NLS1s of low radio luminosities. The radio luminosity versus radio-size plot infers that the radio jets in NLS1s are either in the early

evolutionary phase or possibly remain confined within the nuclear region due to low-power or intermittent AGN activity. **[**Singh, V. and **Chand, H.** (2018). *Mon. Not. Roy. Astron. Soc.*, *480,* 1796-1818**].**

Polarimetric and spectroscopic study of radio-quiet weak emission line quasars

A small subset of optically selected radio-quiet quasars showing weak or no emission lines may turn out to be the elusive radio-quiet BL Lac objects, or simply be radio-quiet QSOs with a still-forming/shielded broad line region (BLR). High polarization (p > 3-4 per cent), a hallmark of BL Lacs, can be used to test whether some optically selected `radio-quiet weak emission line quasars' (RQWLQs) show a fractional polarization high enough to qualify as radio-quiet analogues of BL Lac objects. Out of the observed six RQWLQs candidates showing an insignificant proper motion, only two are found to have p > 1 per cent. For these two RQWLQs, namely J142505.59+035336.2 and J154515.77+003235.2, we found polarization of 1.03 ± 0.36 per cent and 1.59 ± 0.53 per cent, respectively, which again is too modest to justify a (radio-quiet) BL Lac classification. A statistical comparison of the optical spectral index, for a set of 40 RQWLQs with redshift-luminosity matched control sample of 800 QSOs and an equivalent sample of 120 blazars is also conducted. The spectral index distribution of RQWLQs is found to differ, at a high significance level, from that of blazars and is consistent with that of the ordinary QSOs. Likewise, a structure-function analysis of photometric light curves presented here suggests that the mechanism driving optical variability in RQWLQs is similar to that operating in QSOs and different from that of blazars. These findings are consistent with the common view that the central engine in RQWLQs, as a population, is akin to that operating in normal QSOs and the primary differences between them might be related to differences in the BLR. **[Kumar, P., Chand, H.,** Srianand, R., Stalin, C. S., Petitjean, P. & Gopal-Krishna (2018). *Mon. Not. Roy. Astron. Soc., 479,* 5075-5082**].**

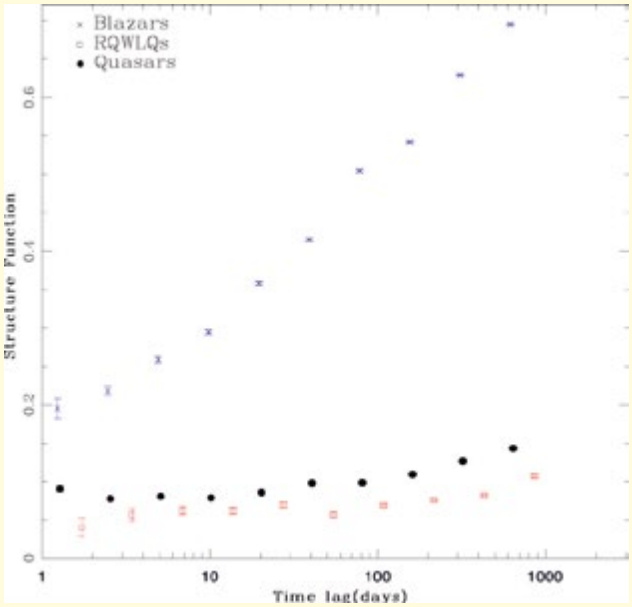

Figure 5. Structure-function (SF) for RQWLQs (open square), QSOs (filled circle) and blazars (blue stars). Our SF analysis makes use of the sample of the 40 RQWLQs and the corresponding control samples of 800 QSOs and 120 blazars. Clearly, the SF of RQWLQs is far better matched to that of the normal QSOs, as compared to the SF for blazars. This supports the premise that, as a class, RQWLQs are closer to normal QSOs in term of variability mechanism and are clearly different from blazars.

Studies of Active Galactic Nuclei

Using ESA (European Space Agency) multi-wavelength satellite *XMM-Newton* and EPIC/pn detector on board which operates in 0.15 – 15 keV, a possible ~1 hour quasi-periodic oscillation (QPO) detected in a ~55 ks X-ray observation of the narrow-line Seyfert 1 galaxy MCG-06-30-15. A total modulation of 16% is estimated in the light curve and found a 3670 second quasi-period using Lomb-Scargle periodogram (LSP) and weighted wavelet Z-transform (WWZ) techniques. The LSP indicates a statistically significant (~3σ) QPO detection. A WWZ analysis shows that the signal at this possible roughly 3670 second period is present, and rather persistent, throughout the observation; however, a signal around 8735 s is more persistent. Various AGN emission models that can produce X-ray QPOs with such periods in narrow line Seyfert 1 galaxies are discussed, as both other claimed QPO detections in this class of AGN had very similar periods. **[Gupta, A. C.,** et al. (2018). *Astron. & Astrophy, 616,* L6 (1-5pp)**].**

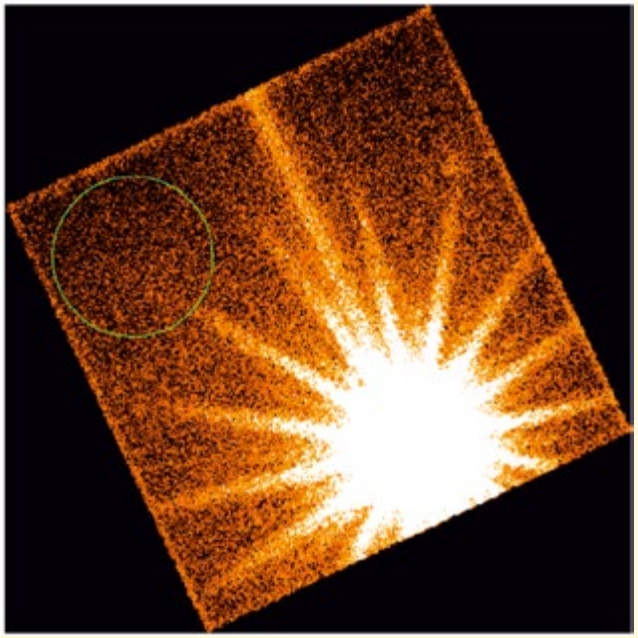

Figure 6. *XMM-Newton* EPIC/pn image of the NLSy1 MCG–06–30–15 and the selected background region, denoted by a circle.

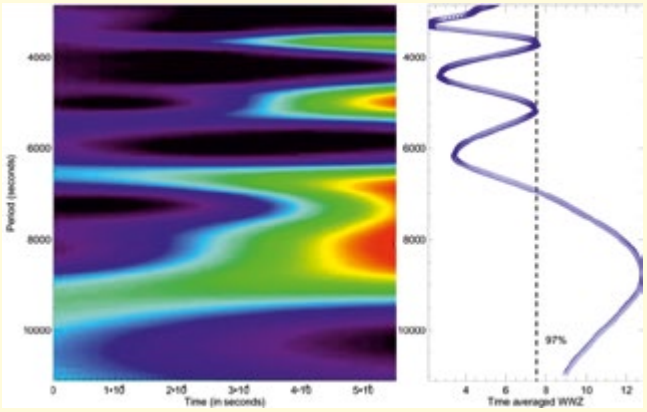

Figure 7. Left panel: distribution of color-scaled WWZ power (with red most intense) in the time-period plane. Right panel: time-averaged WWZ power (blue curve) as a function of period. The dotted black curve represents 97% global significance.

Investigating roles of intra-cluster thermo-nuclear supernovae in particle acceleration and radio emission in clusters of galaxies

A possibility of generating a population of cosmic-ray particles accelerated in supernovae type-Ia (SNIa) remnants in the intra-cluster medium (ICM) was discussed. The presently constrained host-less SNIa rates in the clusters were found to be sufficient to fill a few hundred kpc region with cosmic-ray electrons within their typical synchrotron life-time of 100 Myr. The SNIa have already been considered potential sources of excess Fe abundance in cool-core clusters, distributed heating and turbulence in ICM. A good fraction of total radio power from mini-halos can be sourced from the SNIa energy deposited in the ICM with required energy conversion efficiency <1 per cent. The radio power estimated from low Mach number shock acceleration in SNIa remnants is consistent with the observations within the uncertainties in the estimates. Some observational properties of the radio mini-halos are broadly consistent with the SNIa scenario. It is also speculated that radio powers and possibly detections of mini-halos are linked to star formation and merger histories of the clusters. **[Omar, A.** (2019). *Mon. Not. Roy. Astron. Soc.*, *484,* L141-L146**].**

Spatially-resolved abundance studies of blue compact dwarf galaxies

Spatially-resolved optical spectroscopic observations of four nearby dwarf Wolf-Rayet (WR) galaxies were presented. The ages of the most recent star burst events in these galaxies are found between 3 and 10 Myr. The gas-phase metallicities [12+log(O/H)] for the spatially-resolved star-forming regions are derived using several indicators. The star-forming regions within the galaxies are found chemically homogeneous within the uncertainties in the estimates. Nitrogen-enrichment as expected in the WR regions is not detected. This implies that metal-enrichment due to supernovae explosions in the most recent star-forming episode is not being detected here. It is suggested that the newly synthesized metals still reside in hot gas-phase. The metals from the previous episodes, cooled by now and well mixed across the whole extent of galaxies, are making galaxies chemically homogeneous with normal N/O ratio. These galaxies are residing in dense environments with galaxy density in the range of 8−80 Mpc. **[Paswan, A., Omar, A., & Jaiswal, S.** (2019). *Mon. Not. Roy. Astron. Soc.*,*482,* 3803-3821**].**

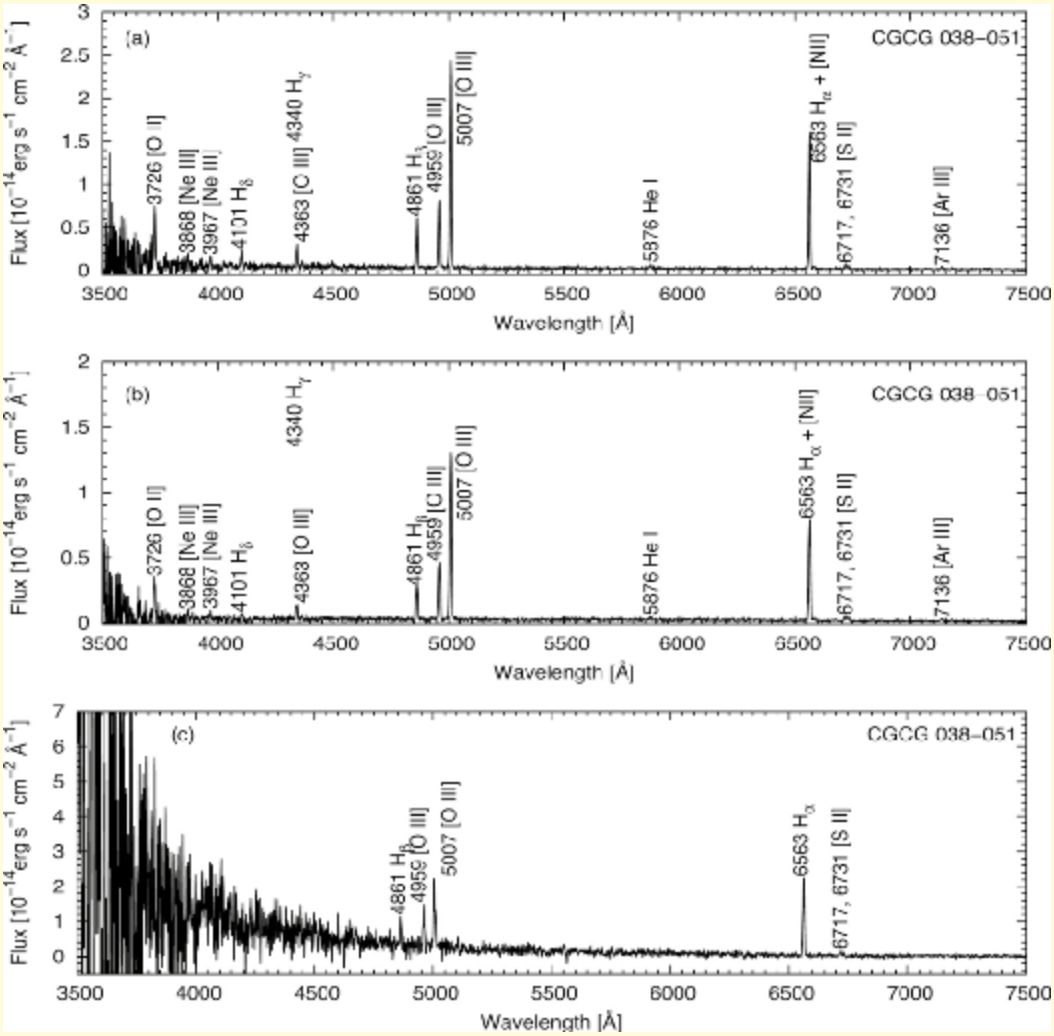

Figure 8. The optical spectrum of three star-forming complexes in the blue compact dwarf galaxy CGCG 038-051, obtained from FOSC on 2m Himalayan Chandra Telescope.

6. Blazars

Multi-wavelength flux and spectral variability of blazars

NuStar (Nuclear Spectroscopic Telescope Array) is a NASA X-ray satellite which works in the X-ray energy range 3 – 79 keV. By using NuStar observations of six TeV-emitting high-frequency peaked blazars, a detailed timing and spectral studies of these blazars were carried out. Two TeV blazars, 1ES1101-232 and 1ES 1218+304, showed strong evidence of intraday flux variations in the energy range 3 – 79 keV. An intraday variability timescale of 23.5 ks in the light curve of 1ES 1218+304 is estimated using ACF method. Different parameters of the blazar 1ES 1218+304 are estimated as, magnetic field ~0.3 Gauss, electron Lorentz factor 2.16×10^6, and the size of X-ray emission region to be ~1.19×10^{16} cm. The spectrum of the TeV blazar 1ES 0414+009 is well described by a single power law with a photon index 2.77. The spectra of the other five HBLs are somewhat better represented by log-parabola models with local photon indices (at 10 keV) ~2.23 – 2.67 and curvature parameters 0.27 – 0.43. **[Pandey, Ashwani., Gupta, A. C.** & Wiita, P. J. (2018). *Astrophy. Jr., 859*: 49 (11pp)**].**

OJ 287 is a binary black hole blazar which show quasi-periodic double peaked outburst at every ~12 years. To observe and study the muti-wavelength properties of OJ 287, an observing campaign since 2015 was coordinated. Multi-wavelength observations taken during July 2016 – December 2017. The daily γ–ray fluxes from NASA Fermi-Large Area Telescope (LAT) are consistent with no variability. The strong optical-to-X-ray variability is accompanied by a change in power-law spectral index of the X-ray spectrum from <2 to >2, with variations often associated with changes in optical polarization properties. The LAT spectrum before the very high-energy (VHE) activity is similar to preceding quiescent state spectrum, while it hardens during VHE activity period and is consistent with the extrapolated VHE spectrum during the latter. No genuine IDV in optical flux or color is detected, but multiple flaring were seen on long timescale. Large changes in the degree of optical polarization and substantial swings in the polarization angle were detected. The fractional Stokes parameters of the polarization showed a systematic trend with time in the beginning of these observations, followed by chaotic

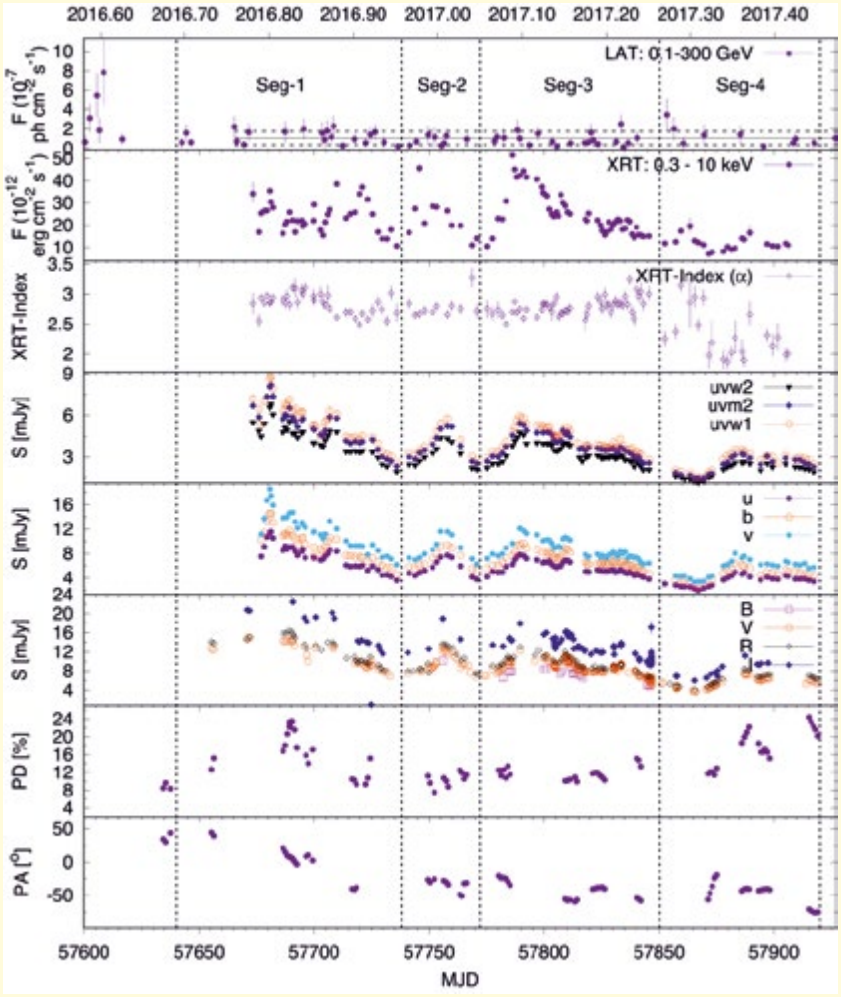

Figure 9. Light curves of OJ 287 from γ-ray to optical bands between 2016 April and 2017 July along with X-ray photon spectral index (α), optical ploarization angle (PA), and degree (PD). The daily γ-ray points (LAT: 0.1 –300 GeV) belong to the Fermi-LAT observations, while the X-ray (XRT: 0.3 –10keV), UV (uvw2, uvm2, uvm1), and optical (u, b, v) are from the different bands of the Swift observatory. The optical B, V, R, and I data are from the nine ground-based 1–2m class telescopes. The vertical dashed lines delineate the four high-activity periods of the source, while the horizontal solid and dashed lines in the top panel represent the mean LAT flux and its error for the duration over which they are drawn.

changes and then an apparently systematic variation at the end. These polarization changes coincide with the detection and duration of the source at very high energies as seen by VERITAS. Overall, the broad-band spectral energy distributions (SEDs) during high-activity periods are a combination of a typical OJ 287 SED and a high-energy peaked (HBL) SED and can be explained in a two-zone leptonic model, with the second zone located at parsec scales, beyond the broad line region, being responsible for the HBL-like spectrum. **[**Kushwaha, P., et al. (including **Gupta, A. C.** & **Gaur, H.**) (2018). *Mon. Not. Roy. Astron. Soc., 479,* 1672-1684; **Gupta, A. C.,** et al. (including **Gaur, H.** & **Pandey, A.**) (2019). *Astron. Jr., 157:* 95 (12pp)**].**

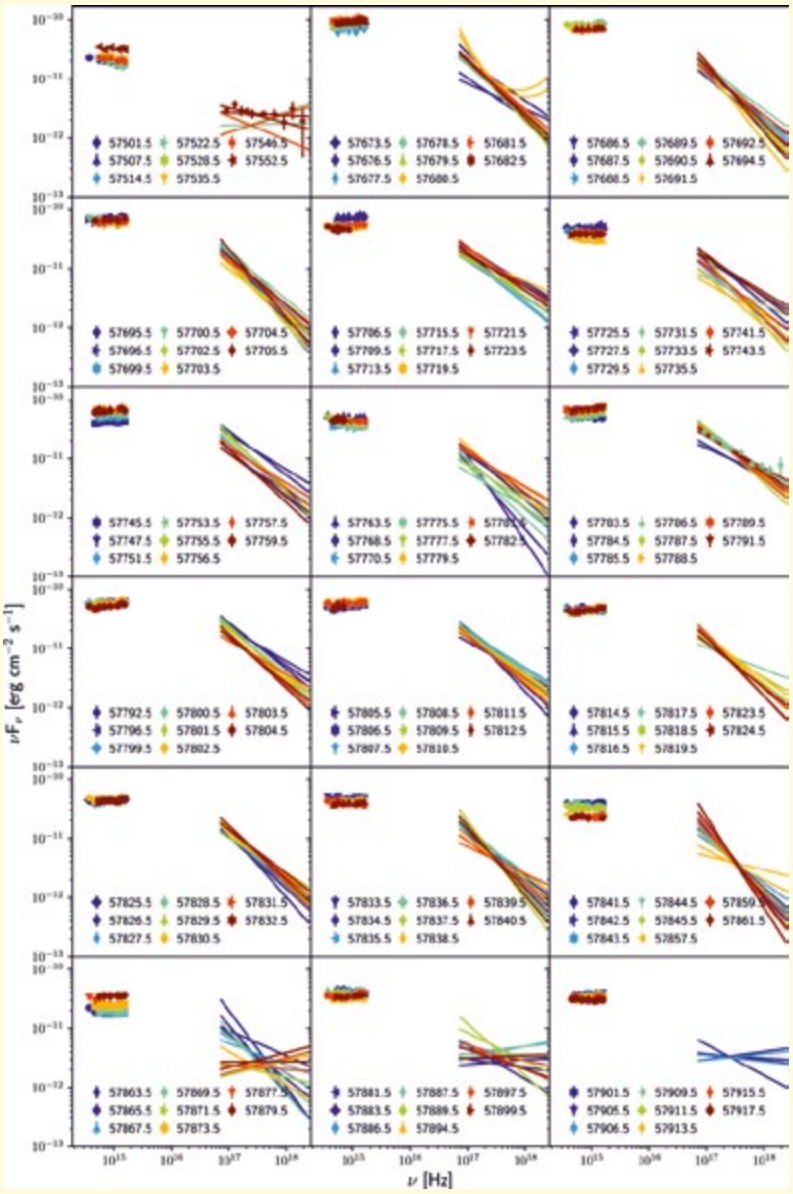

Figure 10. The daily optical to X-ray SEDs of OJ 287 between MJD 57500 and 57920, shown only for days having observations in at least four different bands. The optical to UV measurements are shown by actual data points, while the X-ray spectrum is shown by the 1σ range of the best-fitting spectrum , which is a good representation of the observed SED as shown by the overlaid X-ray data in the first and the ninth plot in the respective colour.

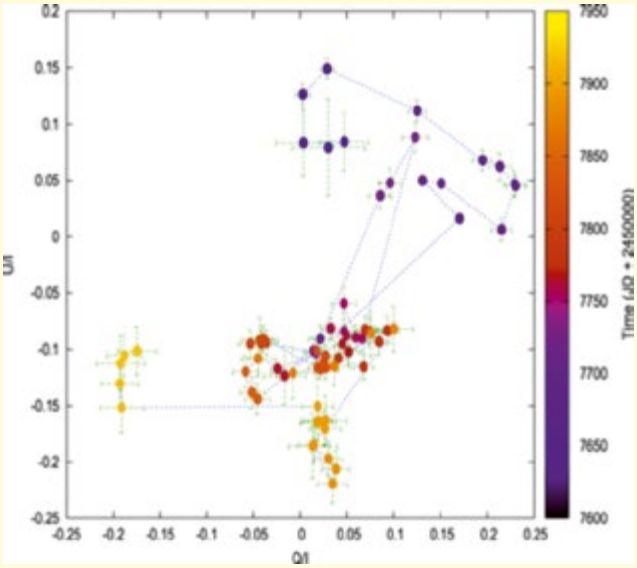

Figure 11. Fractional polarization variations over the course of data presented in this study.

Quasi-simultaneous optical *VRI* bands photometric observations using ARIES 1.04m ST and 1.3m DFOT telescopes were carried out in eight nights in April 2016 for the TeV blazar PG 1553+113. Intraday flux and color

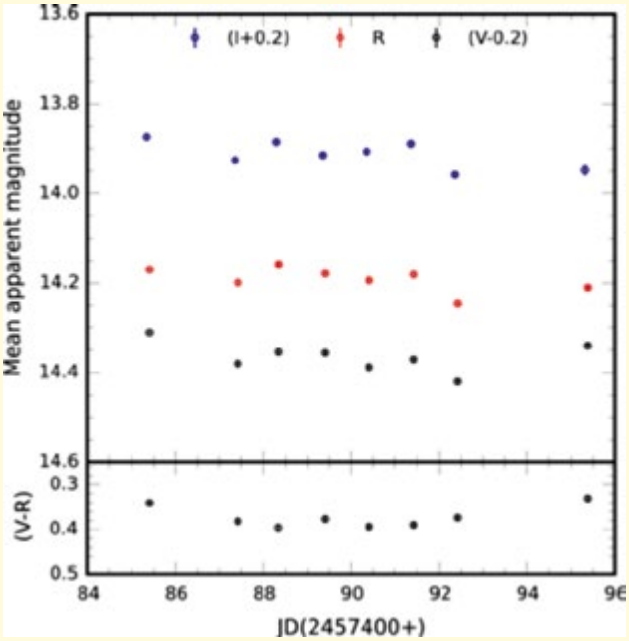

Figure 12. Upper panel displays STV optical (*VRI*) light curves of PG 1553+113; they are shown in black (*V*), red (*R*), and blue (*I*), respectively. The bottom panel represents the color ($V - R$) variation on STV timescales.

variations were searched using two of the most powerful tests: the power-enhanced F-test and the nested ANOVA test. The source was found to be significantly (>99%) variable in both V and R bands only on one night while no temporal variation was seen in the color during the observation period. A mean optical spectral index of 0.83±0.02 is estimated with a maximum variation of 0.21 by fitting a power-law in the optical (VRI) spectral energy distribution. **[Pandey, Ashwani, Gupta, A. C.,** Wiita, P. J. & Tiwari, S. N. (2019). *Astrophy. Jr., 871:*192 (8pp)**].**

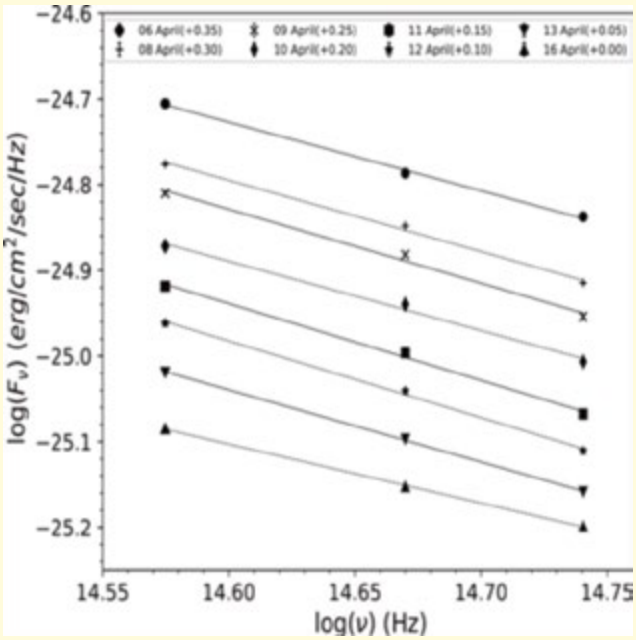

Figure 13. The SED of PG 1553+113 in V, R, and I bands.

Chandra is a NASA X-ray satellite which works in the *X*-ray energy range 0.3 – 10 keV. An extensive intraday variability based on 15 years (2000 – 2015) were carried of the TeV blazar Mrk 421. Various intraday variability parametres, e.g. fractional variability amplitudes that range up to 21.3 per cent, duty cycle 84 per cent, and variability time-scale in the range of 5.5 to 30.5 ks were estimated. Soft (0.3 – 2.0 keV) and hard (2.0 – 10 keV) show strong correlation with zero lag, indicating that very similar electron populations are responsible for the emission of all the X-rays observed by Chandra. The hardness ratios of this X-ray emission indicate a general 'harder-when-brighter' trend in the spectral behaviour of Mrk 421. Spectral index-flux plots provide model-

independent indications of the spectral evolution of the source and information on the X-ray emission mechanisms. **[Aggrawal, V.**, et al. (including **Pandey, Ashwani & Gupta, A. C.)** (2018). *Mon. Not. Roy. Astron. Soc.*, *480,* 4873-4883**].**

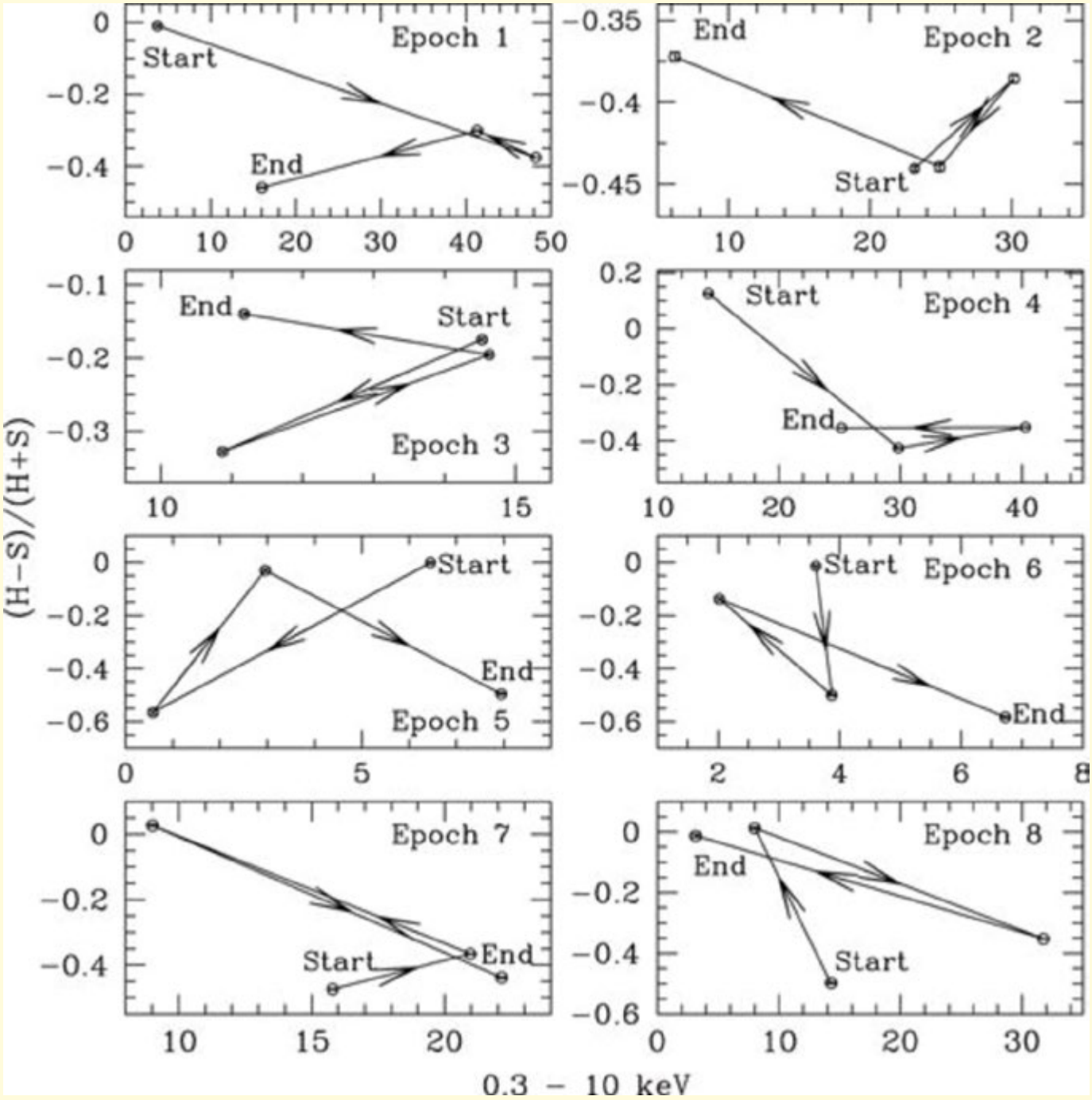

Figure 14. Spectral variations of Mrk 421 in various epochs with start and end points marking the loop directions. Each epoch corresponds to the time interval during which the data were acquired for each loop, considered from Epoch 1 to Epoch 8: Epoch 1: 29-05-2000 to 13-07-2004; Epoch 2: 08-11-2009 to 02-02-2010; Epoch 3: 04-02-2010 to 06-02-2010; Epoch 4: 13-03-2010 to 14-03-2010; Epoch 5: 14-03-2010 to 04-07-2011; Epoch 6: 05-07-2011 to 03-07-2012; Epoch 7: 07-02-2013 to 30-06-2013; and Epoch 8: 01-07-2013 to 25-06-2014.

7. Theoretical and Numerical Studies

Radiation driving and heating of general relativistic jets under a Compton-scattering regime

Interaction of intense radiation from the underlying accretion disc with a steady, general-relativistic jet was studied. The radiation field imparts momentum as well as energy to the outflowing jet under Compton scattering. As a result, the jet gains momentum and is simultaneously heated up. Jets can be classified as types A, B and C according to their base properties. In this study it was found that A-type jets can undergo shock transition. It is also shown that, in the Compton-scattering regime, radiation can drive jets starting with very small thermal energy at the base (B- and C-type jets), such that radiation can even accelerate bound matter (generalized Bernoulli parameter $E < 1$) in the form of relativistic transonic jets. This is in stark contrast to radiatively driven jets in the Thomson-scattering regime, where transonic jets were obtained only for $E > 1$. It was also show that, for a given disc luminosity, jets in the Compton-scattering regime exhibit a minimum terminal speed, unlike in the Thomson-scattering domain. Further, the impact of accretion-disc luminosity and jet plasma composition is studied. The e^--p^+ jets are accelerated up to Lorentz factors of about a few, while for lepton-dominated jets the minimum Lorentz factor exceeds 10 for moderate disc luminosities and can go up to a few tens for highly luminous discs. **[Vyas, M. K. & Chattopahyay, I.** (2019). *Mon. Not. Roy. Astron. Soc.*, *482,* 4203-4214**].**

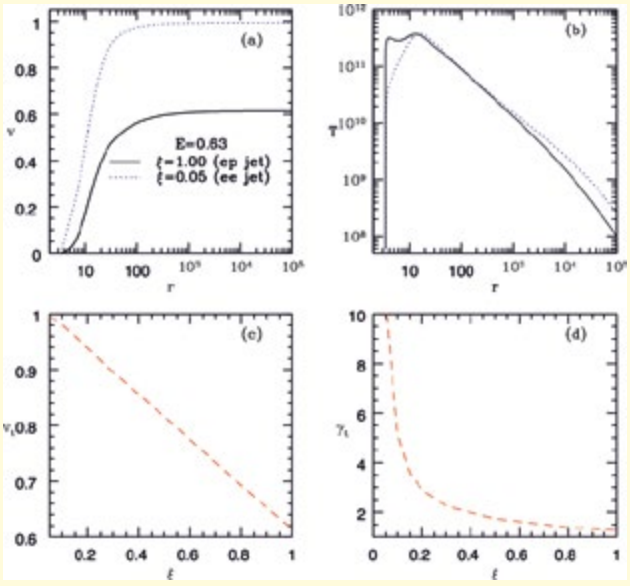

Figure 15. (a) v and (b) T profiles as a function of r for $\xi = 0.05$ (dotted) and $\xi = 1.00$ (solid). (c) v_t and (d) γ_t as a function of ξ. For all curves, $E = 0.63$ and $l = 1.0$.

Research Working Group – II

All the scientists working on the Sun and Atmospheric Sciences are members of WG – II. The group consists of 5 scientists. The solar physics research group (consisting of one scientist) is basically concentrated on the observations and modeling of the transients (e.g., flares and associated plasma processes, jets, spicules, etc.), space weather phenomena, and magneto-hydrodyanmic waves in the solar atmosphere. Atmospheric Science group (consisting of 4 scientists) is mainly engaged in the investigation of aerosols, trace gases, dynamics, meteorology etc., of the lower atmosphere. The extracts of the publications made by the members are briefly presented below.

1. Solar Physics

Photospheric Doppler enhancement and Hα evolution of an X-class flare

The relation between photospheric Doppler enhancement and Hα intensity is being established for the X-class solar flare observed at active region 11748 on 15 May, 2013. The flare shows two ribbon structure and the separation speed is ~ 10 km s^{-1}. The formation of flare ribbons and the post-flare loops can be interpreted by "CSHKP" (Carmichael–Sturrock–Hirayama–Kopp–Pneuman) reconnection model. In the Dopplergrams, the four velocity enhancement clusters are observed, from which only two Hα flare kernels are co-spatially aligned. After the flare, proton beam in form of hydrodynamic shocks penetrates into the atmosphere earlier than the electron beam resulting in high-energy emission of seismic waves from the observed sources and temporally delayed by 4 minutes. On the contrary, other two kernels shifted by 2-3 arcsec with the flare evolution. The time delay in spatially

aligned kernels can be interpreted as penetration of proton beam in the solar atmosphere. The shifted velocity enhancement with respect to Hα kernels can be explained by the coupling of energy driven by Lorentz force. **[Monga, A.**, Chandra, R. & **Uddin, W.** (2018). *New Astron., 62,* 85-93**].**

2. Atmospheric Sciences

Source apportionment of black carbon aerosols over Delhi during winter fog experiment

The contribution of fossil-fuel combustion (BC_{ff}) and biomass (or wood) burning (BC_{wb}) to wintertime Black Carbon (BC) concentrations in Delhi using the "Aethalometer model" approach is studied. The continuous measurements of 7-wavelength Aethalometer (AE-33) were taken from December 2015 to February 2016 at Delhi downtown as part of a multi-instrument research campaign revealing high BC concentrations of 24.4 ± 12.2 μg m^{-3} (range from 3.2 to 59.9 μg m^{-3}). The BC_{ff} contribution dominates with an average fraction of 72% at 880 nm and 56% at 370 nm, also implying an important contribution from biomass-burning sources that further deteriorate the air quality. The daily-averaged Absorption Ångström Exponent ($AAE_{370\text{-}880}$) varies between 1.08 and 1.46 due to changes in the BC emission rates, variations in the relative strength between fossil-fuel and wood-burning sources and mixing processes in the atmosphere. The average BC_{ff}/ BC_{wb} ratio is estimated as 2.90 ± 1.47 at 880 nm, while it decreases to 1.45 ± 0.74 at 370 nm, suggesting a significant wavelength dependence and larger contribution of the BC_{wb} at shorter

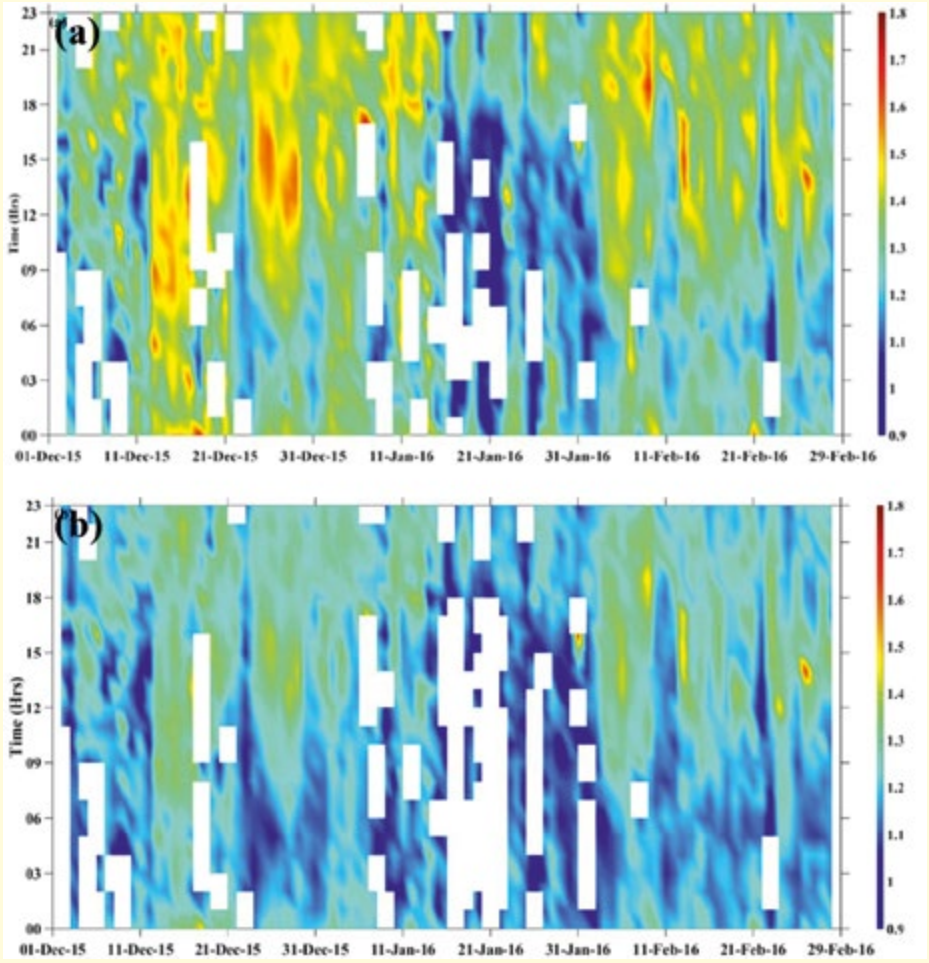

Figure 16. Daily-diurnal contours of BC_{ff} (a) and BC_{wb} (b) concentrations at 880 nm in Delhi during the whole campaign period.

wavelengths. The BC, BC_{ff} and BC_{wb} concentrations exhibit remarkable diurnal variations with maximum values in the morning and evening/night hours and lower around noon, primarily driven by changes in the mixing-layer height. The highest BC, BC_{ff} and BC_{wb} concentrations are associated with weak winds (< 2 m s^{-1}), revealing a dominance of local emission sources within the Delhi metropolitan area. A sensitivity analysis is performed by changing the wavelength pairs and AAE values in order to evaluate the stability of the "Aethalometer model" in assessment of the BC source apportionment. The results reveal that the "Aethalometer model" is more sensitive in estimating the BC_{wb}, while the changes in the BC_{ff} component are very low. **[Dumka, U. C.,** et al. (including **Singh, N.**) (2018). *Atmospheric Envir., 194,* 93-109**].**

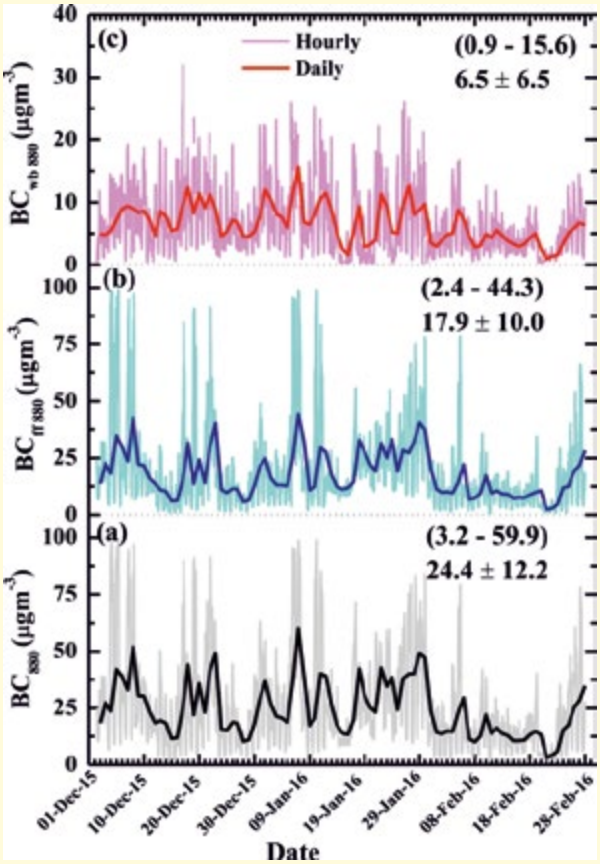

Figure 17. Hourly and daily variation of the BC_{880} (a), $BC_{ff\,880}$ (b) and $BC_{wb\ 880}$ (c) concentrations over Delhi during December 2015 - February 2016. The range (in parenthesis), the mean values and standard deviations are given in each plot.

Trace Gases in the central Himalaya and its foothills region

Simultaneous observations of trace gases were made in Nainital, Bode, and a low altitude site Pantnagar in the IGP under a multinational field campaign SusKat-ABCto understand local to regional scale processes influencing air quality in the Himalayan region. The diurnal variations at Bode showed a daytime buildup in O_3 while CO shows morning and evening peaks. Similar variations (with lower levels) were also observed at Pantnagar but not at Nainital. Several events of hourly ozone levels exceeding 80 ppbv were also observed at Bode. The hourly mean ozone and CO levels showed a strong negative correlation during winter, but this negative correlation gradually becomes weaker, with the lowest value in May (r^2=0.12) **(Figure 18)**. The background O_3 and CO mixing ratios at Bode were estimated to be about 14 ppbv and 325 ppbv, respectively. The rate of change of ozone at Bode showed a more rapid increase (~17 ppbv/hour) during morning than the decrease in the evening (5-6 ppbv/hour), suggesting prevalence of a semi urban kind of environment at Bode. The lower CO levels during spring suggests that regional transport also contributes appreciably to springtime ozone enhancement in the Kathmandu Valley on top of the local in situ ozone production. The regional pollution resulting from agricultural crop residue burning in north-western IGP led to simultaneous increases in O_3 and CO levels at Bode and Nainital during first week of May 2013 **(Figure 19)**. Biomass burning induced increase in ozone and related gases was also confirmed by a global model and balloon borne observations over Nainital. A comparison of surface ozone variations and composition of light non-methane hydrocarbons among different sites indicated the differences in emission sources of the Kathmandu Valley and the IGP. These results highlight that it is important to consider regional sources in air quality management over the Himalayan region. **[Bhardwaj, P.,** et al. (including **Naja, M.**) (2018). *Atmos. Chem. Phys., 18,* 11949-11971**].**

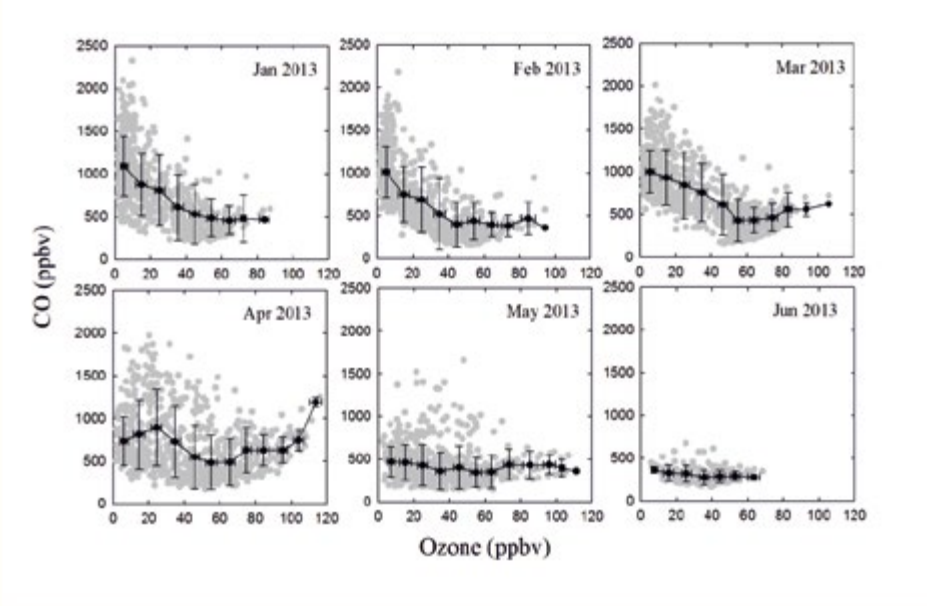

Figure 18. Relation between ozone and CO from January 2013 to June 2013 at Bode. Grey dots are hourly average data and black filled dots are 10 ppbv binned averaged with respect to ozone. The spread around the mean value is one sigma value.

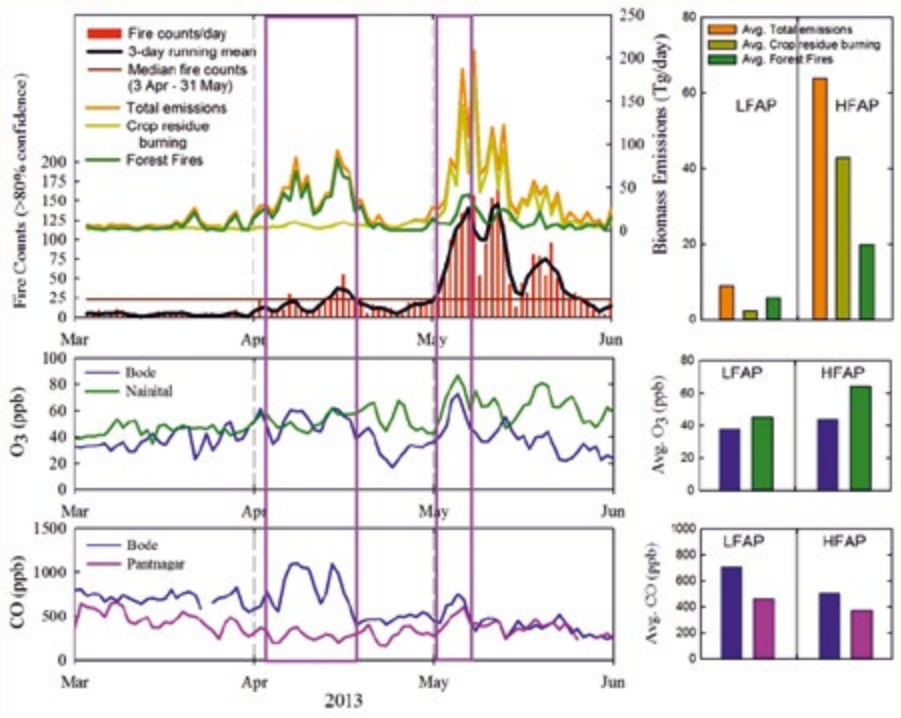

Figure 19. Top Left: time series of MODIS daily fire counts for the fire period (3 April -31 May 2013). Total biomass burning emissions, crop residue burning emissions and forest fire emissions around Bode are also shown. Top right: average biomass burning emissions for two fire activity periods over Bode region. Center: time series of surface ozone mixing ratios at Bode and Nainital (line plot-Left) and average ozone mixing ratios during two fire periods (as bar plot-Right), respectively. Bottom: time series of surface CO mixing ratios at Bode and Nainital (line plot-Left) and average CO mixing ratios during two fire periods (as bar plot-Right), respectively. The two fire events in April and May are also shown highlighted (in violet boxes).

MAX-DOAS Observations of formaldehyde and glyoxalusing MAX-DOAS instrument

Continuous multi-axis differential optical absorption spectroscopy (MAX-DOAS) observations have been performed for the first time at Pantnagar (29.03° N, 79.47° E), a semi-urban site located in the Indo-Gangetic Plain region from January, 2017 to December, 2017. The Japanese MAX-DOAS profile retrieval algorithm, version 2 was used to retrieve vertical profiles of eight components separately. Here formaldehyde (HCHO), glyoxal (CHOCHO) and nitrogen dioxide (NO_2) concentrations for the lowest layer (0-1 km) of the retrieved vertical profiles are reported. The ratio of CHOCHO to HCHO concentrations (R_{GF}), an important tracer indicative of changes in volatile organic compound (VOC) emissions was estimated. During spring and autumn enhanced concentrations of HCHO and CHOCHO were observed due to the influence of biomass burning. The annual mean R_{GF} for Pantnagar was estimated to be 0.029 ± 0.008. Comparing with similar MAX-DOAS observations in the central Thailand and reported literature values, we found that the R_{GF} tends to be < ~0.04 under the influence of biomass burning. Lower R_{GF} was observed at Pantnagar for strong anthropogenic VOC emission sources, consistent with results reported from satellite observations and other field studies. **[**Hoque1, H. M. S., Irie, H., Damiani, A., **Rawat, Prajjwal** & **Naja, M.** (2018). *SOLA, 14,* 159-164**].**

Anomalous variations of VLF sub-ionospheric signal and Mesospheric Ozone prior to the Earthquake

The ionospheric response from the Indian Subcontinent to Nepal Gorkha Earthquakes occurred between April and May 2015, which were the most powerful and disastrous natural calamities in past ~80 years over the Himalayan region was analysed. Here, a case which shows a strong link in anomalous variations between VLF subionospheric signal and mesospheric ozone prior to both 25 April, 2015 (Mw = 7.8) earthquake and its biggest aftershock on 12 May, 2015 (Mw = 7.3) was reported for the first time. Observations show an unusual variation in VLF signal samplitude /shift in terminator time (TT) strongly linked with positive (negative) mesospheric ozone anomaly in D-region altitudes prior to the Gorkha Nepal earthquakes **(Figure 20)**. It is surmised that simultaneous continuous observations of both VLF waves and mesospheric ozone can be considered as an important tool to identify the prior earthquake signatures in the vicinity of the extremely earthquake-prone zone such as Himalayan region. In this context, the current report opens up a new dimension in lithosphere-atmosphere-ionosphere coupling during the earthquake preparation processes itself. **[Phanikumar, D. V.,** et al. (including **Naja, M.**) (2018). *Nature (Scientific Reports), 8: 9381* (1-9pp)**].**

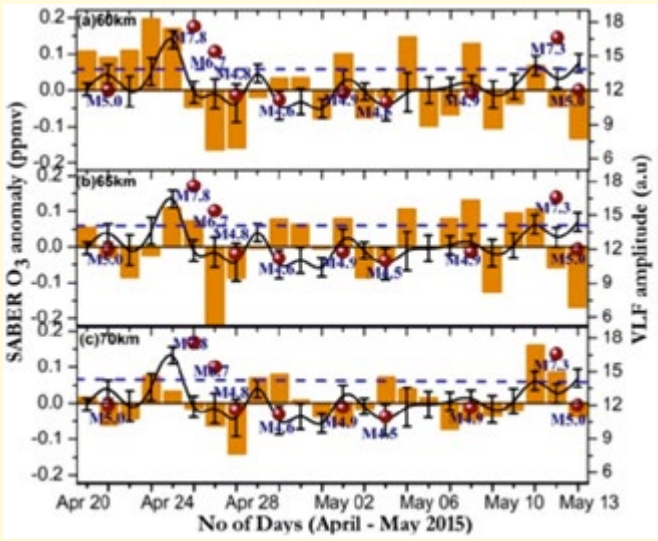

Figure 20. Temporal variation of SABER mesospheric ozone anomaly along with mean VLF amplitude (spline interpolated solid black line) and magnitude of EQs (red circles) for three different regions (**a**) 60 km, (**b**)65 km and (**c**) 70 km, respectively during April 20 – May 13 2015. Blue dotted line shows 95% significance level.

List of Publications

Refereed Journals

1. Ghosal, B., et al. (including **Agarwal, A**. & **Gupta, A. C**.) (2018). Search for very high energy gamma-ray emission form the peculiar radio galaxy IC 310 with TACTIC during 2012 to 2015. *New Astronomy, 60*, 42-47.

2. **Gangopadhyay, A.,** et al. (including **Misra, K., Singh, Mridweeka, Dastidar, R., Kumar, Brijesh** & **Pandy, S. B.**) (2018). SN 2015as: a low-luminosity type IIb supernova without an early light-curve peak. *Mon. Not. Roy. Astron. Soc., 476,* 3611-3630.

3. **Singh, Kuldeep** & **Chattopadhyay, I.** (2018). Study of magnetized accretion flow with variable equation of state. *Mon. Not. Roy. Astron. Soc., 476,* 4123-4138.

4. Nandi, A., et al. (including **Chattopadhyay, I**.) (2018). Accretion flow dynamics during 1999 outburst of XTE J1859+226—modeling of broadband spectra and constraining the source mass. *Astrophy. Space Science, 363*:90 (1-12 pp).

5. Mkrtichian, D. E., et al (including **Joshi, S**.) (2018). The eclipsing binary star RZ cas: accretion-driven variability of the multimode oscillation spectrum. *Mon. Not. Roy. Astron. Soc., 475,* 4745-4767.

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7. **Pandey, A., Gupta, A. C.** & Wiita, P. J. (2018). X-ray flux and spectral variability of six TeV blazars with NuStar. *Astrophy. Jr., 859*: 49 (11pp).

8. **Monga, A.,** Chandra, R. & **Uddin, W.** (2018). Photospheric Doppler enhancement and Hα evolution of an X-class flare. *New Astron., 62*, 85-93.

9. **Omar, A.** & **Paswan, A**. (2018). Far-infrared-radio correlation and magnetic field strength in star-forming early-type galaxies. *Mon. Not. Roy. Astron. Soc., 477,* 3552-3566.

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11. Vernier, J.-P., et al. (including **Kumar, S.**) (2018). BATAL: the balloon measurement campaigns of the Asian tropopause aerosol layer. *American Meteorological Society, BAMS, 99*, 955-973.

12. **Vyas, M. K.** & **Chattopadhay , I.** (2018). Radiatively driven relativistic jets in Schwarzschild space-time. *Astron. & Astrophy.,614, S51 (14pp).*

13. **Phanikumar, D. V.,** et al. (including **Naja, M**.) (2018). Anomalous variations of VLF sub-ionospheric signal and mesospheric ozone prior to 2015 Gorkha Nepal earthquake. *Nature (Scientific Reports), 8: 9381* (1-9pp).

14. Kushwaha, P., et al. (including **Gupta, A. C.** & **Gaur, H.**) (2018). The ever-surprising blazar OJ 287: multiwavelenth study and appearance of new component in X-rays. *Mon. Not. Roy. Astron. Soc., 479,* 1672-1684.

15. Kaskaoutis, D. G., et al. (including **Dumka, A. C.**) (2018). Long-term variability and trends in the Caspian Sea – Hindu Kush Index: Influence on atmospheric circulation patterns, temperature and rainfall over the Middle East and Southwest Asia, *Global and Planetary Change, 169,* 16-33.

16. **Dastidar, R.,** et al. (including **Misra, K., Singh, Mridweeka, Gangopadhyay, A., Kumar, B.** & **Pandey, S. B**) (2018). SN 2015ba: a type IIP supernova with a long plateau. *Mon. Not. Roy. Astron. Soc., 479,* 2421-2441.

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19. **Bhardwaj, P.,** et al. (including **Naja, M.**) (2018). Variations in surface ozone and carbon monoxide in the Kathmandu valley and surrounding broader regions during SusKat-ABC field campaign: role of local and regional sources. *Atmos. Chem. Phys., 18,* 11949-11971.

20. **Gupta, A. C.,** et al. (2018). Possible ~1 hour quasi-periodic oscillation in narrow –line Seyfert 1 galaxy MCG-06-30-15. *Astron. & Astrophy, 616,* L6 (1-5pp).

21. **Aggrawal, V.,** et al. (including **Pandey, A.** & **Gupta, A. C.)** (2018). X-ray intraday variability of the TeV blazar Mrk 421 with Chandra. *Mon. Not. Roy. Astron. Soc., 480,* 4873-4883.

22. **Dumka, U. C.,** et al. (including **Singh, N.**) (2018). Assessment of biomass burning and fossil fuel contribution to black carbon concentrations in Delhi during winter. *Atmospheric Envir., 194,* 93-109.

23. Savanov, I. S., Dmitrienko, E. S., **Karmakar, S. & Pandey J. C.** (2018). Activity of young dwarfs with planetary systems: EPIC 211901114 and K2-33. *Astronomy Reports, 62,* 532-541.

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30. Singh, V. and **Chand, H.** (2018). Investigating kpc-scale radio emission properties of narrow-line Seyfert 1 galaxies. *Mon. Not. Roy. Astron. Soc., 480,* 1796-1818.

31. McHardy, I. M. et al. (including **Chand, H.**). (2018). X-ray/UV/optical variability of NGC 4593 with Swift: reprocessing of X-rays by an extended reprocessor. *Mon. Not. Roy. Astron. Soc., 480,* 2881-2897.

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44. Ojha, Vineet, Gopal-Krishna & **Chand, H.** (2019). Intra-night optical monitoring of three γ-ray detected narrow-line Seyfert 1 galaxies. *Mon. Not. Roy. Astron. Soc., 483,* 3036-3047.

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26. Sharma, S., Pandey, A. K., Pandey, R. & Sinha, T. (2018). Triggered star-formation in the NGC7538 HII region. *Bulletin de la Societe Royale des Sciences de Liege, 87*, 253-256.

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28. **Sinha, T., Sharma, S., Pandey, R.** & **Pandey, A. K.** (2018). Pre-main sequence variables in young cluster Stock 18. *Bulletin de la Societe Royale des Sciences de Liege, 87*, 262-265.

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31. **Jalan, P., Chand, H.** & Srianand, R. (2018). Transverse and longitudinal proximity effect. *Bulletin de la Societe Royale des Sciences de Liege, 87*, 330-333.

32. **Mishra, A.,** Kantharia, N. G. & Das, M. (2018). Giant low surface brightness galaxies. *Bulletin de la Societe Royale des Sciences de Liege, 87*, 365-370.

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34. Joshi, Y. C. (2018). Open star clusters and Galactic structure. *Proceedings IAU Symposium, 12*, 227-228.

35. Savanov, I. S., Dmitrienko, E. S., **Pandey, J. C.** & **Karmakar, S.** (2018). Ultra-fast rotators from Kepler observation. *INASAN Science Proceeding*, 116-119.

36. **Karmakar, S., Pandey, J. C.,** et al. (2018). Four years of starspot evolution on an active F-type ultra-fast rotator KIC 6791060. *Proceedings IAU Symposium, 13*, 229-232.

37. **Kumar, Ashish, Singh, N.** & Anshumali. (2019). Study on cloud types distribution over northern India using raDAR-liDAR (DARDAR). *URSI AP-RASC Conf. 2019*, New Delhi, India, 09 - 15 March 2019.

38. **Singh, N., Kumar, Ashish**, Anshumali, **Chandra Prakash** & Pandey, C. P. (2019). Study on the satellite and ground based aerosol measurements over Himalayan region. *URSI AP-RASC Conf. 2019*, New Delhi, India, 09 - 15 March 2019.

Ph.D. Theses

Awarded

1. Study of the tropospheric trace gases over the Indian subcontinent, **Piyush Bhardwaj**, (Supervisor & Co-Supervisor: **Manish Naja** and H. C. Chandola), *Kumaun University*, July, 2016. (Awarded 22-10- 2018).

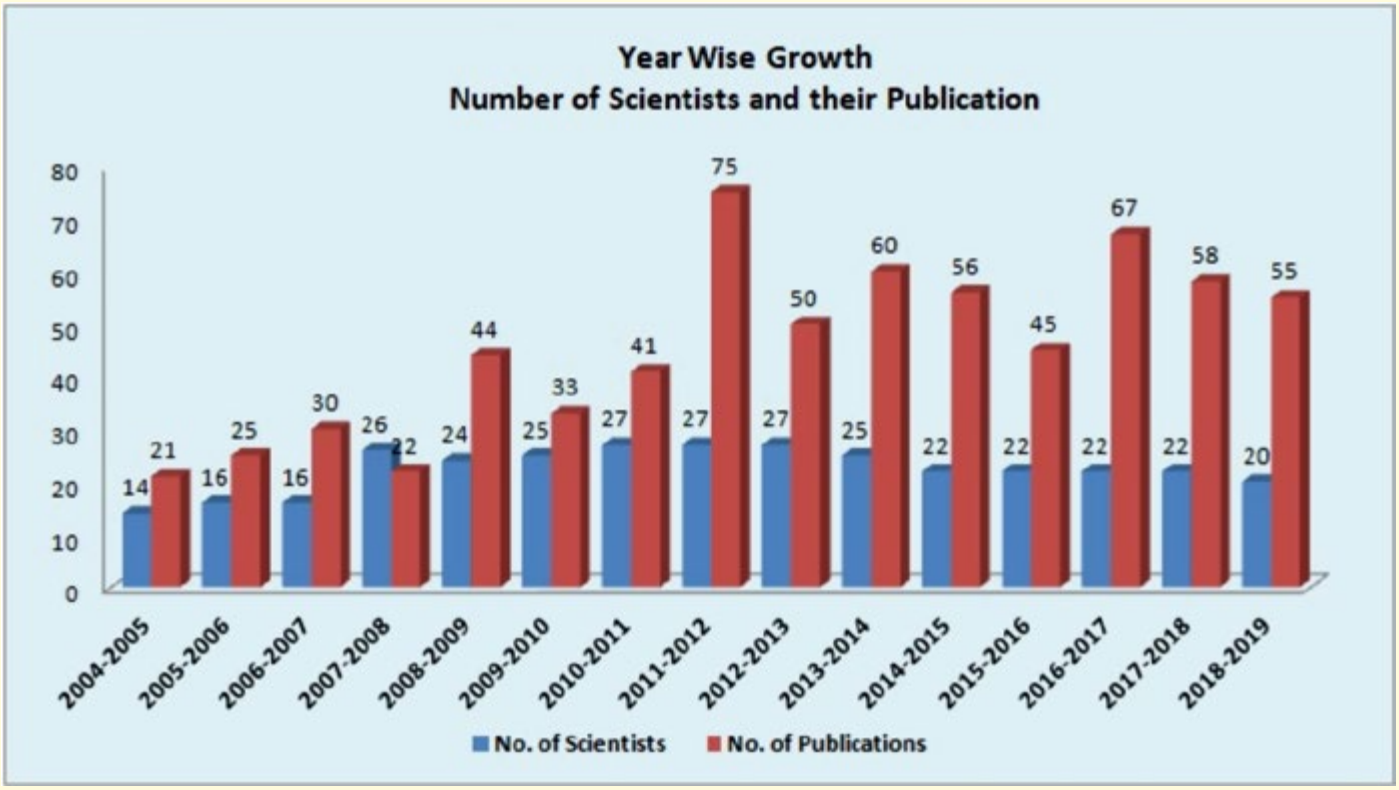
2. Evolution of magnetic activities in late-type stars, **Subhajeet Karmakar**, (Supervisor: **Dr. Jeewan C. Pandey**), *Pt. Ravishankar Shukla University*, July, 2017 (Awarded 28-08-2018).

Submitted

1. Multi-wavelength study of magnetic cataclysmic variables, **Arti Joshi**, (Supervisor: **Dr. Jeewan C. Pandey** and Prof. H. P. Singh), *Delhi University*, May, 2018.

2. Astrophysical jets in relativistic regime: thermal and radiative driving, **Mukesh Kumar Vyas**, (Supervisor: **Indranil Chattopadhyay**), *Delhi University*, August, 2018.

3. Optical studies of hydrogen deficient supernovae, **Mridweeka Singh**, (Supervisor: **Dr. Kuntal Misra**), *Pt. Ravishankar Shukla University*, January, 2019.


Year Wise Growth
Number of Scientists and their Publication
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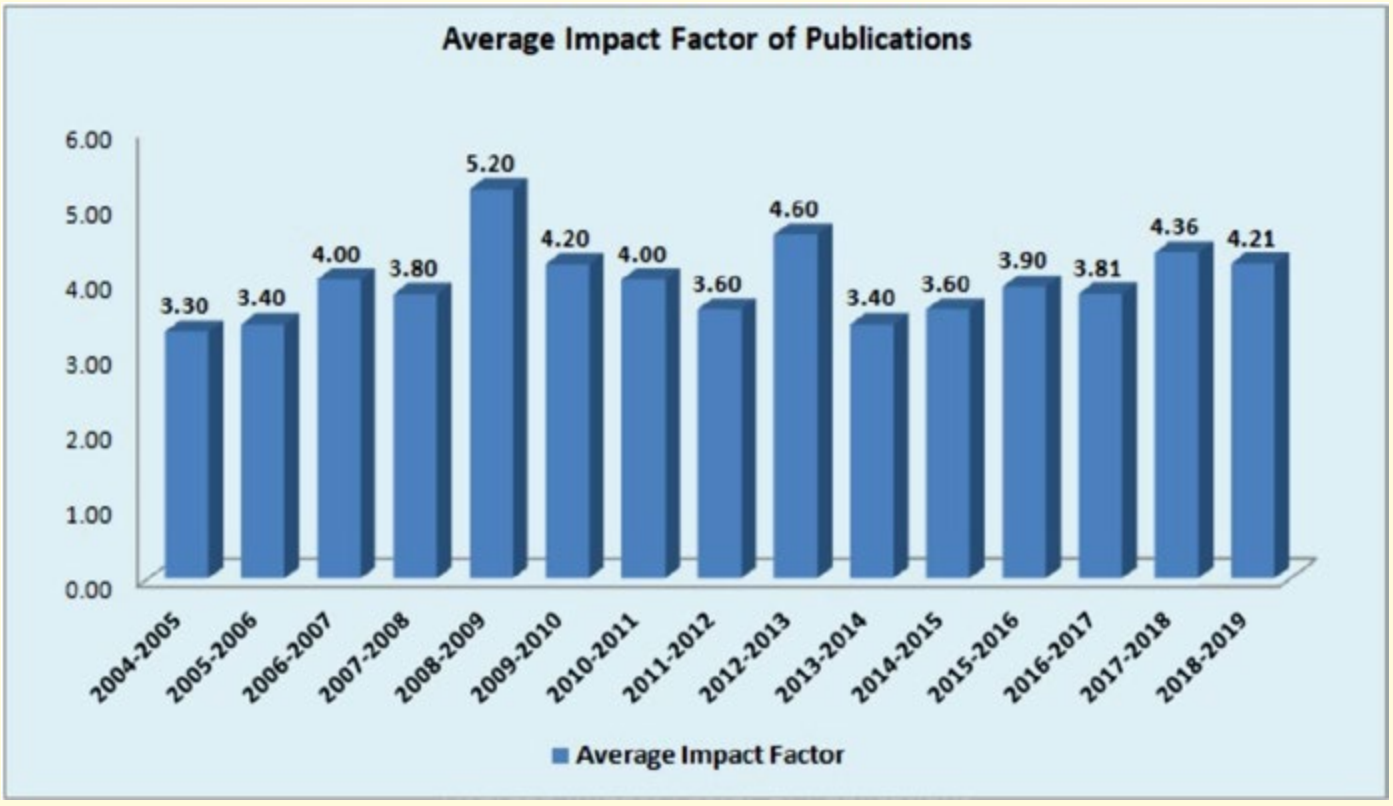
Average Impact Factor of Publications
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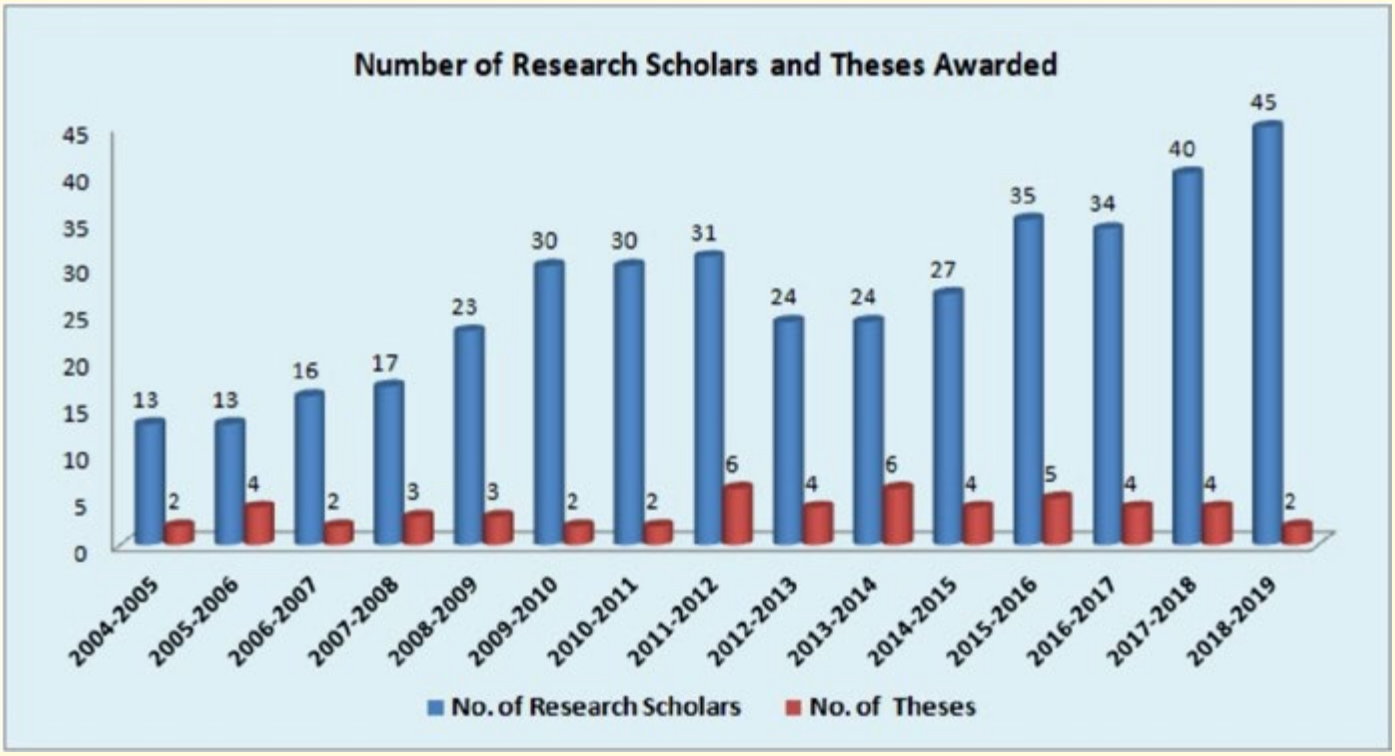

Summary

1.	Total Number of Publications in Refereed Journals	55
2.	Number of Publications in Circulars/Bulletin	38
3.	Ph.D. Theses Awarded	2
4.	Ph.D. Theses Submitted	3

International and National Research Projects

In year 2018-2019 following research projects were ongoing from outside funding agencies.

Name of Project: Observational signature of super massive Black Holes: TeV blazars in multi-wavelength view
PI (ARIES): Alok C. Gupta
PI of the collaborating institute: M. Ostrowski, Astronomical Observatory, Jagiellonian University, Krakow, Poland
Funding Agency: DST, Govt. of India
Project Code: DST/INT/POL/P–19/2016

Name of Project: Identifying essential mechanics of star cluster formation with wide-field optical observations
PI (ARIES): Anil K. Pandey
PI of the collaborating institute: N. Kobayashi, Kiso Observatory, Japan
Funding Agency: DST, Govt. of India
Project Code: DST/INT/JSPS/P-233/2016

Name of Project: International Liquid Mirror Telescope
PI (ARIES): Hum Chand
PI of the collaborating institute: Jean Surdej, Liege University, Belgium
Funding Agency: ARIES, Belgium and Canada
Project Code: CSNOF-09

Title of Project: Belgo-Indian Network for Astronomy and Astrophysics (BINA)
PI (ARIES): Santosh Joshi
PI of the Collaboration institute: Peter De Cat, Belgium
Funding Agency: DST, New Delhi
Project Code: DST/INT/Belg/P-02/2014

Name of Project: Flares from F to M-type mass stars.
PI (ARIES): Jeewan C. Pandey
PI of the collaborating institute: Igor S. Savanov, Institute of Astronomy, Moscow, Russia
Funding Agency: DST, Govt. of India
Project Code: INT/RUS/RFBR/P-271

Title 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

Name of Project: Probing fundamental characteristics of extreme astrophysical phenomenon.
PI (ARIES): S. B. Pandey
PI of the collaborating institute: IUCAA Pune, IIT Mumbai, IKI Moscow Russia and 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: Physics of radio bright gamma ray burst afterglows.
Co-PI (ARIES): Kuntal Misra
PI of the collaborating institute: Lekshmi Resmi, IIST, Thiruvanthapuram

Funding Agency: DST, Govt. of India
Project Code: EMR/2016/007127

Title 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.

Title 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.

Title of Project: Atmospheric Boundary Layer Network & Characterization: Network of Observatories for Boundary Layer Experiments (ABLN&C: NOBLE)
PI (ARIES): Narendra Singh
Funding Agency: ISRO, VSSC Trivandrum

Title of Project: Devasthal optical telescope - AGN Reverberation Monitoring (DOT-ARM): Probing AGN black-hole masses and broad line regions.
PI (ARIES): Hum Chand
Co-PI (ARIES): Amitesh Omar
Funding Agency: DST/SERB

Title of Project: Magnetic Fields as Probes of Astrophysical Phenomena
Co-PI (ARIES): Hum Chand
PI (DU): Prof. T. R. Seshadari
Funding Agency: DST/SERB

Updates on the Major Facilities

ARIES ST Radar (ASTRAD)

ARIES Stratosphere Troposphere Radar (ASTRAD), operating at 206.5 MHz frequency has been installed at ARIES, Nainital for observations of vertical profiling of wind. The activities during 2018-19 are :

- All the 12 clusters of ASTRAD have been setup and tested successfully at ARIES Nainital **(Figure 21)**.

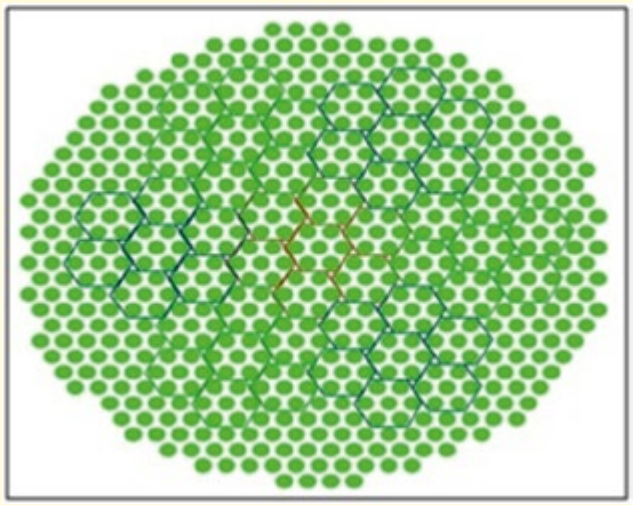

Figure 21. Readiness (green color) of all 12 clusters of ARIES ST Radar. One cluster consists of 49 TRMs and thereby making total 588 TRMs.

- Observations from ST radar are also used to derive temperature profiles (by deduction of Brunt Vaisala frequency peak). Derived temperature profile agrees well with the temperature profile obtain from balloon observations (GPS radiosonde) **(Figure 22)**.

- Further, following the good agreement in temperature profile, vertical distribution of turbulence parameters (Kinetic energy dissipation rate, ε ; Eddy diffusivity for momentum, Km ; and Outer length scale for turbulence, LB) are also derived **(Figure 23)**.

- **Comparison with balloon-borne radiosondes:** ARIES has conducted two balloon flights (31 Oct. and 2 Nov., 2018) to compare the winds obtained from ARIES ST Radar (ASTRAD). ASTRAD showed reasonably good data up to about 18 km which is in good comparison with wind data obtained from balloon-borne GPS radiosonde, launched from ARIES, Nainital **(Figure 24).**

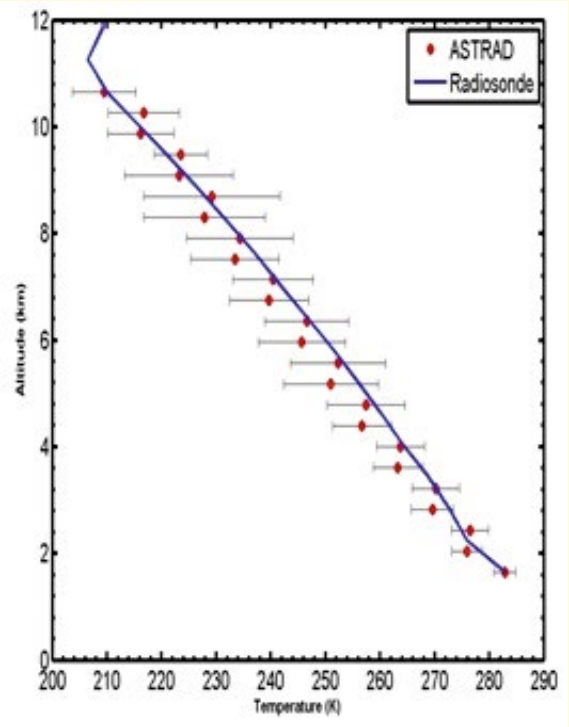

Figure 22. A typical temperature profile obtained estimated using ST Radar (red) data and a comparison with temperature profile obtained from in-situ using balloon-borne GPS radiosonde (blue) at ARIES, Nainital.

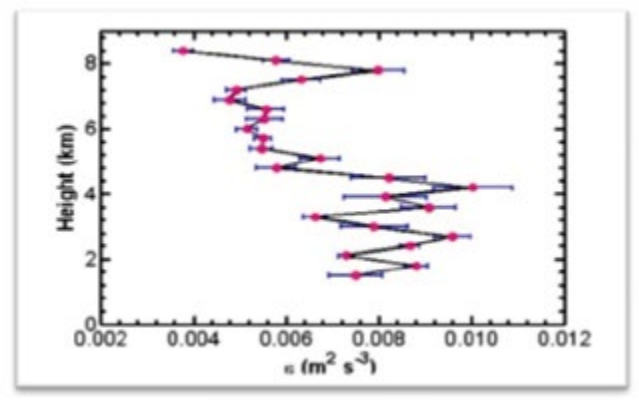

Figure 23. Vertical profile of kinetic energy dissipation rate estimated using ST Radar data.

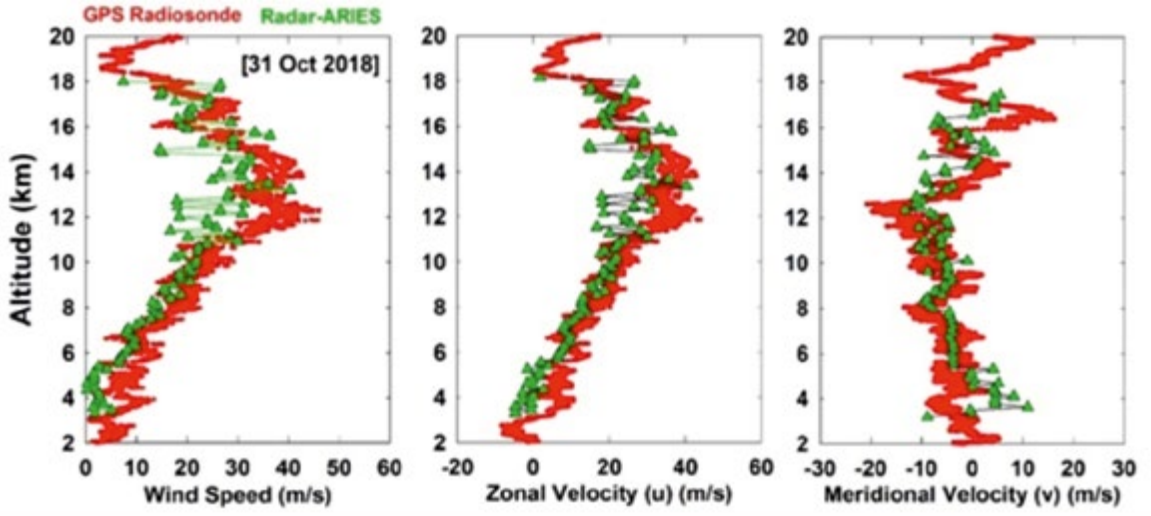

Figure 24. ST Radar winds (green triangle) with 12 clusters and its comparison with balloon-borne GPS radiosonde (red circle) at ARIES. Data have been obtained up to ~ 18 km using ASTRAD.

- ARIES is also working on in-house design and development of TRMs. Mechanical enclosure and heatsink of the TRM are fabricated in ARIES workshop while the assembly, integration and testing of the TRM has been carried out in the RF laboratory of the Radar facility (**Figure 25**). The TRM has met all critical performance parameters including the thermal dissipation and achieved required peak power and gain sufficient for an element of the active aperture of the Radar system. As the architecture of the developed TRM is similar to the TRMs which are presently working, easy replacement is possible in case of any failure.

- Several students have done projects using ASTRAD system and were familiarised with basic operation of radar. This training is part of human resource development towards research using wind profile radar.

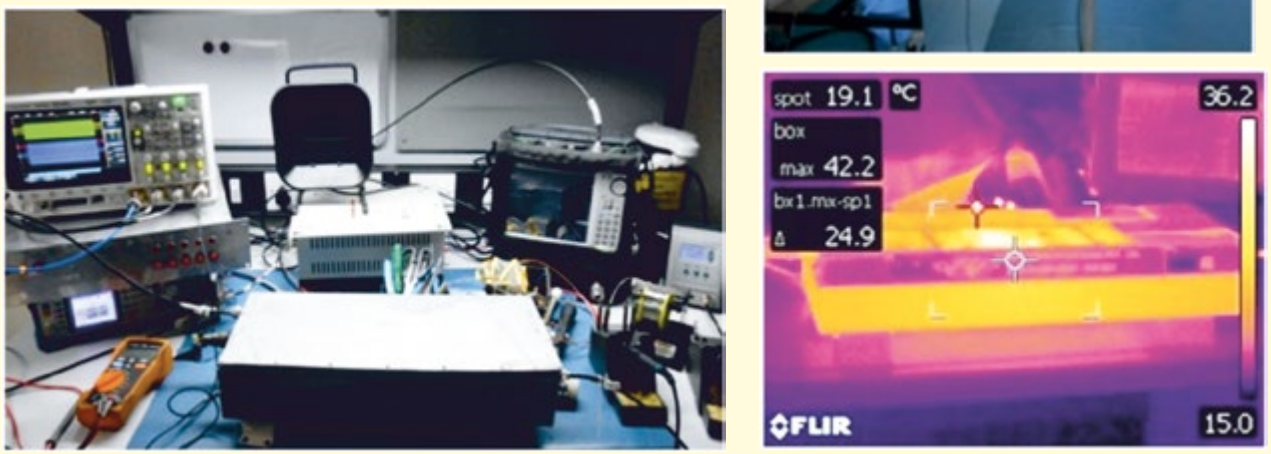

Figure 25. Testing of in-house developed TRM in RF laboratory at ARIES. Thermal dissipation testing is also done.

4m International Liquid mirror telescope: A Status Report

ARIES is establishing a 4m International Liquid Mirror Telescope (ILMT) project in collaboration with the Institute of Astrophysics and Geophysics (Li`ege University), the Canadian Astronomical Institutes from Qu´ebec (Laval University), Montreal (University of Montreal), Toronto (University of Toronto and York University), Vancouver (University of British Columbia) and Victoria (University of Victoria).

For zenith-pointing observations, Liquid Mirror Telescopes (LMTs) can deliver the same performance as classical telescopes with much lower cost and greater simplicity of operation, for celestial observations from a good astronomical site. The 4m ILMT will be entirely dedicated to a photometric and astrometric variability survey of a narrow strip of sky (about half a degree) passing through the zenith offering best image conditions (atmospheric seeing and extinction). A long CCD image recorded each night, will be compared to a reference one and any transient source or highly variable object should be easily detected. Follow-up strategies can also be implemented with 3.6m DOT. The first light is expected during fall of 2019.

Until the last financial year 2017-2018, ILMT building, installation of compressor, installing the mechanical structure, control system for pneumatic system and activation of the air bearing power supply were already completed. The main milestone achieved in this financial year (2018-2019) are as follows:

1. Alignment of the center of the primary mirror and the corrector lens

Determining the position of the optical corrector lens center surrounded by several mechanical structures at the prime focus and ensuring its horizontality is not found to be trivial. Initially a laser pointer was installed at the corrector lens structure pointing vertically towards the mirror. Then the sliders on the corrector lens were used to induce linear motions of the corrector lens. By adjusting the slider, the motion of the laser point was traced and a correlation was established between the displacement of the laser dot at the mirror plane as a function of the slider movement **(Figure 26)**. It was found that, the centers of the mirror and corrector lens was aligned with a precision better than 1 mm.

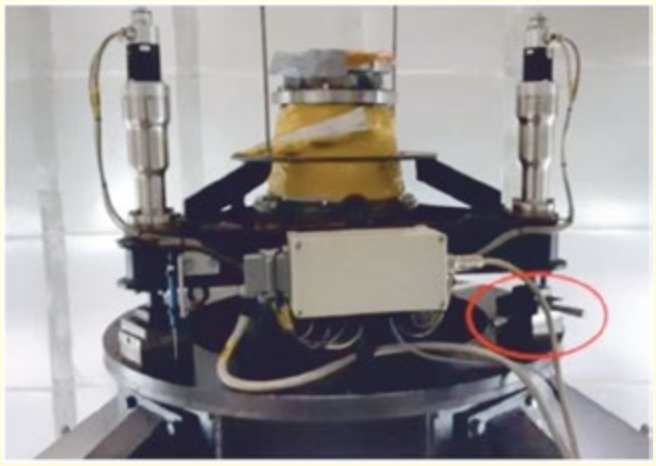

Figure 26. Two orthogonal sliders on the corrector lens setup for inducing a linear translation of its center.

2. Installation of CCD and its corrector interface

The CCD-corrector interface, after its repair in Belgium last year, arrived on site this year **(Figure 27)**. After its successful installation, the major task of installing the CCD was also done. For this, the vacuum inside the CCD was also refreshed and then refilled with NF-50 cooling gas inside the CCD compressor for which the setup was borrowed from Spectral Instruments, USA **(Figure 28)**. Finally a filter tray was installed for the SDSS broad band filters in g, r, i band **(Figure 29)**.

Figure 27. The mechanical interface (at left) and the interface's component to hold the CCD camera (at right).

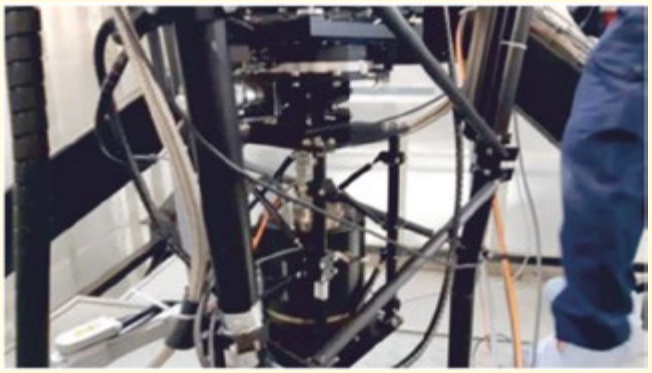

Figure 28. ILMT CCD imager placed inside the Socabelec mechanical interface.

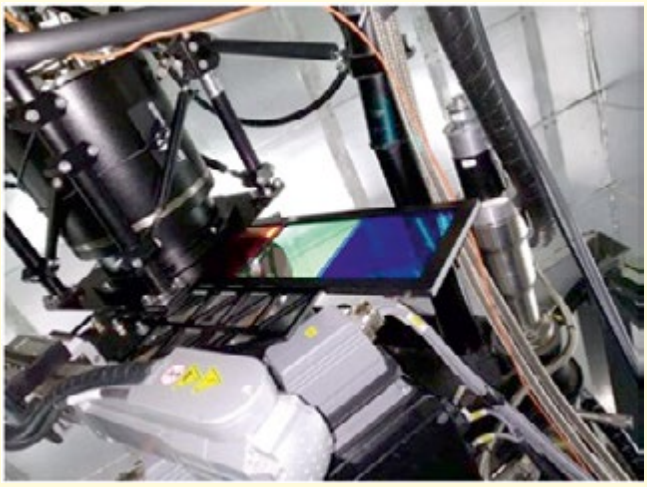

Figure 29. Installation of the tray with the SDSS broadband filters on the Socabelec mechanical interface at the prime focus.

3. Installation of Hg vapour extractor and mylar cover setup

The Hg vapour extractor composed of a powerful pump and activated charcoal filter has been installed to minimise the Hg-varopur contamination inside ILMT building **(Figure 30)**. Also, a setup of optical quality mylar cover is installed, to protect Hg oxidation layer over the mirror surface from dust, insects and debris along with preventing the mercury vapour to escape from the mirror **(Figure 31)**.

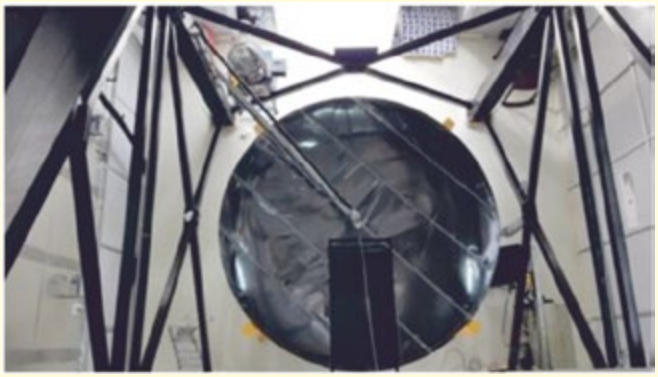

Figure 31. Top view of the mylar insulation over the primary mirror.

4. Rotation of primary mirror filled with mercury

Mercury was poured in the primary mirror on 19th April 2019. Immediately after this, intense attempts were made, to close the mercury surface. Holes were systematically appearing after some time near the periphery of the mirror . To form a continuous mercury layer over the primary mirror having a diameter of 4.1 meters, a minimum average Hg thickness of 3 mm is required. It was later realized that the amount of mercury at our disposal was slightly less than 3 mm in thickness. Minimum ~ 5 liters of mercury was short that was required to form a stable mercury layer over ILMT mirror. As a result, it was decided to procure 15 liters mercury which is scheduled to arrive in September 2019.This will enable the functioning of ILMT over the next observing season.

Figure 30. Hg vapour extractor located on a brown platform at right filled with carbon filter. One end of the black pipe is connected to the extractor and the other end goes near the center of the primary mirror.

Furthermore, Hg vapour monitoring was also done from 17-22 April, 2019, inside the telescope building. Normally, when the Hg vapour concentration is less than 25 micro-gram per cubic meter, one could work every day without wearing a mask during a shift of 8 hours. The Hg vapour concentration never exceeded 4 micro-gram per cubic meter in the ILMT telescope building **(Figure 32)**.

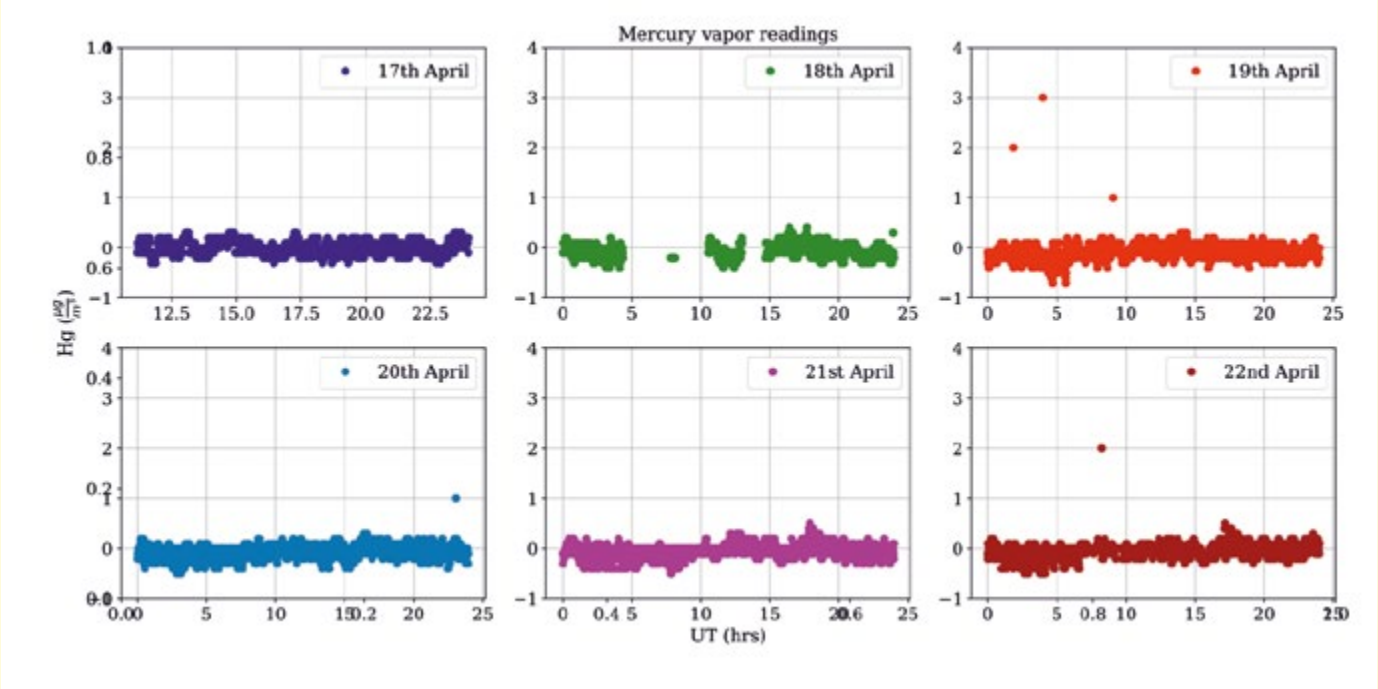

Figure 32. Hg vapour monitoring from 17-22 April, 2019, inside the telescope building. Normally, when the Hg vapour concentration is less than 25 micro-gram per cubic meter, one could work every day without wearing a mask during a shift of 8 hours. The Hg vapour concentration never exceeded 4 micro-gram per cubic meter.

Status report on the upcoming instruments

ARIES Devasthal Faint Object Spectrograph &Camera (AD-FOSC)

The *ARIES Devasthal Faint Object Spectrograph & Camera (AD-FOSC),* which was completed at ARIES, Nainital through in-house research and development activities, was mounted on the 3.6m DOT during the month of April 2018 for various science observations. AD-FOSC is a low-resolution optical spectrograph-cum-imager. Various optical elements such as broadband and narrowband filters, grisms and prisms, and slits can be placed in the optical path through a motorized filter wheel. It has a motorized unit for spectral calibration and flat-fielding using spectral and continuum lamps. The spectrograph uses a large-format (~62 mm) closed-cycle cryogenically cooled 4Kx4K CCD camera, which was also assembled in ARIES. The following modes of science operations are possible using this instrument: (i) Deep photometric imaging using broadband and narrowband filters, (ii) Long-slit/slit-less spectroscopy using grisms and prism, (iii) Fast imaging at milli-second cadence (GPS-assisted) in single color-band or in the prism-spectroscopy (multi-color) mode using an electron-multiplying frame-transfer CCD camera (iv) Differential Image Motion Monitor (DIMM) to measure atmospheric seeing (iv) autonomous sky monitoring while science observations are ongoing. The maximum field of view available with the 4Kx4K CCD is 13.6'x13.6' and that with the frame-transfer CCD is 1.8'x1.8'. The slit length is 8' and widths are between 0.4" and 2.0". The three different grisms provide first order dispersion near 0.23, 0.16, and 0.10 nm/pixel (15 micron) at the center wavelength of the respective grisms.

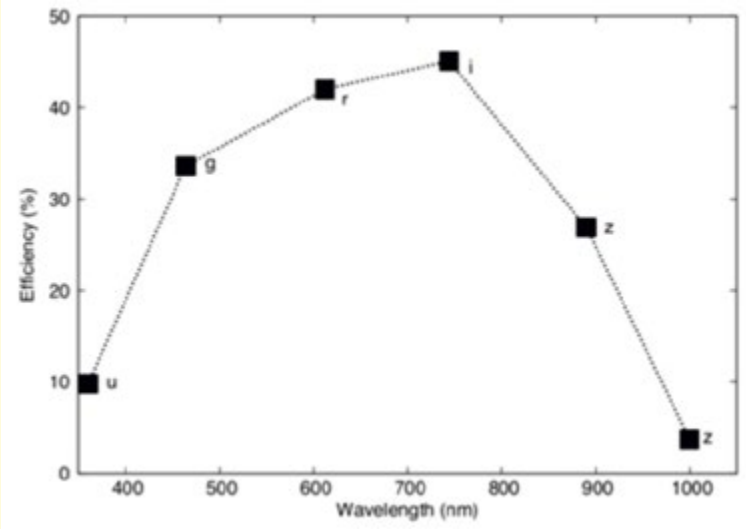

Figure 33. Expected peak efficiency of the AD-FOSC in different color bands.

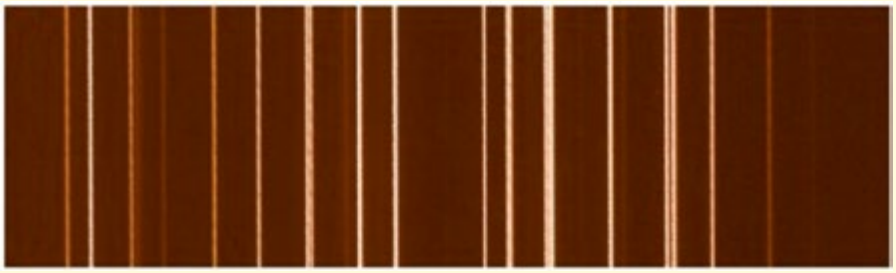

Figure 34. Slit spectrum showing spectral lines of Argon, obtained from AD-FOSC.

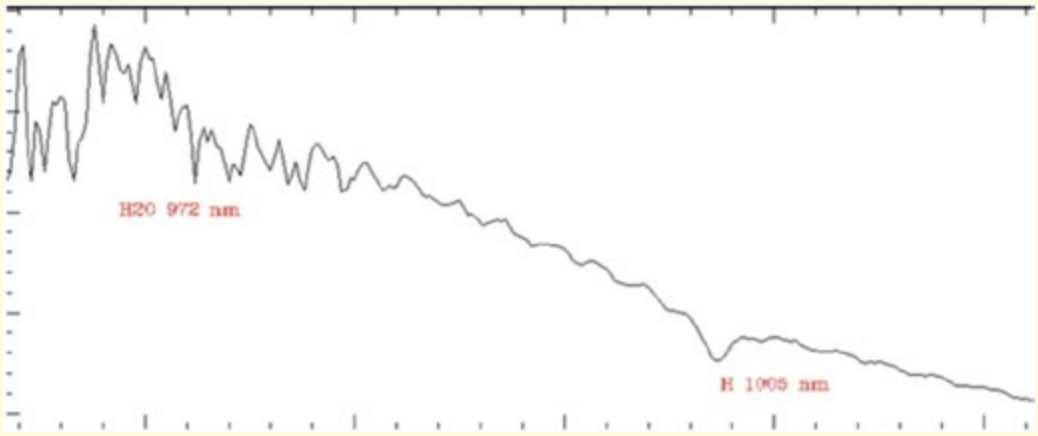

Figure 35. Part of the AD-FOSC spectrum (in first order with ~0.3 nm/pixel resolution) of a bright star showing detection of Hydrogen Paschen series line (n=7 to 3 transition) at 1005 nm near the sensitivity cutoff of AD-FOSC in the near-infrared region.

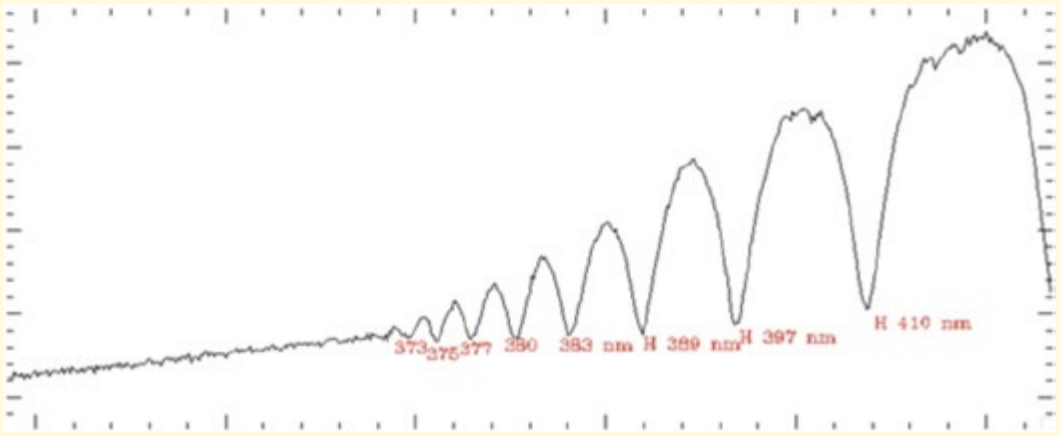

Figure 36. Part of the AD-FOSC spectrum (in second order with ~0.05 nm/pixel resolution) of a bright star showing detection of Hydrogen Balmer series lines near the sensitivity cutoff of AD-FOSC in the blue region.

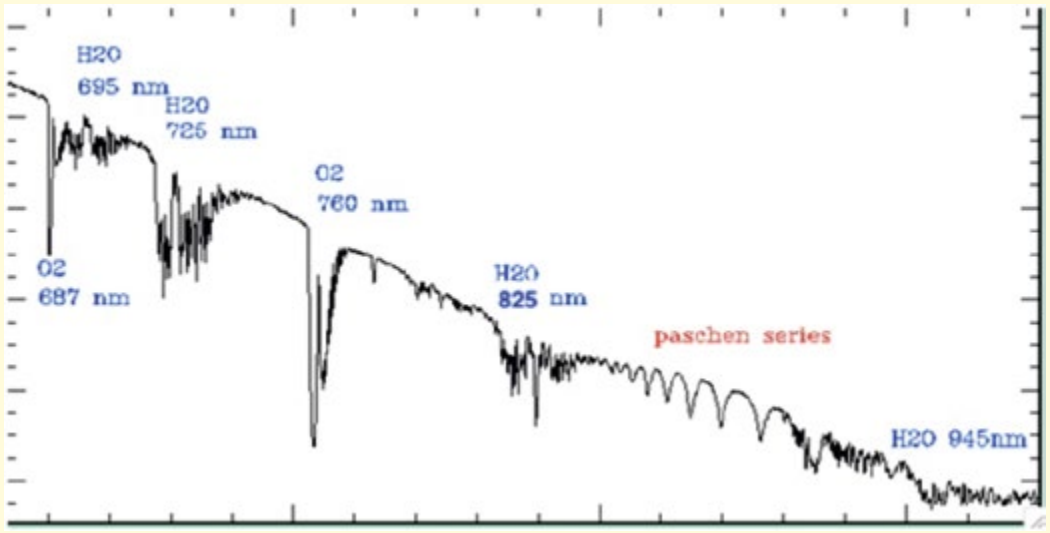

Figure 37. Earth's atmospheric absorption lines/bands of H_2O and O_2 seen in the spectrum of a bright star, observed with the AD-FOSC.

4K x 4K CCD Imager

Analysis of the data taken by the CCD Imager for objects like globular cluster, supernovae and host galaxies of gamma-ray bursts were analysed and 2-3 papers were submitted to various international journals during the year 2018-19. The imager is now ready in all respects for regular observations.

It is also planned to procure a new CCD camera in near future and use indigenously developed controller etc to make the CCD Camera more user friendly and easy to troubleshoot etc. With due approval from the GC, efforts have been started in collaboration with IUCAA to get an indigenously developed controller and CCD Camera within a year.

TIFR-ARIES Near Infrared Spectrometer (TANSPEC)

TIFR-ARIES Near Infrared Spectrometer (TANSPEC) is being built in collaboration with TIFR, ARIES and MKIR, Hawaii for the 3.6m DOT. It will be a unique spectrograph which provides simultaneous wavelength coverage from 0.6 to 2.5 micron, and a resolving power of R ~ 2000-3000. The spectrograph operates in two modes which images the spectrum on to a 2k x 2k H2RG array. In cross-dispersed (XD) mode combination of a grating and two prisms are used to pack all the orders on to the H2RG array at a resolution of R ~ 2000-3000. It also has a low resolution prism mode (R ~ 150) for high throughput observations. TANSPEC consists of an independent imaging camera (built-in slit viewer) with a 1k x 1k H1RG detector. The reflected beam from the back of the mirrored slit is imaged to this camera through a filter wheel which consists of broad band r', i', Y, J, H, Ks and narrow band H2 & BrG filters. This camera has a field of view of 1 x 1 arcmin^2, and is used for guiding the telescope (IR guider) as well as imaging field for photometry. It also functions as a pupil viewer for instrument alignment on the telescope. For calibration, a uniform flat field from an integrating sphere outside the dewar as an identical f/9 beam from the telescope will be imaged. Wavelength calibration will be done by Argon and Neon lamps. Spectroscopy sensitivity (100-σ in 1 hour, 1" seeing) is expected to be 15.4 mag, whereas in prism mode it would be 17.3 mag in the J-band.

TANSPEC will be used for a wide range of studies from local star formation to extra-galactic astronomy. Simultaneous coverage of wavelength from 0.6 to 2.5 micron makes TANSPEC a unique instrument and ideal for studies which require simultaneous measurement of lines in optical and near-infrared waveband.

Status:

Successful factory tests of the TANSPEC were carried out during November-December 2018. Stage by stage report on the activities carried out thereafter related to the installation and testing of TANSPEC on 3.6m DOT are given below:

(i) Shipping of TANSPEC (21 February- 10 March 2019)

It was shipped to India by MKIR (USA) on 20 February 2019 and reached IGI, Delhi on 7 March, 2019. Saurabh (ARIES) and Rajesh Jadhav (TIFR) reached Delhi on 7 March, 2019 to carry out the custom clearance of TANSPEC and arrange the transportation from Delhi to Devasthal. Formalities related to the custom clearance of the TANSPEC were completed on 8 March, 2019. There was 100% exemption of the custom duties on TANSPEC. The loading of the TANSPEC boxes on two trucks was done on 9 March, 2019. The movement of the trucks started on the early hour of 10 March, 2019 (3 AM) from Delhi and it reached Devasthal site on the evening of same day. Unloading and storing of TANSPEC boxes were done the same night at DOT extension building.

(ii) Initial ground testing (28 March – 7 April 2019)

Work on ground test of TANSPEC was started on 28 March 2019 after the arrival of Douglas Toomey from MKIR. ARIES/TIFR engineering and scientific team were also involved towards the installation and testing of TANSPEC on 3.6m DOT.

(a) Opening of boxes and initial inspection (28 March – 31 March 2019)

(b) Fabrication of TANSPEC (1 – 2 April 2019)

(c) Testing of the mounting trolley on TANSPEC (01 April 2019, inhouse activity)

(d) Fabrication of Chiller-Unit (1 -8 April 2019, in-house activity)

(e) Vacuuming of dewar of the spectrograph (30 March - 1 April 2019)

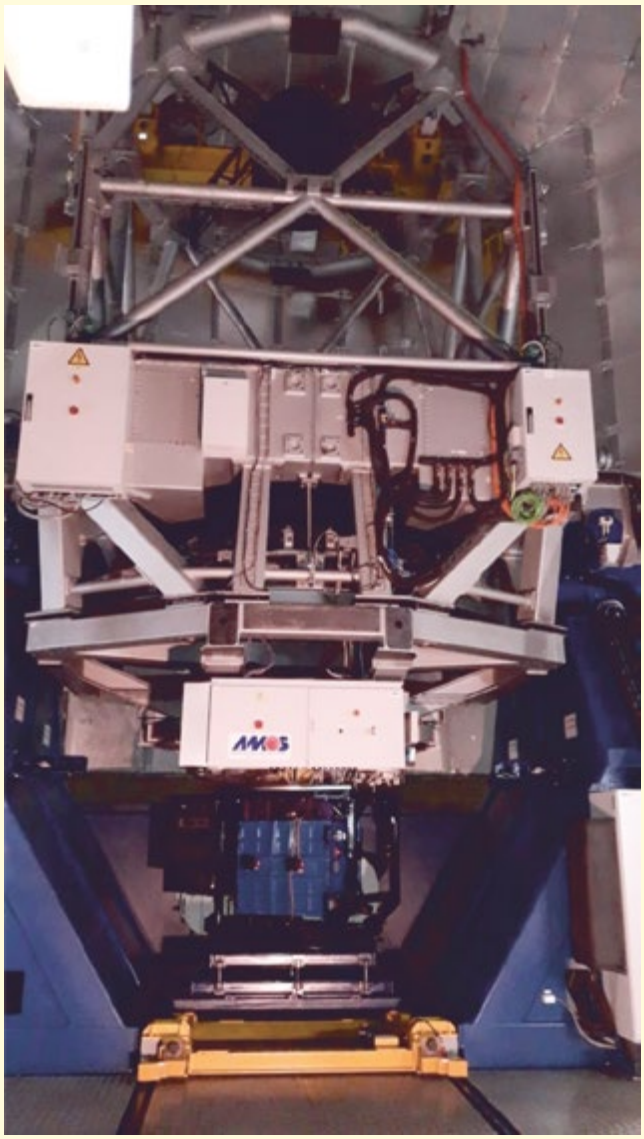

Figure 38. Fully assembled and powered ON TANSPEC on 3.6m DOT.

(iii) Mounting of TANSPEC on 3.6 m DOT (2 – 12 April, 2019)

(a) Movement from extension building to the telescope floor (2 April, 2019)

(b) Mounting on the telescope (2 April, 2019)

(c) Installation of ARC and cabling on TANSPEC (3 April, 2019)

(d) Helium line installation (4 – 5 April, 2019)

(e) Start of cooling of the spectrograph (6-11 April, 2019)

(f) Balancing of TANSPEC on 3.6m DOT (12 April,2019)

(iv) Sky observations (12 April - 15 May 2019)

On 12th April, 2019, the first light images was taken with TANSPEC. SKY test of TANSPEC on 3.6m DOT were subsequently carried on several clear nights from 12 April to 15 May, 2019.

TIFR Near Infrared Imaging Camera-II (TIRCAM2) on the 3.6m Devasthal Optical Telescope

TIFR Near Infrared Imaging Camera-II (TIRCAM2) is a closed-cycle Helium cryo-cooled imaging camera equipped with a Raytheon 512 × 512 pixels InSb Aladdin III Quadrant focal plane array having sensitivity to photons in the 1–5 μm wavelength band. The instrument is used on 3.6m Devasthal Optical Telescope (DOT) for near-infrared calibration of the site and for science observations. The camera offers a field-of-view of ~86.5 arcsec x 86.5 arcsec at the axial port on the DOT with a pixel scale of 0.169 arcsec.

In last academic session TIRCAM2 has been used for scientific observations and recently (January, 2019) it has been mounted on the side port of 3.6m DOT. Details of the observations and estimated parameters are presented in the paper: TIFR Near Infrared Imaging Camera-II on the 3.6m Devasthal Optical Telescope, Baug, T. et al. Necessary modification were carried out on TIRCAM2 structure and mountings by ARIES/TIFR team.

Thirty meter telescope – a status report

ARIES as one of the founder PI institutes, is involved towards the project since very beginning of the project. The project related activities are now evolved considerably with many other institutes participating recently. Most of the activities now are centrally controlled by India TMT co-ordination centre (ITCC) at IIA, Bangalore. During this year, most of the staff members of ARIES were involved in the 3.6m DOT related activities. However, ARIES scientists were managed to join many regular meetings and teleconferencing related to the TMT project during 2018-19 and actively participated during weekly MAC I-TMT and SAC meetings. Also, Director ARIES and co-ordinator of TMT related activities and SAC member at ARIES regularly participate in the project management board meetings to take decisions on various technical and administrative aspects related to the project. ARIES scientists also participated during ongoing scientific activities of several International Science Development Teams as members during the year 2018-19.

Figure 39. Artist's rendering of the Thirty Meter Telescope (Image source: www.google.com)

Report from existing observing facilities

1.04m Sampurnanand Telescope (ST)

The 1.04m Sampurnanand Telescope (ST) situated at Manora Peak, Nainital is being used as a main observing facility by PhD students and faculty members of ARIES since 1972. The preventive maintenance is carried out by the scientific and engineering staff of ST and workshop.

The major back-end instruments used at 1.04m ST are 1kx1k CCD and ARIES Imaging polarimeter (AIMPOL). A PyLon 1300x1340 CCD is also used for observations. The major scientific programs being carried out includes a study of star clusters, young star-forming regions, HII region, optical variability in AGN, optical counterpart of Gamma-Ray-Burst, Supernovae and X-rays sources.

Activities performed in 2018-19

1. A total of 184 observing nights were allotted for CCD and AIMPOL from Oct. 2018 to March 2019. 84 nights were clear for observations and data were collected by the observer during those nights. Partial data set taken with 1.04m ST are used in two PhD thesis, submitted during 2018-19.

2. A newly acquired 4096x4096 CCD was mounted on the telescope in March 2019 for testing the performance on telescope. Useful data was obtained which is being analysed. CCD is now available to observers for regular observation.

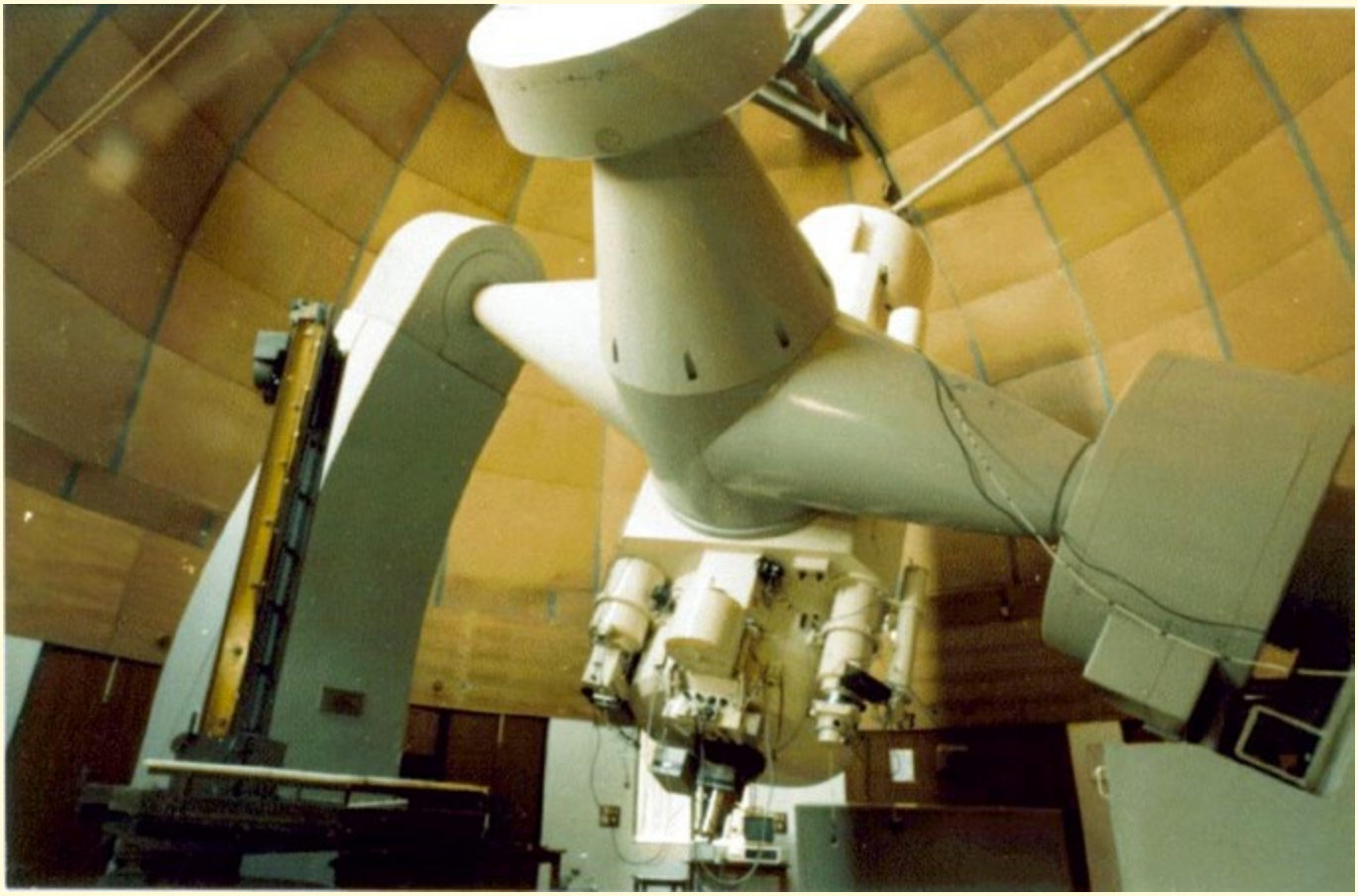

Figure 40. 1.04m Sampurnanand Telescope.

1.3m Devasthal Fast Optical Telescope (DFOT)

After every monsoon, before the start of observing cycle and during the observing cycles, a regular maintenance/checkup of the telescope and the related cameras/instruments along with mirror cleaning and updating the pointing models is done. Extra precautions have been taken on the 1.3m telescope during the period of heavy monsoon, high humidity, frequent lightening, and ongoing construction work.

1. Observational support: One observational assistant on a temporary basis was recruited. Two permanent scientific assistants are also available to operate the telescope during the observing runs. This has enabled smooth and efficient operation of the telescope and avoided any mishandling by unfamiliar or less experienced observers. No major malfunctioning has been reported during last one year.

2. Infrastructural works: Several steps have been taken to develop the infrastructure of 1.3m telescope building. Dehumidifiers in TCS room and telescope floor are deployed to maintain the air humidity in the required range. The Telescope floor is isolated by barricading the access, applying insulation foam in between the rails and roll of roof gap and covering the telescope with thin plastic sheets along with cloth cover.

3. Repair works: Telescope primary mirror lateral support pad gluing mission was successfully completed. The existing filter unit internal hardware was replaced with a new reliable, robust filter changing mechanism to change the required filter smoothly. Earlier weather station of 1.3m was down due to some unknown reasons which were later rectified/repaired and weather station was made functional. A new GPS was installed in telescope control system for accurately recording the time of observation. 1.3m facility backup power supply system battery bank was replaced with a new one which enhances the backup power supply time.

4. Observations from 1.3m telescope: A total of 161 clear nights were observed out of 247 allotted nights during 2018-19. The data acquired with the 1.3m telescope has resulted in a total of 58 publications in referred journals.

The 3.6m Devasthal Optical Telescope

ARIES operates India's largest 3.6m aperture optical telescope at Devasthal as a national facility. This facility consists of a modern 3.6m optical new technology telescope, a suite of instruments, an observatory with a coating plant, a control room and a data center. The 3.6m Devasthal Optical Telescope (DOT) has instruments which provide imaging capabilities at visible and near-infrared bands. In addition to optical studies of a wide variety of astronomical topics, it is being used for follow-up studies of sources identified in the radio region by GMRT and UV/X-ray by *Astrosat*.

The 3.6m DOT project was completed in the year 2016. The telescope has been put into regular operation since March 2016. The day-to-day operation, maintenance and enhancement activities related to scientific, engineering and technical, and administrative aspect of the facility is executed by the DOT team consisting of scientists, engineers and support staff from ARIES and working under overall control and supervision of Astronomer In-charge, DOT (ADOT). The ADOT works under the guidance and supervision of the Director, ARIES. The internal discussions within the DOT Team and with Director ARIES could happen on 58 occasions with one hour each.

A Devasthal Operation and Maintenance Committee (DOMC) with thirteen members from ARIES has been constituted to review the operation of telescope, to take active part in the enhancement of the facility and to liasion with National and international users of the facility. The DOMC is chaired by ADOT. The ADOT is assisted by Assistant ADOT in all the above activities. Two engineer-in-charges take lead in electronics and mechanical related activities of DOT. The DOMC met on two occasions dated 22 May and 7 August, 2018 to discuss matter related to operation and maintenance of the facility.

The operational advisory committee for Devasthal (OACD) has been constituted under chairmanship of

Professor S. Ananthakrishnan and co-chairmanship of Director, ARIES, for advising on operations and maintenance of all the observational facilities at Devasthal. The OACD met on one occasion during 5-6 April, 2018. The activities of 3.6m DOT Facility is also reviewed and monitored from time-to-time by a ten member Project Management Board (PMB) chaired by Professor P. C. Agrawal and co-chaired by Professor S. Ananthakrishnan. The PMB Chairman reviewed the activities on one occasion during 25-27 July, 2018. The allotment of observing time on 3.6m DOT is done by a six member National Level Committee, namely DTAC (DOT Time Allotment Committee) under the Chairmanship of Professor T. P. Prabhu.

The activities performed during the current financial year 2018–2019 are summarised below.

Successful completion of cycle 2018A (Apr-May): The telescope was made ready on 18 March, 2018, and it was utilised for test as well as science observations with IMAGER, TIRCAM2 and ADFOSC instruments. Considering the restricted functioning of azimuth motor as well as a special advisory on operation of telescope under supervision of technical team, It was decided to open the telescope for users from ARIES only. Observing proposals from scientists and engineers were invited for the instruments. After evaluation of the proposals, the time on telescope was allotted by Director, ARIES. The IMAGER was mounted during 18 March to 03 April, 2018. Science as well as test observations for three proposals on IMAGER were carried out. The ADFOSC instrument was mounted during 4 April to 7 May, 2018. Observations from 5 proposals were done. The TIRCAM2 was mounted until 31 May, 2019. A total of seven proposals were executed with TIRCAM2.

Upkeep and health of telescope during Monsoon: The telescope needs to be protected from high humidity during Monsoon period and hence during June to middle of August 2018, the 3.6m DOT was parked and it was not made available for science observations. The gaps between rotating and non-rotating part was filled with foam and dehumidifiers were installed inside the building. A few parts of the telescope viz azimuth, altitude, rotator, adapter, sensor arm focus and turntable, M2 hexapod, and M1 mirror; were moved fortnightly to keep good health of the telescope. The health of telescope was recorded and checked on about half a dozen occasions during the monsoon period.

3rd Aluminisation of Primary Mirror (M1) of 3.6m DOT: Following due approvals from competent authorities, the 3rd aluminisation of Primary mirror took place in September 2018. The preparatory activities started from 15 August, 2018. This was a major activity executed by the ARIES technical (engineers and scientists) team. The primary (M1) mirror was first coated in February 2015 and then second time in March 2017 and this coating was the third attempt. It is noted that the 2nd coating of M1 was completed under supervision and guidance of engineers present at Devasthal site from the telescope manufacturer (AMOS). The 3rd M1 coating was planned and executed solely by ARIES team and the coating was successfully achieved. The cleaning, washing and coating of the mirror was performed during 6-9 September, 2018. The freshly coated mirror gave average reflectivity of 85% between 360 nm to 960 nm. (**Figure 41)**

Installation of TIRCAM2 on sideport-1: The TIRCAM2 instrument has been successfully tested and commissioned at the main axial prot of the telescope. It was decided to mount this instrument permanently at the sideport-1. The design and fabrication was finalised by the TIFR-ARIES team. The instrument was successfully mounted with the telescope in December 2018. (**Figure 42)**

Azimuth motor repair : The azimuth motor is malfunctioning since 23 November, 2017. Though the telescope is made functional by reducing acceleration of azimuth motion, it is technically essential to replace the azimuth motor as soon as possible. ARIES released a purchase order with M/s MACCON dated 23 August, 2018. A technical committee has been constituted by ARIES for monitoring motor manufacturing at MACCON factory, acceptance at the factory, and installation of the new motor in the telescope at Devasthal site. During November 2018, the design drawings and the

test procedures were reviewed by ARIES and AMOS. The corrosion protection measures to be incorporated in the new motor were discussed. The representatives from ARIES and AMOS met on two occasions on 1 May, 2018 and on 23 March, 2019 to discuss matter related to azimuth motor repair.

Maintenance and Repair Activities:

Electronics, computer and related: The routine preventive maintenance activities are being performed by ARIES team as per the matrix provided in the manuals. The all weather system for 3.6m DOT was fully designed, developed and interfaced with the telescope. The temperature and humidity sensors are being replaced every year, soon after the monsoon period, for reliable measurements. An identical spare all weather station was developed in October 2018 and kept ready. The UMAC controllers of ARISS gave problems. This issue was attended by ARIES team in consultation with AMOS. The WFS and AGU cameras stopped working in November 2018. The ARIES team unmounted the cameras and did exhaustive investigations to find out the root cause of the problem. Some of the spares such as UMACs, PLCs, Drives, and Motors were procured during the current year. The requirement of laboratory for storing, testing and periodically energizing the spares have been proposed and discussed in meetings. The number of spare is large and requires special setups for testing, upkeeping and learning them. It is planned to install this lab at the earliest. New industrial PCs for TCS and AOS of telescope were procured and interfaced with the telescope hardware. Data archiving system is setup with FTP facility. All instrument team members are allotted username/password to access the same.

Mechanical, structural and related: Indigenous manufacturing and assembly of slit locks with 3.6m dome were successfully completed and tested. The tendering and ordering of scissor lift for dome and telescope maintenance were completed. The mechanical team prepared the telescope for receiving the TANSPEC instrument which reached the site in March 2019. Mechanical team participated in solving of various technical issues with DOT such as correction in axial fixed definer of DOT mirror and problem encountered in azimuth rotation. Mechanical maintenance of four 10 MT capacity EOT Overhead Cranes in enclosure was carried out. Defective tower bolts of doors of exhaust fans on 11m floor were replaced. Scaffoldings outside dome were erected for maintenance of fan louvers, fan hoods and enclosure sheets.

Miscellaneous activities: Update on 3.6m DOT facility was presented at different forums during the financial year. Altogether, eight contributions related to various aspects of the facility appeared in the conference proceedings and refereed Journals. The work on 3.6m DOT facility presented at the 2nd Indo-Belgium BINA Workshop held during 9-12 October, 2018 at Royal Observatory Belgium. The proceedings are planned to be published in the Bulletin of the Royal Science Society of Liege. Presentation related to 3.6m DOT activities were also made at the 37th Meeting of the Astronomical Society of India held during 18- 22 February, 2019.

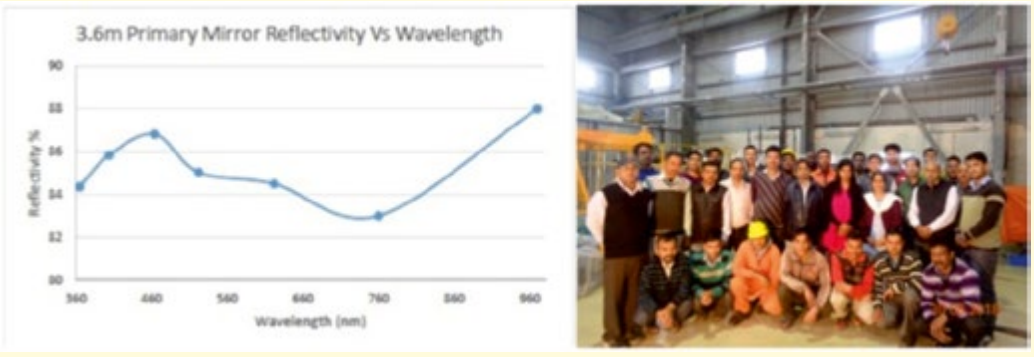

Figure 41. The reflectivity of freshly coated primary mirror of 3.6m DOT. A picture of ARIES coating team is shown in right panel.

Figure 42. The TIRCAM2 instrument mounted at sideport-1 of 3.6m DOT. The Yellow instrument structure is mounted on main axial port.

The 15cm Solar Telescope

The main solar observing facility at ARIES is 15cm, f/15 Coudé Solar Tower Telescope equipped with Hα filter, and CCD camera (1Kx1K, 13 micron, 16 bit, 10 MHz read out rate, frame transfer, back illuminated). It has a spatial resolution of 0.58" per pixel. It is an automatic Hα flare patrolling system, which takes fast sequence of images in the flare mode observations. Regular observations of the solar eruptive events (e.g. solar flares, filaments and prominences eruptions, surges etc.) were routinely done with the telescope. The telescope is also equipped with FeX 6374 Å, FeXIV 5303 Å, FeXI 7892 Å filters to observe the corona during total solar eclipse. The telescope is located in a reasonably good site especially during first half of the day. The total clear observing days are approximately 200 per year.

Figure 43. The 15cm Coude solar tower telescope for solar observations.

Report from the Labs

Electronics Laboratories

Electronics section plays an important role to cater the need of installation and maintenance of different observing facilities in the institute. In addition, technical members of the section are relentlessly engage in in-house developmental work in different fronts like telescope control system, RF engineering etc to develop a culture of self-reliance. The brief description of the major activities which have carried out by the members of the section.

A. Installation of SCADA based substation at Devasthal site: A modern SCADA based substation system (100KVA and 400KVA) with suitable power backup from DG sets has been developed and installed at ARIES, Devasthal for providing quality electrical power to all observering facilities located at the site. The substations are equipped with automatic load management, distribution, computerized remote control, monitoring and event logging features. The substation system consists of two units configured in master and slave mode separated by a distance of ~ 1.5 km. Both substations are electrically inter-connected and linked through LAN network.

Figure 44. 400KVA SCADA based substation at Devasthal.

Figure 45. SCADA based operation panel (400 KVA).

Figure 46. 100KVA SCADA based substation at Devasthal.

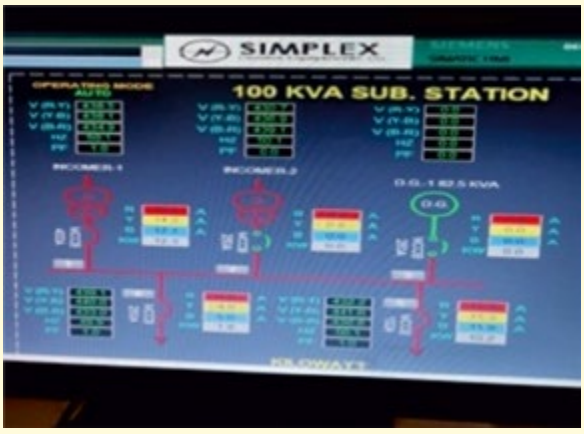

Figure 47. SCADA based operation panel (100 KVA).

Figure 48. 400KVA, 160KVA and 82.5 KVA DG sets at Devathal.

B. New electronics lab for telescopes and instruments for integrated design and development work: A new humidity controlled ESD safe laboratory has been developed for storing, periodically energizing and especially learning different aspects of the complete range of sophisticated electronics, mechatronics and optoelectronics spares of the 3.6m DOT. This ESD safe lab space has been created by partitioning the central electronics lab. The lab is equipped with ESD safe workbenches, chairs, sleepers and tools like mixed signal oscilloscope, advanced function generators, programmable high accuracy power supplies, LCR meters, high accuracy bench top multimeter, serial decoder and protocol analyser, test cameras, precision drilling and cutting tools etc. along with facilities like three phase UPS supply, industrial PC with special interfacing ports etc.

C. Upgradation of display and Operating console for 1.04m Sampurnanand Telescope: A GUI based computer controlled operating console for 1.04m telescope has been developed and installed successfully. Development work has been carried out without disturbing the old console i.e. old telescope console and the new computer based GUI control will work in parallel with the old one. Two absolute encoders are being used to read RA and Dec positions of the telescope .The GUI has been developed on Visual basic platform to interface with embedded PIC micro controllers which runs a C code.

D. Development work for International Liquid Mirror Telescope (ILMT) Project:

a). A GUI based software has been developed to operate the mechanical interface between CCD and corrector of the telescope to adjust the optical focus of CCD remotely. Using the software, commands for different positions i.e focalization, rotation and line filter can be given. In addition, monitoring the status of motors, position of focus and limit switch status on the GUI can also be done.

b). In-house development of remote operation and monitoring ILMT building: As we know that the liquid mirror telescope uses mercury to form a mirror and exposure to mercury even a small amount may cause serious health hazards. To avoid this issue, it is important to operate the roof cover remotely by computer. Hence, a PIC microcontroller with CAN protocol electronic boards, and relay boards have been developed to operate it remotely.

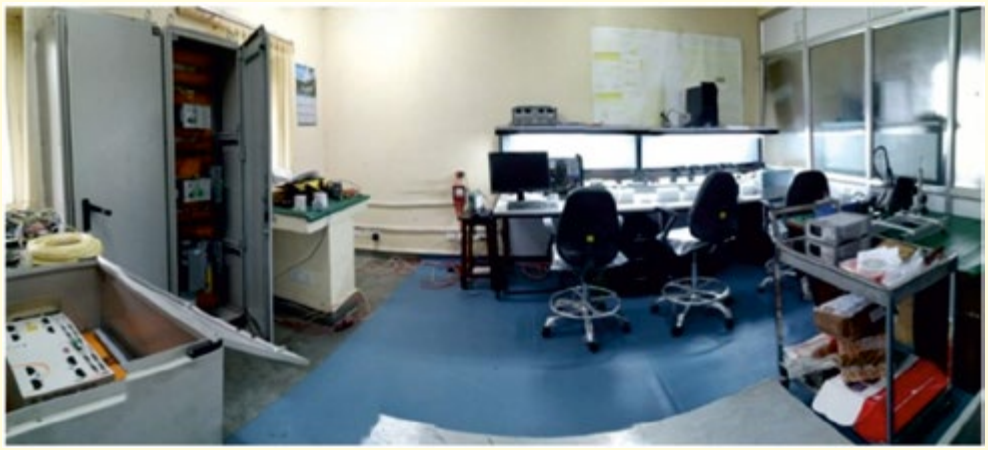

Figure 49. The Electronic lab for 3.6m DOT activities.

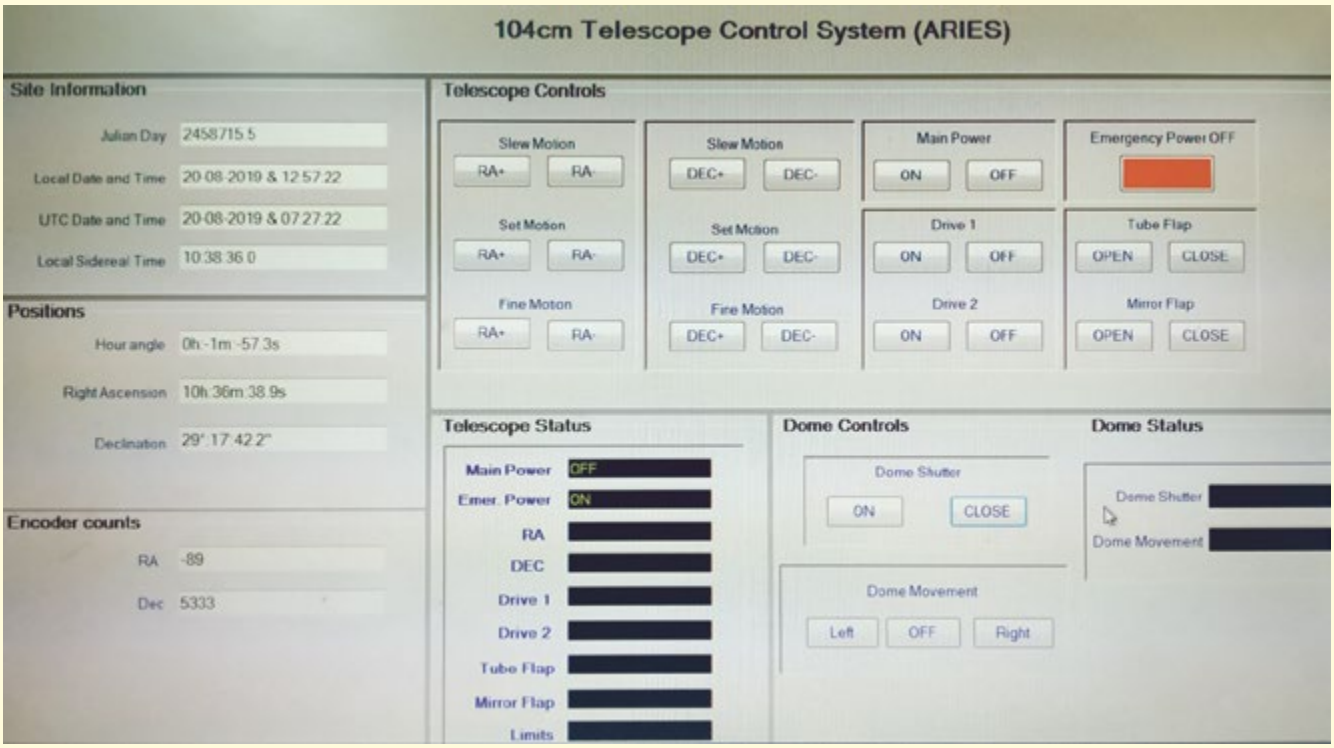

Figure 50. The GUI to operate 1.04m Telescope.

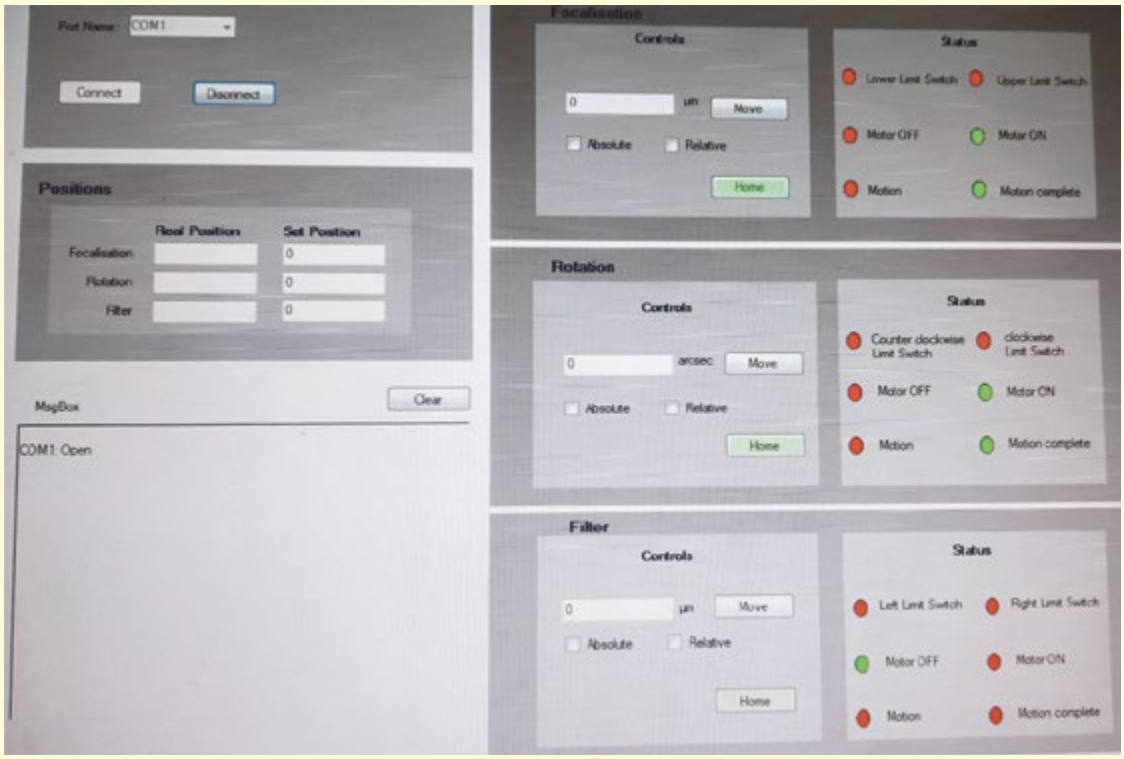

Figure 51. The GUI to operate the mechanical interface between CCD and corrector.

E. ARIES ST Radar (ASTRAD): In the reported year all twelve clusters (588 modules) of the radar have been activated and operated. Members of the section executed calibration, testing, verification and activation of the system. Subsequently, wind data obtained after radiation has been validated with balloon-borne GPS radiosonde and a reasonably good agreement has been observed upto ~ 18 Km .The section has played a crucial role in signal processing and validation of the system. In addition to the activation work, in-house development of RF units like prototype of Transmit Receive Module (TRM) , RF modules have been carried out successfully.

F. In parallel to up-gradation/developmental and new-facility installation work, the section has devoted significant time in the maintenance of all observing and estate facilities at Manora Peak and Devasthal. A dedicated true online UPS system has been installed by the section for the data network facility under the computer section.

Optics Lab

Optics section is actively involved in the instrumentation activities related to various projects. Testing, verification of various systems/subsystems was carried out using facilities/instruments available in optics laboratory.

A. Primary mirror cleaning, old coating removal and re-coating of 3.6m Devasthal Optical Telescope (DOT): Third realuminisation of 3.6m primary mirror of DOT was carried out during 6-9 Sept., 2018. Primary Mirror of 3.6m DOT was shifted to washing unit in the afternoon of 06 Sept, 2018. Primary mirror cleaning and old coating removal procedure started on 07 Sept at 08:30 AM and ended at 2:45 PM. After that, primary mirror was shifted to coating chamber using mirror handling tool. At 3:30 PM coating chamber was closed and chamber was evacuated to $5x10^{-4}$mbar pressure. Coating chamber was again evacuated on 08 Sept, 2018 to $4.8x10^{-6}$mbar pressure and Ion beam cleaning (30 min) and sputtering (100 min) was carried out. Coating chamber was opened on 09 Sept, 2018 and mirror coating was inspected and reflectivity values were measured. Reflectivity value ranges from 84-88% for wavelength range of 365-970nm.

Figure 52. Covered the mirror surface with wet cotton pads and soap solution.

Figure 53. Cleaning the mirror using cotton pads and soap solution.

Figure 54. Pouring KOH solution to remove the old aluminium coating

Figure 55. Drying the mirror surface using lint free towels.

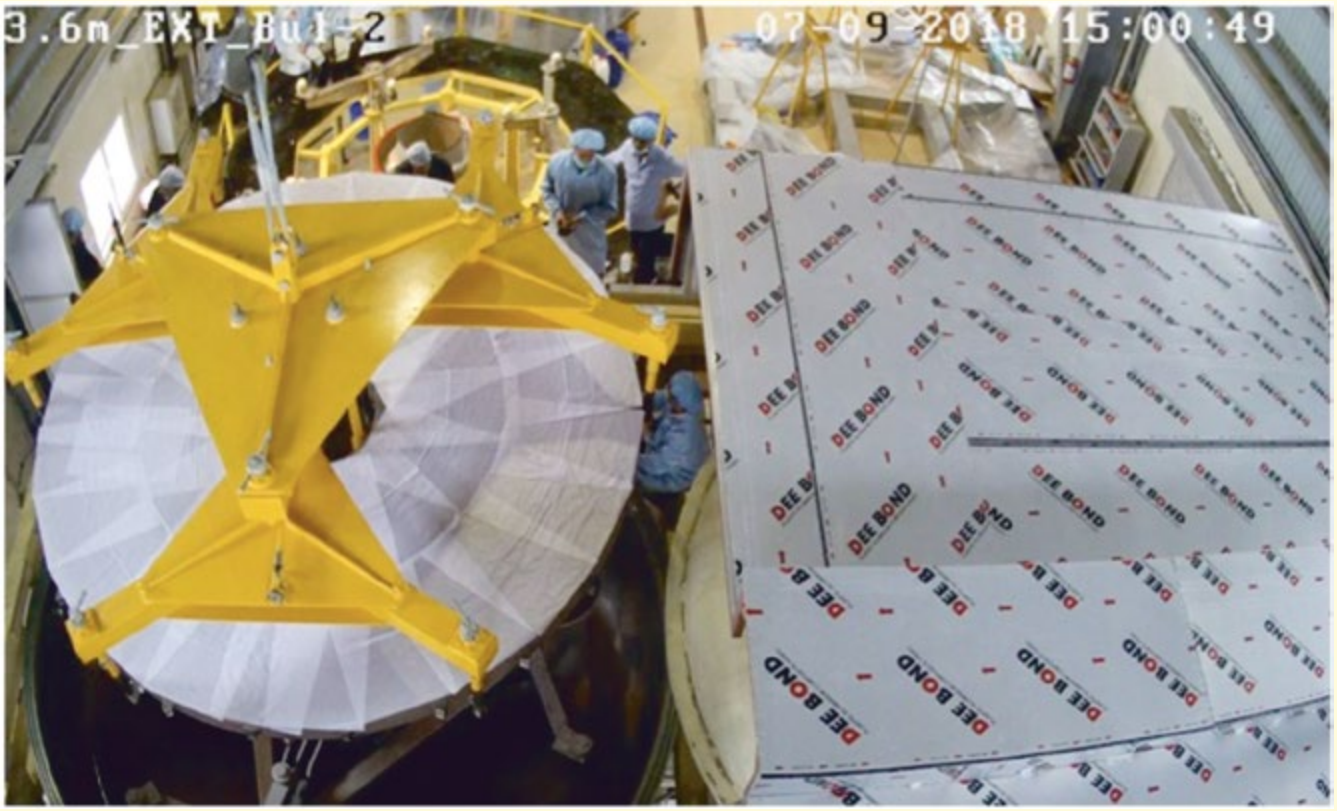

Figure 56. Placing the mirror inside coating chamber

(B). 3.6m DOT Primary mirror mounting/ dismounting from mirror cell: Optics team has taken the lead role after the primary mirror cell was rested on integration stand at extension building. Mirror was disintegrated from the mirror cell as per the procedure given by AMOS. First the aperture stops were removed then external and internal restrainers were removed. Lateral supports and lateral levers were disconnected. Then axial pads were disconnected. Central guide was installed and mirror was shifted to washing unit using mirror integration tool and extension building crane. After mirror coating, mirror was integrated back to the mirror cell. Integration of mirror back in the mirror cell is a very sophisticated procedure and needs to be executed very carefully. Primary mirror integration into its cell was started on 03 October, 2018. The positioning of primary mirror was confirmed by inspecting the contact point of three inner integration candles with the v-grooved centering reference pads respectively. The height of the mirror wrt mirror cell was also measured at three locations of lateral defining (LD) support. The measured heights from LD1, LD2 and LD3 (with mirror on integration candles) are 242, 241.9 and 241.9 mm respectively. During the previous coating mission in March, 2017, shims of thickness 0.2-0.3 mm were inserted below the three restrainers (#2, #3 and #4). Also during optical alignment shim of thickness 0.5mm was inserted in AFP-1 and later on in October, 2017, shim of thickness 1.1mm was inserted in AFP-3. During this fresh mirror integration all these shims were removed after discussion and confirmation from AMOS. The forces values on 69 actuators, lateral levers, axial and defining supports etc. were found okay and no abnormal forces were seen. After successful integration of primary mirror into its cell mechanical team took over the charge of mirror cell mounting to the telescope. Telescope optical alignment was also carried out successfully by optics team.

Figure 57. Lifting 3.6m mirror from mirror cell using mirror integration tool (yellow) and extension building crane.

Figure 58. Inspection of mirror cell (actuators, radial supports etc.) after disintegrating primary mirror.

(C). 3.6m DOT Primary Mirror Axial Pad Gluing: There are three axial fixed points (AFP) in primary mirror and during the inspection of mirror cell it was observed that one of the axial fixed pad (AFP-1) was unglued from the mirror back surface. Optics team was involved in gluing back the support to the desired location. The surface of the new pad is rubbed using sand paper and later on cleaned optically using alcohol, acetone and other chemicals. After treating the pad surface, glue was prepared by mixing the two parts of the glue material. Glue is applied to the pad surface and then pad is pushed under the deck to remove the extra glue. Then the pad is glued to the mirror surface using the support system.

Figure 59. Applying glue to axial pad.

Figure 60. Axial pad after gluing to mirror surface.

(D). 1.3m Primary mirror cleaning: Annual in situ cleaning of primary mirror of 1.3m telescope was carried out on 27 September, 2018. The measured reflectivity values of primary mirror before cleaning were 60% @ 365nm & 63 % @ 970nm. After a thorough cleaning process reflectivity values were improved to 79% @ 365nm & 88% @ 970nm. Corrector lens was taken out from its mount and cleaned with soap solution and distilled water. After cleaning, corrector was assembled back to its mechanical mount. SDSS (u, g, r, i, z) and UBVRI filters were also cleaned.

(E). 1.3m Radial Pad gluing: During primary mirror cleaning it was observed that the mirror has shifted from its reference position. After a detailed investigation it was discovered that one of the radial pad of primary mirror was unglued. For regluing the radial pad, mirror cell was brought down using the MCLA assembly and rested over the maintenance stand. After that radial counter weight assembly was removed and unglued pad was cleaned thoroughly. The mirror surface was also cleaned optically to provide good bonding between pad and surface. Glue mixture was prepared and thin layer was applied using a spatula. A mechanical tool is used to position the radial pad. Then the radial counter weight assembly was mounted in such a way that the lever of the radial support is always in tension so as to apply continuous pressure at the radial pad. This arrangement was helpful to make god bonding of radial pad with mirror surface. After gluing the radial pad, optical alignment of 1.3m telescope was also carried out successfully.

(F). Optics Team Contribution in FOSC

- An auxiliary CCD camera, imaging f/9 beam of the telescope (in addition to AD-FOSC main CCD imaging f/4.3 beam) has been mounted on AD-FOSC. This set up can be used in multiple way e.g. external auto guiding, real time seeing measurement, fast imaging etc.

- Two low-dispersion (100-200) grating+prism are included in the ADFOSC system on experimental basis. A very low dispersion (~10) wedge-prism system was also included and tested successfully on

the sky during April, 2018 run. In addition, a DIMM measurement setup has also been included in the system for experiments related to seeing measurements.

- The calibration unit has been upgraded with new integrating sphere and calibration lamps (Hg-Ar, Ne). This setup is expected to provide highly spatially uniform internal light source for spectral and flat-fielding calibrations.
- Cleaning of FOSC optics e.g. lenses, prisms, filters were carried out and mounting and dismounting was done.

(G). Devasthal Coating Plant:

Following activities were performed after March 2018.

- Coating cycles on samples mirrors were performed with different combinations of sputtering power and sputtering time. The aim of this exercise is to fine tune the parameters of coating plant to achieve the optimum value of reflectivity.
- Coating thickens changes with sputtering time. Hence sputtering time was varied and thickness of samples was measured to optimise the sputtering time for mirror coating. Coating thickness also changes for the cases of mask used and mask removed.

Different parameters were varied and coating thickness and reflectivity were measured and a table was formed to obtain the parameters for best result. Aim of the above exercise is to assess the reflectivity performance of Devasthal coating plant. Theses result formed a basis for us to tune the coating plant parameters during the primary mirror coating in monsoon, 2018.

(H). Others:

- In-situ cleaning of 3.6m primary mirror is carried out periodically using CO_2 snow cleaning apparatus.
- Load testing of mirror integration tool and extention building crane was done by using a dummy mirror.
- Optical design analysis for FOSC, 1.3m telescope, 3.6m telescope, etc. was carried out at various stages to understand and rectify issues.
- Several items were procured, mostly related to cleaning and coating of 3.6m primary mirror.
- Cleaning and testing of of filters, small optics etc has been carried out.
- Optics team was actively involved in mounting/ dismounting of guiding and wfs camera, their shutter replacement and testing.
- Regular operation of 3.6m Devasthal coating plant was carried out.
- Optics team was involved in assembly, integration and verification of TANSPEC instrument at telescope main port and TIRCAM 2 at side port of 3.6m DOT.
- Optics team was also actively involved in diagnosing and rectifying several issues related to 3.6m DOT, related instruments and other facilities of the institute.

Mechanical Engineering Section

To fulfill the stringent requirements in astronomical and atmospheric instrumentation, Research and Development a fairly well equipped mechanical section has been established. The mechanical section is actively involved in design, development and maintenance activities viz. 3.6m telescope upgradations and maintenance, IMAGER instrument development, ADFOSC subsystems developments, 1.3m telescope maintenance, 1.04m telescope instrument upgradations, CCD attachments, Encoder mountings, optical alignment of the telescope, Enclosure building and modernizing the existing facilities.

The mechanical section is equipped with a vertical machining center CNC and conventional machines such as lathe, milling, radial drilling, surface grinder, mechanical power hacksaw, tool grinder, air compressor, single phase and three phase welding machine, gas cutter equipment, TIG welding machines, etc. and a portable

CMM machine is equipped for measuring the geometry of physical objects by sensing discrete points on the surface of the object with a probe.

Our Engineers are familiars in Pro E, Unigraphics, Auto Cad, Ansys, and Master cam software for design, simulation, and computer-aided manufacturing of mechanical systems.

Major Contribution carried in brief

A. TANSPEC Spectrograph Instrument Installation:

The Spectrograph was manufactured by Mouna Kia infrared, Hawai and supplied to 3.6m facility.

Figure 61. The whole setup lifted to the telescope floor with the help of cranes and hatch trolley.

The instrument is approx 650kg and dummy weights are 1150 kgs, complete setup was assembled in the enclosure building and aligned all the optical and electrical systems as per the requirement and the whole setup was lifted to the telescope floor with the help of cranes and hatch trolley. Finally, the whole setup has been installed in the axial port 3.6m telescope with the help of newly built TANSPEC mounting trolley.

This instrument needs closed-cycle cooling to keep the optics and detectors in below 73 Kelvin and closed cycle cooler is Brookes 9600 helium compressor and workshop team built in-house chiller for the compressor and helium lines from compressor to telescope floor.

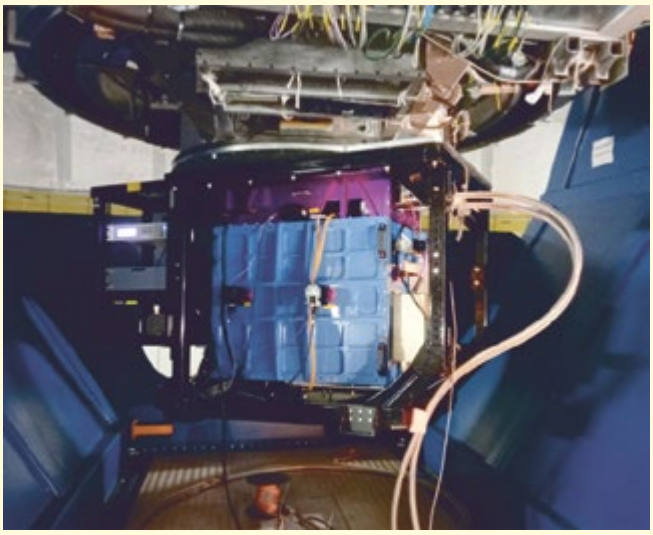

Figure 62. TANSPEC instrument mounted at 3.6m DOT.

B. 1.04m 4kx4k filter unit:

The filter unit is closed box structure made of aluminum alloy and it houses the Broadband filters, filter drive mechanisms and supports the 4kX4k CCD detector with less flexure at elevations.

The complete design and developments were carried in-house using CNC and conventional machines and the whole setup was installed with new 4kx4kCCD and instrument was balanced with the help of counterbalance weights and successfully tested instrument in ongoing observation cycle.

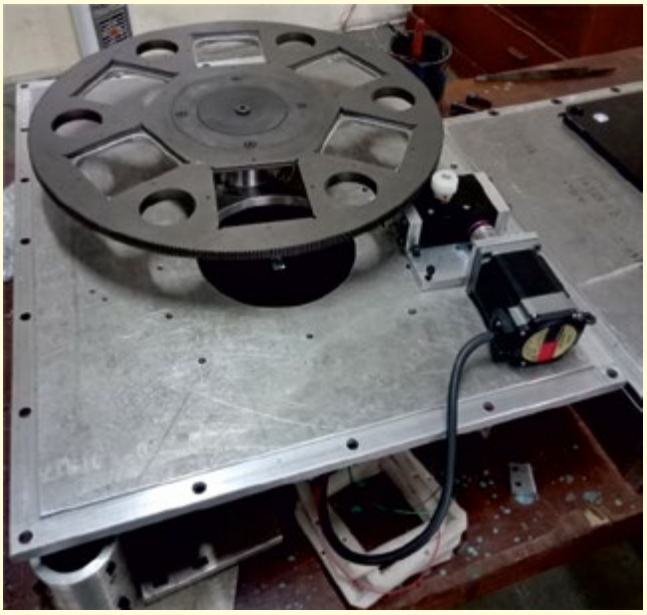

Figure 63. The complete design and developments of filter unit were carried in-house using CNC and conventional machines.

Figure 64. The whole setup installed with new 4kx4k CCD at 1.04m ST.

C. 3.6m DOT Facility

The work involving disintegration and integration of primary mirror cell and ARISS-octagon assembly with 3.6m telescope in 3rd M1 Coating Mission were carried out independently by ARIES mechanical team for the first time **(Figure 65)**. A detailed understanding of procedures, planning of manpower, materials and tools etc. was carried out for performing such heavy, complex and precise operations. ARISS-octagon assembly was again disintegrated and integrated with telescope for AGU and WFS cameras and for guider shutter replacement missions. Detailed technical discussions were carried out with AMOS engineers for sorting out telescope alignment related issues and provided them required technical information in the form of mechanical reports, pictures and videos etc. Inspection and measurements of centering devices and guide pins of M1 cell of 3.6m telescope were carried out. Manual slit lock arrangement design for dome was finalized, manufactured in-house in mechanical workshop and implemented from inside of dome. Mechanical team supported in mounting and un-mounting of various instruments such as FOSC, TIRCAM2 and TANSPEC on DOT. Concept design of tools arrangement for side port instrument mounting was prepared. Procurement of spares for DOT was initiated. Few spares such as connectors arrived, order for self-propelled electric scissor lift was placed and other spares procurement was in process. Shims were prepared for the issue of image quality degradation and mechanical support was provided in their fitment for M1 axial definers. Routine maintenance and checks of different telescope systems and its enclosure were carried out. Maintenance matrix charts were also prepared for the same. Layout of storage of TANSPEC instrument boxes was prepared. Mechanical team was involved in replacement of hoisting brake system of the dome crane. Foam fitted in 3.6m Telescope dome circle and exhaust fans etc. during monsoon period (to avoid fog entry) was removed and dome was made functional. Materials like nylon bolts, nuts and washers etc. developed for dome were fitted. Few students pursuing degree and diploma in mechanical engineering carried out their summer training in mechanical section of ARIES.

Figure 65. Primary mirror cell containing mirror was disintegrated on 28 August, 2018

Computer Lab

Computer Division is backbone of ARIES which provides various Computing and Network services through Information & Communication Technologies for its Staff members including Scientists, Engineers, Students, Technical and Administrative Staff. Computer Centre administers and manages the entire Campus Computer Network which includes Departments/ Sections, Main Administrative Building, Hostels and the Guest House.

The Division manages Servers, Storage Device, Work Stations, Desktop and Laptop Computers, Printers, Plotters, Scanners, CCTV, Projectors, Video-Conference, DSLAM, Software and Network (Wired & Wireless) infrastructure along with setup, maintenance and support.

The Division also provides secured network services of campus wide LAN/WAN solutions and internet /intranet solutions besides providing computing services to ongoing R&D projects(3.6m DOT,1.3m DFOT, ST-Radar etc). The IT group has been in the forefront of deploying information technologies to help faculties to be in their chosen area of research/work.

The Division has extended its service to all users with 34 Mbps ILL connection from BSNL. We also have NKN (National Knowledge Network) link provided by NIC. The present ARIES Network facility management system has been upgraded with latest technologies like Webmail, Band width management and Firewall.

An advance setup of Computers, Storage System, Servers, Workstations, Printers, Video-Conference has been established at Devasthal. We have a PTP Microwave link between Nainital and Devasthal. Internet & Telephone facilities are being provided at Devasthal using this link since last 10 years. Recently we have installed a new 10Mbps ILL at Devasthal.

Technical Activities:

- Wired and Wireless Networking Solutions & Services
- Software Development &Data Base Management
- Windows and Linux Server Administration
- Internet Connectivity to all Scientists, Engineers, Staff and Students of ARIES
- Infrastructure Procurement, Set-up, Installation, Management and Maintenance
- E-Administration Services including Software and Hardware installations, printers, scanners and all other computer related devices
- E-mail Service for ARIES Staff members including Scientists, Engineers, Technical and Administrative Staffs and Students
- Technical support in Video Conferencing / Seminars/ Training Schools/ Scientific Workshop
- Network Security
- Web Services include Website (Website Development , Administration and Maintenance)
- Management of Point to Point link (Microwave link) between Nainital and Devasthal.
- Management of Bio Metric Attendance System at Nainital and Devasthal

Facilities:

- Servers/Workstation for services like Web, Email, DHCP, DNS etc.
- Email services for all Staff and Students.
- Wi-Fi Internet Management System.
- VPN Network Service Management System.
- Centralized Storage System.
- Centralized printing facility.
- Network Management System with high speed Routers and Switches.
- Network Security Management System with Firewalls.
- Various advanced and special purpose software for users.
- A ~30TB EMC data storage system has been installed at Devasthal. This is being used for storing/retrieving data safely for all facilities running at Devasthal.
- A new LFD (Large Format Display) has been installed for Seminar/workshop/ training schools /Skype/ WebEx etc.

Future Plan of Action:

- A Hyper converge system is planned to provide cost effective virtual server infrastructure to faculties with dynamic compute/storage provision. **Hyper-convergence** is a type of infrastructure system that tightly integrates compute, storage, networking and virtualization resources and other technologies will be combined in a commodity hardware box.
- Digitization of office records.
- E-Office management for smooth running of office.
- Upgradation of firewall at both offices, Nainital and Devasthal.
- Data/Video Wall for the display of updates of Office activities.

Knowledge Resource Center

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, its 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). 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 ARIES KRC is a member of FORSA (Forum for Resource Sharing in Astronomy and Astrophysics), which was established by Indian Astronomy Librarians in 1979. The ARIES KRC is also a member of National Knowledge Resource Consortium (NKRC). NKRC provides free access of Subscribed Online Databases to DST and CSIR institutions.

KRC Resource Development

During the period 2018 – 2019, the following information resources were added:

Books	:11
Subscription to Journals	:74 (Print + Online) + Full Text Databases
Publications in refereed journals	: 55
Theses awarded	: 02

The collection at the end of the period is

Books	: 11003
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 new features of Online Catalogue are available at Web-OPAC in ARIES home page. DSpace, an open source software is used for the digital repository of ARIES, where KRC preserves scientific documents, academic reports, photographs of special events, newspaper clippings, etc.

Figure 66. KRC main reading hall.

Academic Programmes of ARIES

The Academic Committee (AC) of ARIES is pursuing to improve the academic environment of the institute. The present members of the committee are:

Dr. Manish Naja (Chariman)

Dr. Sneh Lata

Dr. Narendra Singh

Dr. Yogesh Joshi

Dr. Saurabh

Mr. Ramdayal, secretary to the AC and AC is also assisted by Mr Arjun Singh and Prashant Kumar.

Major academic activities of 2018-2019 are listed below:

[A] Joint Entrance Screening Examination (JEST)

Academic Committee actively participated in the overall planning of the JEST on the behalf of ARIES. One of the members of AC (Dr. Narendra Singh) took the responsibility of conducting the JEST 2019 examination at Nainital centre and exam was conducted on 17 February, 2019.

[B] PhD entrance interviews

AC organizes interviews every year to select PhD students as Junior Research Fellows (JRFs) in ARIES. Dr Saurabh and other AC members screened all applications and interviews were conducted during 11-15 June 2018. Students who are MSc in physics/ astrophysics and have qualified JEST/ NET/ GATE are invited to appear for the interviews. Candidates who have successfully qualified the interviews are selected as JRFs and are inducted in ARIES to undergo a pre-PhD course work. Eight students have joined ARIES in year 2018.

[C] Summer Project Students

The summer project internship is one of the significant programs of the academic committee. In this, we intend to provide training to the Bachelor/Master level students from various universities/institutes and provide glimpses of the cutting-edge research and development activities that are being carried out in the Institute.

[D] Conducting the Course Work of ARIES Post Graduate School

Academic Committee has made the detailed course work structure in Astronomy/Astrophysics, and Atmospheric Science for the students joining ARIES. Committee conducts the teaching classes in four terms followed by three months project in the specialized area of the basic research.

The extensive course work is followed by rigorous examination. Each instructor takes the examination under the supervision of the AC, and evaluates the students as per the criteria made by the AC. The project related evaluations, commissioning of respective committees and experts, and arrangements of the project talks, are also executed by AC. In 2018-2019, AC conducted the examination and project presentations of the first year batch and following students successfully negotiated the Pre PhD course work, and entered the main PhD programme of ARIES:

[1] Amit Kumar

[2] Vinit Dhiman

[3] Prajjwal Rawat

[4] Vibhore Negi

[5] Aditya Jaiswal

[6] Ankur

[7] Jaideep

[E] PhD Thesis Awarded/submitted

Two students were awarded Ph.D. degree and Three students have submitted their PhD thesis during April, 2018-March, 2019.

[F] Post Doctoral Fellows

Eight postdocs are at ARIES during 2018-2019.

[G] Conducting the Annual Student/Postdoc Reviews

Every year around the month of July/August, AC under the guidance of the Director, forms the expert panels,

select the examiners, and furnish the details of the Junior and Senior Research Fellows of the Institute to conduct their annual reviews. The recommendations on upgrading their fellowships (JRF to SRF), thesis submissions etc are based on the significant review process organized by the committee. In 2018 the following students have been promoted to SRF after the review process:

[1] Krishan Chand

[2] Arpan Ghosh

[3] Alaxender Panchal

[4] Priyanka Srivastava

[5] Sadhana Singh

[H] Orientation Programme 2018

Every year Academic Committee organizes orientation programme to welcome new students, and distributes pre-PhD course certificates to successful and outgoing first students of ARIES. Orientation programme 2018 was conducted on 31 July 2018 **(Figure 67)**.

Figure 67. Group photo with newly joined JRF and pass out JRF of Pre PhD course work during orientation programme conducted on 31 July 2018.

Public Outreach Activities

ARIES conducted several public outreach programs to increase general awareness about astronomy and basic sciences among common people. Nainital and nearby places are full of schools and colleges and are major center for primary education in this part of the country. For this purpose, resources available at ARIES science center (having one lecture hall, equipped with projector and sitting arrangements of about 40 students and a exhibition hall to display the science models and posters), a small 14-inch telescope (to facilitate live night sky visual observation for the general public) and a 5m planetarium were used for astronomy popularization.

Institute catered around a dozen of visitors per day and 3-4 educational tour per month to demonstrate ARIES scientific facilities and delivered popular talks (for educational tour) or had slide shows (for general visitor). Apart from this, print and electronic media was also used to communicate information related to astronomical events as and when required as a part of public outreach activities during the year. Popular talks in nearby schools and colleges were also arranged.

About 9000 visitors benefitted under the above mentioned visits to science center, out of which nearly 60% were students from various schools/colleges in the country. Students from various colleges and schools in local area were specially invited and entertained to promote science and related activities. Several popular talks were also given occasionally in local schools and colleges for high-school and intermediate students.

Popular science Programmes:

Apart from its main research activities in astronomy, astrophysics and atmospheric sciences, ARIES is consistently engaged in dissemination of Science and Technology to general public, particularly astronomy. Related to this, last year five popular science programs were organized as described below.

Aryabhat Foundation

Aryabhat Foundation is social service organization based on efforts made by Madhya Pradesh towards Science popularization. The state annually organizes state level astronomy quiz for school students in which around 5000 students participate from different schools across the state. Out of selected meritorious students, a group of three students are selected to visit ARIES every year. During this visit, students interact with scientists and research scholars to know more about astronomy and astronomical facility of ARIES. There visit is generally held in the month of May every year.

HIMWATS's Workshop

HIMWATS is a Champawat (Uttarakhand) based NGO working in the field of social, educational and environmental issues of Uttarakhand. They annually organized a workshop for school children with resources provided by ARIES. This year it was held during 3-5 June, 2018, in which two scientists from ARIES participated and delivered popular talks on astronomy and atmospheric sciences.

UNISED's One day programme at ARIES

UNISED (A Society of IIT Kanpur, Dept of Physics) working for Science and Educational Development, organized a one day exhibition on 17 May 2018 at ARIES. The students participated in developing models, postersand exhibition which concluded with a prize distribution.

Basics of Telescope and Astronomy Workshop

On request of St. Joseph's College, ARIES organized a five day workshop on "Basics of Telescope and Astronomy" during 24 to 28 September, 2018. 25 student of classes 11 and 12 participated in this workshop. The workshop consisted of a series of lectures, observations through 14-inch telescope, hands-on training of handing a telescope, and maintenance of telescope.

Public Outreach Day Celeberation

As a precursor programme of India International Science Festival 2018, ARIES conducted a one day prgramme for Govt School Students on 18 September, 2018. About 50 students participated in this programme. The participants interacted with scientists and were informed about recent progress towards front-line research within the country towards astronomy and atmospheric sciences.

National Science Day Celebration

This programme was organized at ARIES on 28 February 2019 on the occasion of National Science Day under the theme of "**Science for the people and people for the science**". In this programme, about 80 students of Rajeev Gandhi Navoday Vidyalay, Syat, Kotabag participated.

ARIES Training School of Observational Astronomy (ATSOA)

ARIES training school in Observational Astronomy (ATSOA) is an annual programme of ARIES. ATSOA was organized during 05-15 March, 2019 at ARIES, Manora Peak Nainital to provide young Indian universities/college M.Sc. final year or fresh Ph.D students the necessary expertise/skill to independently conduct data-analysis related to observational astrophysics in optical domain. About 30 participants from various universities and institutes participated in the school this year. The focus was on hands on experience using 1m class ARIES telescope. About two dozens of lectures were delivered by ARIES faculties to the participants and small-scale observational projects supervised by ARIES research scholars were conducted to give a first-hand experience on real astronomical data. Towards the end, participants also delivered short presentations on the project work carried out during the school.

Participation in science related exhibitions

ARIES participated in two major science and technology exhibitions namely India International Science Festival (IISF) at Lucknow 05-08 October, 2018; and Women Empowerment 2019 (The Mega Expo) at Shimla 12-14 March, 2019, in different part of country to showcase the observational facilities and different activities. In these two exhibitions a group of ARIES scientists, staff and resource persons interacted with a large number of students and general public to update them about ongoing scientific projects of the institute and front line research activities.

Figure 68. Dr. A. K. Pandey, Director, ARIES interacting with Aryabhata Foundation's students.

Figure 69. Night sky watching programme during HIMWATS workshop.

Figure 70. Dr. A. K. Pandey, Director, ARIES interacting with students during UNISED's programme.

Figure 72. ARIES stall at IISF exhibition, Lucknow.

Figure 71. Dr. Narendra Singh briefing about activities and facilities of ARIES to Prof. Ashutosh Sharma, Secretary, DST, Govt. of India during IISF exhibition, Lucknow.

Figure 73. Dr. S. B. Pandey explaining facilities of ARIES during Women Empowerment 2019 (The Mega Expo) at Shimla .

Figure 74. Group photo of Public Outreach Day celebration at ARIES.

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 SAI Hospital, Haldwani (Dist.-Nainital), Brijlal Hospital, Haldwani (Dist. - Nanital) and Krishna Hospital and Research Centre, Haldwani (Dist.-Nainital) on cashless basis through which bills on expenses are reimbursed as per CGHS rates. One doctor is engaged by ARIES who visits the institute twice a week. Facilities like rest bed and pressure machine are readily available in the dispensary.

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.

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.

Prevention of Sexual Harassment of Women at Work Place:

Necessary steps and guidlines are laid out in compliance of the instructions on the subject. No complaints have been received during the year.

Implementation of Right to Information Act:

The provisions of RTI Act have been implemented.

Members of ARIES

Academic (20)

Wahab Uddin *(from 01-12-18)*
(Director In-charge)
Anil K. Pandey *(till 30-11-18)*
Brijesh Kumar
Indranil Chattopadhyay
Manish Naja
Ramakant Singh Yadav
Saurabh
Yogesh C. Joshi
Alok C. Gupta
D. V. Phanikumar
Jeewan C. Pandey
Narendra Singh
Santosh Joshi
Snehlata
Amitesh Omar
Hum Chand
Kuntal Misra
Neelam Panwar *(from 23-05-18)*
Shashi Bhushan Pandey
Umesh C. Dumka

Engineering (13)

Ashish Kumar
Jayshreekar Pant
Nandish Nanjappa
Samaresh Bhattacharjee
Tripurari S. Kumar
B. Krishna Reddy
Mohit K. Joshi
Purushottam *(till 22-06-18)*
Shobhit Yadava
Chandra Prakash
Mukeshkumar B. Jaiswar
Sanjit Sahu
Tarun Bangia

Administrative and Support (13)

Ravinder Kumar
(Registrar)
Abhishek Kumar Sharma
Himanshu Vidhyarthi *(from 12-01-18)*
Mohan Singh Bisht *(till 31-01-19)*
Rajendra Prasad Joshi
Bharat Singh
(Asstt. Registrar)
Anand Singh Bisht *(till 30-06-18)*
Mahesh Chandra Pande
Praveen Solanki
Virendra Kumar Singh
Hansa Karki
Manjay Yadav
Rajeev Kumar Joshi

Scientific and Technical (34)

Abhijit Misra
Arjun Singh
Bharat Bhushan
Darwan Singh Negi
Harish Chandra Tewari
Javed Alam
Lalit Mohan Dalakoti
Nitin Pal
Prashant Kumar
Rajendra Prasad
Srikant Yadav
Vinod Kumar Sah
Anant Ram Shukla
Ashok Kumar Singh
Bipin Chandra Pant *(till 31-03-19)*
Girija Nandan Pathak
Hemant Kumar
Kanhaiya Prasad
Manoj Kumar Mahto
Pavan Tiwari
Rajdeep Singh
Ravindra Kumar Yadav
Tileshwar Mahto
Anil Kumar Joshi
Babu Ram
C. Arjuna Reddy
Girish Kumar *(till 17-09-18)*
Ishwari Dutt Joshi *(till 31-01-19)*
Kanti Ram Maithani
Naveen Chandra Arya
Pradip Chakarborty
Rajan Pradhan
Sanjay Kumar Singh
Uday Singh

Laboratory Assistant/Attendants (10)

Ashok
Basant Ballabh Bhatt
Harish Chandra Arya *(till 31-05-18)*
Laxman Singh Kanwal
Mohan Singh Rana
Rakesh Kumar
Ramdayal Bhatt
Shyam Giri
Shyam Lal
Suresh Chandra Arya

Post Doctoral Fellows/Research Associate (08)

Abhishek Paswan *(till 26-07-18)*
Arti Joshi *(from 06-08-18)*
Mridweeka Singh *(from 26-02-19)*
Mukesh Kr. Vyas *(from 01-10-18)*
Neha Sharma *(till 08-06-18)*
Sarvan Kumar *(till 20-06-18)*
Srabanti Ballav
Subhajeet Karmakar *(till 03-07-18)*

Research Scholars (40)

Abha Monga
Aditya Jaiswal
Akanksha Rajput
Amar Aryan
Alaxender Panchal
Amit Kumar
Anjasha Gangopadhyay
Ankur Ghosh
Arpan Ghosh
Arti Joshi *(till 05-08-2018)*
Ashwini Pandey
Bharti Arora
Dimple
Gaurav Singh
Jayanand Maurya
Jaydeep Singh
Krishan Chand
Kuldeep Singh
Mohan Singh *(till 01-11-2018)*
Mridweeka Singh *(till 25-02-19)*
Mahendra C. Rajwar
Mukesh K. Vyas *(till 30-09-18)*
Nikita Rawat
Pankaj Sanwal
Parveen Kumar
Prajjwal Singh Rawat
Priyanka Jalan
Priyanka Srivastava
Rajkishore Joshi
Rahul Gupta
Rakesh Pandey
Raya Dastidar
Sadhana Singh
Sapna Mishra
Shilpa Sarkar
Tirthendu Sinha
Vibhore Negi
Vineet Ojha
Vinit Dhiman
Vivek Kr. Jha

Visits by ARIES Members

International Visits

Dr. Alok C. Gupta	SHAO, Shanghai, China	21 Apr. – 20 May, 2018 29 Sept. – 13 Oct., 2018 03 Jan. – 02 Feb., 2019
	Hangzhou, China	08 – 11 May, 2018
	Guangzhou University, China	09 – 12 Oct., 2018
	University in Krakow, Poland	14 – 27 Oct., 2018
	CAMK, Warsaw, Poland	27 Oct. – 01 Nov., 2018
Ms. Sapna Mishra	IAP, Paris	22 June – 04 July, 2018
Dr. Yogesh Chandra Joshi	Royal Observatory Belgium, Brussels	08 – 14 Oct., 2018
Dr. Santosh Joshi	Royal Observatory Belgium, Brussels	08 – 18 Oct., 2018
Dr. Kuntal Misra	Univ. of California, Davis, California	01 Oct., 2018 – 31 Mar., 2019

National Visits

Dr. Brijesh Kumar	Delhi	01 May, 2018 23 Mar., 2019
	IIA, Bengaluru	11 Aug., 2018 04 Dec., 2018
	Christ Univ., Bengaluru	18 - 22 Mar., 2019
Dr. Indranil Chattopadhyay	Delhi Univ., Delhi	10 - 11 June, 2018 29 - 30 July, 2018
	SNBNCBS, Kolkata	14 - 17 Nov., 2018
	IACS, Kolkata	25 - 27 Feb., 2019
Dr. Alok C. Gupta	IUCAA, Pune	22 – 24 June, 2018
	TIFR, Mumbai	24 – 26 June, 2018
Dr. Kuntal Misra	IUCAA, Pune	06 – 09 Aug., 2018
Dr. Tarun Bangia	NCRA-TIFR, Pune	14 – 15 Sept., 2018
	Christ Uni., Bangaluru	19 - 21 Feb., 2019
Ms. Shilpa Sarkar	PRL, Ahmedabad	24 – 28 Sept., 2018

	SNBOSE, Kolkata	14-17 Nov., 2018
	SPP Univ., Pune	29-31 Jan., 2019
Dr. Sarvan Kumar	IIFM, Bhopal	24 – 28 Oct., 2018
Dr. Saurabh	IIST, Thiruvananthpura	03 – 07 Jan., 2019
		22 – 24 Mar., 2019
Dr. Yogesh C. Joshi	IIST, Thiruananthpuram	04 - 06 Jan., 2019
	IIA Bangaluru	07 - 09 Jan., 2019
		16 - 17 Feb., 2019
	Maulana Azad Uni. Hyderabad	21 - 24 Jan., 2019
	IUCAA, Pune	29 - 31 Jan., 2019
	Christ Uni., Bangaluru	16 - 17 Feb., 2019
Dr. Santosh Joshi	Delhi Univ., Delhi	30 Jan. – 10 Feb., 2019

Visitors at ARIES

From Abroad

Mr. Bikram Pradhan	Liegue Univ., Belgium	14 - 17 May, 2018 22 – 24 Mar., 2019
Dr. Arti Goyal	Jagiellonian Univ., Krakow, Poland	23 Sept. – 06 Oct., 2018
Prof. W. P. Chen	Taiwan	09 Sept. – 17 Oct., 2018
Prof. Katsuo Ogura	Japan	17 – 20 Nov., 2018
Dr. Pankaj Kushwaha	IAG-USP, SAO PAULO	19 – 29 Nov., 2018
Dr. Ravi Joshi	KIAA, China	22 – 23 Nov., 2018
Ms. Nibedita Kalita	NARIT, Thailand	02 – 07 Dec., 2018
Dr. Rahul Sharma	Spain	23 – 26 Dec., 2018
Mr. Adarsh Ranjan	IAP, Paris	24 – 26 Jan., 2019
Dr. Rajiv Kumar	China	08 Jan. – 07 Feb., 2019
Ms. Angel Priyana Noel	Jagiellonian Univ., Krakow, Poland	28 Feb. – 14 Mar., 2019
Prof. Jean Surdej	Liegue Univ., Belgium	22 – 24 Mar., 2019
Prof. Alain Lecavelier	IAP, Paris	24 – 31 Mar., 2019
Prof. E. Martin	France	24 – 27 Mar., 2019

From other Indian Institutions

Prof. S. Ananthakrishnan	Pune	05 – 08 Apr., 2018
Prof. S. N. Tondon	Pune	05 – 07 Apr., 2018
Dr. Shantikumar Singh	IIA, Bangalore	23 – 28 Apr., 2018
Dr. Vimla Singh	DRDO, Delhi	23 – 28 Apr., 2018
Dr. T. K. Mandal	NPL, New Delhi	06 – 07 May, 2018
Dr. N. K. Chakradhari	Pt. R S Univ., Raipur	05 – 17 May, 2018
Mr. Nandkishore More	BBA Central Univ., Lucknow	21 – 23 May, 2018
Mr. R. R. Shah	PRL, Ahmedabad	10 – 11 June, 2018

Mr. Vishal Joshi	PRL, Ahmedabad	10 – 11 June, 2018
Ms. Nilam Prasad	PRL, Ahmedabad	10 – 11 June, 2018
Mr. Kapil Kumar	PRL, Ahmedabad	10 – 11 June, 2018
Mr. S. K. Samin Kader	NARL, Tirupati	29 – 31 July, 2018
Prof. A. K. Patra	NARL, Tirupati	04 – 05 Sept., 2018
Prof. K. Krishnamoorthy	IISc, Bangalore	04 – 06 Sept., 2018
Prof. R. Krishnan	IITM, Pune	04 – 06 Sept., 2018
Prof. M. M. Sarin	PRL, Ahmedabad	04 – 06 Sept., 2018
Prof. G. B. Pant	IITM, Pune	04 – 08 Spet., 2018
Mr. Suresh Tiwari	IITM, Pune	23 – 24 Sept., 2018
Dr. Sarvan Kumar	IITM, Pune	20 – 22 Oct., 2018
Ms. Ekta Sharma	IIA, Bangalore	09 – 11 Nov., 2018
Dr. Brajesh Kumar	IIA, Bangalore	12 - 14 Nov., 2018 12 – 14 Mar., 2019
Dr. Manas Samal	PRL, Ahmedabad	25 Nov. – 02 Dec., 2018
Dr. Jessy Jose	IISER, Tirupati	26 – 27 Nov., 2018
Mr. Samrat Ghosh	SN Bose, Kolkata	10 – 11 Dec. 2018
Mr. Alik Panja	SN Bose, Kolkata	10 – 11 Dec. 2018
Dr. Suchita Srivastava	IIRS, Dehradun	27 – 28 Dec., 2018
Dr. Bhuwan Joshi	Udaipur Solar Observatory, Udaipur	25 – 29 Dec., 2018
Dr. Shilpa Pandey	BSIP, Lucknow	17 – 18 Jan., 2019
Prof. Mustafa Shah	Univ. of Kashmir, J&K	28 Feb. – 02 Mar., 2019
Prof. Ajeet Maurya	Doon Univ, Dehradun	15 – 17 Mar., 2019

Abbreviations

AC	Academic Committee
ADFOSC	ARIES Devasthal Faint Object Spectrograph & Camera
ADOT	Astronomer In-charge, Devasthal Optical Telescope
AFP	Axial Fixed Points
AGN	Active Galactic Nuclei
AGU	Auto Guider Unit
AIMPOL	ARIES Imaging Polarimeter
AMOS	Advanced Mechanical and Optical Systems
AOS	Active Optics System
ARISS	Adapter-Rotator Instrument Support Structure
ASTRAD	ARIES Stratosphere Troposphere Radar
ATSOA	ARIES Training School in Observational Astronomy
BC	Black Carbon
BSNL	Bharat Sanchar Nigam Limited
BSSs	Blue Straggler Stars
CAN	Controller Area Network
CCD	Charged Coupled Device
CCTV	Closed-Circuit Television
CMM	Co-ordinate Measuring Machine
CNC	Computerized Numerical Control
DFOT	Devasthal Fast Optical Telescope
DG	Diesel Generator
DHCP	Dynamic Host Configuration Protocol
DIMM	Differential Image Motion Monitor

DNS	Domain Name System
DOMC	Devasthal Operation and Maintenance Committee
DOT	Devasthal Optical Telescope
DSLAM	Digital Subscriber Line Access Multiplexer
DTAC	DOT Time Allotment Committee
EOT	Electric Overhead Traveling
ESD	Electrostatic Discharge
ETLSs	Elephant-Trunk-Like-Structure
FTP	File Transfer Protocol
GATE	Graduate Aptitude Test in Engineering
GMRT	Giant Metrewave Radio Telescope
GPS	Global Positioning System
GRB	Gamma Ray Burst
HBL	High-Energy Peaked
ICM	Intra-Cluster Medium
IGP	Indo-Gangetic Plains
IIA	Indian Institute of Astrophysics
IISF	India International Science Festival
IIT	Indian Institute of Technology
ILL	Internet Leased Line
ILMT	International Liquid Mirror Telescope
INOV	Intra-Night Optical Variability
JEST	Joint Entrance Screening Test
JRF	Junior Research Fellow
KRC	Knowledge Resource Centre

LAN	Local Area Network
LAT	Large Area Telescope
LCR	Inductance, Capacitance and Resistance
LMC	Large Magellanic Cloud
LSP	Lomb-Scargle Periodogram
MAX-DOAS	Multi-Axis Differential Optical Absorption Spectroscopy
MCLA	Mirror Cell Lifting Assembly
NET	National Eligibility Test
NGO	Non Governmental Organization
NIC	National Informatics Centre
MKIR	Mauna Kea Infrared
NKN	National Knowledge Network
NLSy1	Narrow-Line Seyfert 1
NuSTAR	Nuclear Spectroscopic Telescope Array
OACD	Operational Advisory Committee for Devasthal
OPAC	Online Public Access Catalogue
PLC	Programmable Logic Controller
PMs	Proper Motions
PMB	Project Management Board
PTP	Point to Point
QPO	Quasi-Periodic Oscillation
QSO	Quasi-Stellar Object
RF	Radio Frequency
RQWLQs	Radio-Quiet Weak emission Line Quasars
SAC	Scientific Advisory Committee

SCADA	Supervisory Control and Data Acquisition
SED	Spectral Energy Distribution
SN	Supernova
SRF	Senior Research Fellow
ST	Stratosphere Troposphere (Atmospheric Facility)
ST	Sampurnanand Telescope (Astronomical Facility)
STV	Short-Term Variability
TANSPEC	TIFR-ARIES Near Infrared Spectrometer
TCS	Telescope Control System
TIFR	Tata Institute of Fundamental Research
TIRCAM2	TIFR Near Infrared Imaging Camera – II
TMT	Thirty Meter Telescope
TRM	Transmitting and Receiving Module
UMAC	Universal Motion and Automation Controller
UPS	Uninterruptible Power Supply
UV	Ultraviolet
VHE	Very High-Energy
VLF	Very Low Frequency
VOC	Volatile Organic Compound
WAN	Wide Area Network
WFS	Wave Front Sensor
WG	Working Group
WWZ	Weighted Wavelet Z-transform
XMM	X-ray Multi-Mirror Mission
YSO	Young Stellar Object

Audit Statements of Account (2018-2019)

Audit Statements of Account (2018-2019)

MANOJ VATSAL & CO
CHARTERED ACCOUNTANTS

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 trusts or institutions

We have examined the balance sheet of **ARYABHATTA RESEARCH INSTITUTE OF OBSERVATIONAL SCIENCES AAAAA8701B** [name and PAN of the trust or institution] as at and the Profit and loss account for the year ended on that date which are in agreement with the books of account maintained by the said trust or institution

We have obtained all the information and explanations which to 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 Returns adequate for the purposes of audit have been received from branches not visited by us subject to the comments given below:

We conducted our audit in accordance with the auditing statndards generally accepted in India. The Audit includes examining on test basis ,evidence supporting the amounts and disclosure in Financial statement. We have obtained all information we have required for those accounts which were placed before us.

In our opinion and to the best of our information, and according to information given to us 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 31/03/2019

ii. in the case of the profit and loss account, of the profit or loss of its accounting year ending on 31/03/2019

The prescribed particulars are annexed hereto.

For MANOJ VATSAL & COMPANY
Chartered Accountants

Place :HALDWANI
Date : 30/09/2019
UDIN : 19025757AAAACK4456

MANOJ VATSAL & CO. M.No. 025757 DCC HALDWANI

MANOJ JOSHI
SR. PARTNER
Membership No: 025757
Registration No: 010155C

Hall 1D, II Floor Durga City Centre, Haldwani (263141) Uttarakhand
Land Line 05946-228558, Cell- 09837170647, E-mail: manojvatsalca@gmail.com
Office:- • HALDWANI • DEHRADUN • NEW DELHI • LUCKNOW

ANNEXURE
STATEMENT OF PARTICULARS
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.	**196385078**
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.	**No**
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.	**16840320**
4.	Amount of income eligible for exemption under section 11(1)(c) [Give details]	**No**
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)	**0**
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 thereof.	**NA**
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 section 11(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 thereto, or	**No**
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	**No**
c.	has not been utilised for purpose 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	**No**

II. Application or use of income or property for the benefit of persons referred to in section 13 [3].

1.	Whether any part of the income or property of the institution was 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 land, building or other 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 favour 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 Nc. and class of shares held	Nominal value of the investment	Income from the investment	Whether the amount in Col. 4 exceeded 5% of the capital of the concern during the previous year-say. Yes/No

For MANOJ VATSAL & COMPANY
Chartered Accountants

MANOJ JOSHI
SR. PARTNER
Membership No: 025757
Registration No: 010155C

Place :HALDWANI
Date : 30/09/2019
UDIN : 19025757AAAACK4456

MANOJ VATSAL & CO

CHARTERED ACCOUNTANTS

INDEPENDENT AUDITORS' REPORT

To
ARYABHATTA RESEARCH INSTITUTE OF OBSERVATIONAL SCIENCES
UNDER DEPARTMENT OF SCIENCE AND TECHNOLOGY
GOVERNMENT OF INDIA
MANORA PEAK
NAINITAL-263129,DISTT. NAINITAL
UTTARAKHAND

Report on the Financial Statements

We have audited the accompanying financial statements of **ARYABHATTA RESEARCH INSTITUTE OF OBSERVATIONAL SCIENCES,MANORA PEAK,NAINITAL,DISTT. NAINITAL-263129 UTTARAKHAND** which comprise the Balance Sheet as at 31st March 2019 and the Statement of Income & Expenditure for the period from 01.04.2018 To 31.03.2019, and receipts & Payment for the period.

Managements Responsibility for the Financial Statements

Management is responsible for the preparation of these financial statements. This responsibility includes the design, implementation and maintenance of internal control relevant to the preparation and presentation of the financial statements that are free from material misstatement, whether due to fraud or error. The Financial statements and records of accounts are to be maintained as per the guidelines of the Financial Rules 2017 and this is the responsibility of the Institute. The Financial statements must also comply with Accounting guidelines and Accounting Standards followed.

Auditor's Responsibility

Our responsibility is to express an opinion on these financial statements based on our audit. We conducted our audit in accordance with the standards on Auditing issued by the Institute of Chartered Accountants of India. Those Standards require that we comply with ethical requirements and plan and perform the audit to obtain reasonable assurance about whether the financial statements are free from material misstatement.

An audit involves performing procedures to obtain audit evidence about the amounts and disclosures in the financial statements. The procedures selected depend on the auditor's judgment, including the assessment of the risks of material misstatement of the financial statements, whether due to fraud or error. In making those risk assessments, the auditor considers internal control relevant to the Company's preparation and fair presentation of the financial statements in order to design audit procedures that are appropriate in the circumstances. An audit also includes evaluating the appropriateness of accounting policies used and the reasonableness of the accounting estimates made by Management, as well as evaluating the overall presentation of the financial statements.

We believe that the audit evidence we have obtained is sufficient and appropriate to provide a basis of our opinion, subject to the Matter of Emphasis and Management letter

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Land Line 05946-228558, Cell- 09837170647, E-mail: manojvatsalca@gmail.com
Office:- • HALDWANI • DEHRADUN • NEW DELHI • LUCKNOW

Opinion

In our opinion and to the best of our information and according to the explanations given to us, the aforesaid financial statements give the information, in the manner so required and give a true and fair view in conformity with the accounting principles generally accepted in India subject to the Matter of Emphasis and Management letter :

(i) In the case of the Balance Sheet, of the state of affairs of the autonomous society as at 31st March, 2019;

(ii) In the case of the of Income & Expenditure Account, of the Surplus for the year ended on that date.

Report on Other Legal and Regulatory Requirements

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 the Matter of Emphasis and Management letter

b) In our opinion, proper books of account as required by law have been kept by the Institution so far as it appears from our examination of those books, subject to the Matter of Emphasis and Management letter

c) The Balance Sheet and the Statement of Income & Expenditure dealt with by this Report are in agreement with the books of account, subject to the Matter of Emphasis and Management letter

d) In our opinion, the Balance Sheet and Statement of Income and Expenditure comply with the Accounting Standards and principles generally accepted in India, subject to the Matter of Emphasis and Management letter

FOR: MANOJ VATSAL & CO.
CHARTERED ACCOUNTANTS

PLACE: HALDWANI
DATED: 30.09.2019

MANOJ VATSAL & CO. M.N. 025757 D.C. HALDWANI

MANOJ JOSHI
FCA,DISA,DIRM
SR. PARTNER
M.No. 25757
Firm Regd. No. 010155C

Manoj Vatsal & Company
Chartered Accountants

UTILIZATION CERTIFICATE OF ARYABHATT RESEARCH INSTITUTE OF OBSERVATIONAL SCIENCES NAINITAL FOR THE FY 2018-19

Gross Receipt as per Income & Expenditure Account	Rs.	185,556,783.24	
Add:+ Capital Grant Receive	Rs.	29,078,081.94	
Add:+ Misc. Projects Grant Receive	Rs.	7,053,843.96	
Less: Intt. Receive (Projects Accounts)	Rs.	(1,409,467.00)	
Less: Misc. Projects Grant Transfer	Rs.	(7,053,843.96)	
Total Fund Receipts	**Rs.**	**213,225,398.18**	
Expenditure as per Income & Expenditure Account	Rs.	359,395,719.83	
Less: Depreciation	Rs.	(180,924,892.26)	
Less: Outstanding Expenses of During the Year F.y 2018-19	Rs.	(15,857,392.28)	
Less: Projects Expenses	Rs.	(7,053,843.96)	
Add: Capital Expenditure	Rs.	25,964,919.72	
Add: Capital WIP during the Year	Rs.	2,832,498.00	
Add: Outstanding Experses of Previous Year paid during the Year 2018-19	Rs.	12,028,069.00	
Total Fund Utilization	**Rs.**	**196,385,078.05**	**92.102%**
Amount of Income applied during the previous year	**Rs.**	**196,385,078.05**	**92.102%**
Amount of Income does not exceed 15%	**Rs.**	**16,840,320.13**	**7.898%**
Surplus over 15%	**Rs.**	**-**	**0.000%**

For Manoj Vatsal & Company
Chartered Accountants

Manoj Joshi
FCA, DISA, DIRM
Sr. Partner
Membership No: 025757

MANOJ VATSAL & CO. CA M.N. 025757 D.C.C. HALDWANI

Dated- 30.09.2019
Place- Haldwani

ARYABHATTA RESEARCH INSTITUTE OF OBSERVATIONAL SCIENCES, NAINITAL
CONSOLIDATED BALANCE SHEET AS AT 31st MARCH 2019

(Amount- Rs)

CAPITAL FUND AND LIABLITIES	Schedule	2018-19	2017-18
CAPITAL FUND	1	1,429,664,941.62	1,566,353,017.55
RESERVES AND SURPLUS	2	-	-
EARMARKED/ENDOWMENT FUNDS	3	107,581,313.06	143,236,942.74
SECURED LOANS AND BORROWINGS	4	-	-
UNSECURED LOANS AND BORROWINGS	5	-	-
DEFERRED CREDIT LIABLITIES	6	-	-
CURRENT LIABLITIES AND PROVISIONS	7	38,225,602.28	47,199,015.00
TOTAL		**1,575,471,856.96**	**1,756,788,975.29**
ASSETS			
FIXED ASSETS	8	1,313,424,884.70	1,462,986,310.01
INVESTMENTS- FROM EARMARKED/ENDOWMENT FUNDS	9	99,001,664.00	36,490,984.00
INVESTMENTS- OTHERS	10	18,564,224.00	9,176,482.00
CURRENT ASSETS, LOANS, ADVANCES ETC.	11	144,481,084.26	248,135,199.28
MISCELLANEOUS EXPENDITURE (to the extent not written off or adjusted)			
TOTAL		**1,575,471,856.96**	**1,756,788,975.29**
SIGNIFICANT ACCOUNTING POLICIES	24		
CONTINGENT LIABILITIES AND NOTES ON ACCOUNTS	25		

For Manoj Vatsal & Co.
Chartered Accountants
Firm Regn. No. 010155C

Manoj Joshi
Manoj Joshi
FCA,DISA,DIRM(ICAI)
SR. Partner
Membership No. 025757
Date:
Place:Nainital

Registrar ARIES

Registrar
ARIES, NAINITAL

Director ARIES

निदेशक / Director
आर्यभट्ट प्रेक्षण विज्ञान शोध संस्थान (एरीस
Aryabhatta Research Institute of Observational Sciences
मनोरा पीक, नैनीताल – 263 001
Manora Peak, Nainital-263 001

MANOJ VATSAL & CO. M.No. 025757 D.C.C., HALDWANI

ARYABHATTA RESEARCH INSTITUTE OF OBSERVATIONAL SCIENCES, NAINITAL
INCOME AND EXPENDITURE ACCOUNT FOR THE PERIOD/YEAR ENDED 31ST MARCH 2019

(Amount- Rs)

INCOME	Schedule	2018-19	2017-18
Income from Sales/Services	12	-	-
Grants/Subsidies	13	175,953,000.00	123,520,000.00
Fees/Subscription	14	-	-
Income from Investments (Income on Invest. From earmarked/endow. Funds transferred to Funds)	15	-	-
Income from Royalty, Publication etc.	16	-	-
Interest Earned	17	7,765,333.96	14,001,653.50
Other Income	18	1,838,449.28	1,308,318.00
Increase/(decrease) in stock of Finished goods and works-in-progress	19	(897,870.34)	256,107.26
TOTAL(A)		**184,658,912.90**	**139,086,078.76**
EXPENDITURE			
Establishment Expenses	20	111,184,089.30	113,961,367.00
Other Administrative Expenses etc.	21	67,286,738.27	57,158,620.95
Expenditure on Grants, Subsidies etc.	22	-	-
Interest	23	-	-
Depreciation (Net Total at the year-end- corresponding to Schedule 8)		180,924,892.26	209,246,634.98
TOTAL(B)		**359,395,719.83**	**380,366,622.93**
Balance being excess of Income over Expenditure (A-B)		(174,736,806.93)	(241,280,544.17)
Prior Period Expenses/Income		4,931,617.00	-
Transfer to Special Reserve (Specify each)		-	
Transfer to/ from General Reserve			
BALANCE BEING SURPLUS/(DEFICIT) CARRIED TO CORPUS/CAPITAL FUND		**(169,805,189.93)**	**(241,280,544.17)**
SIGNIFICANT ACCOUNTING POLICIES	24		
CONTINGENT LIABLITIES AND NOTES ON ACCOUNTS	25		

For Manoj Vatsal & Co.
Chartered Accountants
Firm Regn. No. 010155C

Manoj Joshi
FCA,DISA,DIRM(ICAI)
SR. Partner
Membership No. 025757
Date:
Place:Nainital

Registrar ARIES
Registrar
ARIES, NAINITAL

MANOJ VATSAL & CO. M.No. 025757 D.C.C., HALDWANI

Director ARIES

निदेशक / Director
आर्यभट्ट प्रेक्षण विज्ञान शोध संस्थान
Aryabhatta Research Institute of Observational S
मनोरा पीक, नैनीताल – 263
Manora Peak, Nainital-263 001

ARYABHATTA RESEARCH INSTITUTE OF OBSERVATIONAL SCIENCES NAINITAL
RECEIPT & PAYMENT ACCOUNT FOR YEAR ENDED 31ST MARCH 2019

(Amount- Rs)

RECEIPTS	2018-19		PAYMENTS	2018-19	
I.Opening balance		204,458,136.74	**I.Expenses**		
Cash in Hand	21,213.00		**a) Establishment Expenses**		115,307,477.20
Cash at Bank -SB Account	88,364,935.49		Salary and Allowance	87,493,876.30	
Cash at Bank -UBI Account	84,599,033.00		Interest to Provident Fund		
Amount in LC Account with SBI	3,876,641.00		Contribution to NPS	5,869,585.00	
Project Accounts	27,596,314.25		Medical Reimbursement	1,930,879.00	
			Tuition Fee Reimbursement	1,617,145.00	
II.Grant Received		213,515,543.00	Dispensary Expenses	445,015.00	
Central Government			Honorarium	415,964.00	
Salary	106,250,000.00		Leave Travel Concession	960,925.00	
General	69,703,000.00		Pension	5,515,614.90	
Capital	32,008,000.00		Fellowship	10,958,473.00	
Misc Project Grant-Central Gov.	5,554,543.00				
			b) Administrative Expenses		99,065,141.29
III.Income on Investment		4,488,928.00	Advertisement and Publicity	378,760.00	
a) Earmarked/Endow. Fund	2,935,792.00		ASI -2017		
b) Own Funds	1,553,136.00		Auditor's Remuneration	115,168.00	
			Bank Charges	141,868.49	
IV. Interest Received		4,365,643.96	Computer Accessories & Consumable	1,078,210.00	
			Consumable Expenses	3,376,443.04	
CSIR Travelling Reimbursement	82,945.00		Consultancy Fee	630,719.00	
Projects Bank Accounts	370,658.00		Registration	306,952.00	
			ASTRAD Annual License FEE	721,000.00	
Employee Loan Advances etc			Gardening Expenses	407,286.72	
HBA UT- I	10,020.00		Electricity	4,720,933.00	
HBA UT- I (Intt)	93,090.00		Fuel (POL)	2,231,983.48	
HBA Intt. (ARIES)	25,300.00		Water Charges	1,190,619.00	
OMCA Intt	12,171.00		ATSOA 2019	67,949.00	
Car Advance Intt.	26,000.00		Insurance Charges	335,383.00	
Computer Adv Intt. (ARIES)	25,989.00		Professional Fees	341,130.00	
Interest Received (Grant A/C)	2,245,762.00		Repairs and maintenance Instrument/AMC	1,264,698.00	
Interest On LC	1,473,706.96		Repairs and maintenance others	794,496.00	
			Repairs and maintenance Building	497,268.00	
V.Other Income		2,106,197.80	Vechicles Running and Maintenance	397,445.02	
Miscelleneous Income	1,175.80		JEST	37,470.00	
Electricity Receipts	300,949.76		Observational Facilities	357,870.50	
Guest House Rent A/c	400,260.00		Telephone and Communication Charges	272,394.00	
Hostel/Shop Rent	52,680.00		Postage	56,747.00	
House Licence Fee	394,057.00		Printing and Stationary	331,829.00	
RTI Receipt	874.00		Conveyance Expenses	2,967,484.00	
Telephone Receipts	1,222.00		Travelling Expenses	5,455,448.00	
Water Receipts	79,705.24		TA EXP(M/S Balmer Lawrie & co. ltd)	718,523.00	
Interest Received On Income Tax Refund	877,274.00		Expenses on Seminar/BINA/CNC Workshops	69,978.60	
			Canteen Expenses	2,731,192.00	
V.FDR Matured		70,349,763.00	Cleaning Work	2,497,929.23	
FDR Old Pension	10,349,763.00		Hospitality Expenses	64,510.00	
FDR Grant	60,000,000.00		Legal Charges	702,585.00	
			GPF Withdrawal -	7,994,302.00	
VII.Any Other Receipt		5,587,700.00	Hindi Program Expenses	24,000.00	
Astrosat Workshop			Security*	12,933,483.05	
Earnest Money Received	947,257.00		Sundry Expenditure	69,536.00	
Performance Security	1,021,465.00		Consumable & Maintnence 3.60 Mt. Telescope	922,551.50	
Running Security	24,065.00		Meeting of governing council/FC	26,070.00	
Advance Recovered Employee/Other	903,785.00		Meeting of Other Scientific Bodies	97,090.00	
Income tax Refund	2,691,128.00		Office Exp	2,868,659.70	
			Old Pension Fund Account -	30,864,591.00	
			NSF Expo - 2017	500,000.00	
			Training Expenses	448,742.00	
			Projects Expenses	7,053,843.96	

MANOJ VATSAL & CO. M.N. 025775 FRN

Registrar

			II. Investments and deposits made		137,800,000.00
			a) Out of Earmarked/Endowment funds	69,300,000.00	
			b) Out of Own Funds(Investment others)	60,000,000.00	
			c) FDR STRADAR Projects	6,000,000.00	
			d) FDR ISRO Projects	2,500,000.00	
			III. Expenditure on Fixed Assets & Capital Work in Progress		29,078,081.94
			a) Purchase of Fixed Assets	26,269,582.94	
			b) Capital WIP	2,808,499.00	
			IV. Other Payments		20,867,856.00
			GPF Advance/Withdrawal -	90,600.00	
			Prepaid Expenses	1,606,275.00	
			Custom Clearance Charges	105,101.00	
			Perfomance Security	1,431,016.00	
			Security With Electricity Department	148,529.00	
			Advances to Employees/Car/HBA/LTC/Etc	444,258.00	
			Sundry Advances	36,000.00	
			GLSI	24,507.00	
			Amount Return to DST	4,087.00	
			Running Security Deposit Paid	1,693,187.00	
			Misc Project Grant Expenses	6,800,180.00	
			EMD Paid	1,594,116.00	
			Deposit with Income Tax Department	6,800,000.00	
			V.Closing balance		102,755,356.07
			Cash in Hand	-	
			Cash at Bank -SB Account	81,940,836.80	
			Cash at Bank -UBI Account	2,015,220.02	
			Amount in LC Account with SBI	9,899,581.96	
			Project Accounts	8,899,717.29	
TOTAL		504,873,912.50	TOTAL		504,873,912.50

For Manoj Vatsal & Co.
Chartered Accountants
Firm Regn. No. 010155C

Manoj Joshi
FCA,DISA,DIRM(ICAI)
SR. Partner
Membership No. 025757
Date:
Place:Nainital

Registrar ARIES

Director ARIES

निदेशक / Director
आर्यभट्ट प्रेक्षण विज्ञान शोध संस्थान (एरीज)
Aryabhatta Research Institute of Observational Sciences (ARIES)
मनोरा पीक, नैनीताल – 263 001
Manora Peak, Nainital-263 001

MANOJ VATSAL & CO. M.NO. 025757 D.C.C., HALDWANI

ARYABHATTA RESEARCH INSTITUTE OF OBSERVATIONAL SCIENCES, NAINITAL
SCHEDULES FORMING PART OF BALANCE SHEET AS AT 31ST MARCH 2019

(Amount- Rs.)

SCHEDULE 1- CAPITAL FUND:	2018-19		2017-18	
Capital Fund Opening Balance*		1,833,037,636.79		1,717,892,906.71
Grant-Other Opening Projects		6,647,740.00		16,377,879.24
Unspent Grant:Opening balance		23,769,000.00		98,766,850.84
Total		1,863,454,376.79		1,833,037,636.79
Add: Capital Grant		29,078,081.94		23,769,000.00
Add Previous year unspent adjustment		19,026,048.56		
Add: Projects Grant (Unspent)				6,647,740.00
Less: Misc Project Grant spent		(7,053,843.96)		(10,302,699.00)
Total		1,904,504,663.33		1,853,151,677.79
Grant-Other Projects-Annexure		7,053,843.96		10,302,699.00
Grant Other				
Closing Balance CAPITAL ACCOUNT		1,881,141,767.29		1,863,454,376.79
Unspent Grant:Closing Balance		16,522,035.43		23,769,000.00
Unspent Grant Salary	(4,370,742.30)		7,991,038.00	
Unspent Grant General/Other	5,461,577.67		(23,148,554.00)	
Unspent Grant Capital	15,431,100.06		38,926,516.00	
Unspent Grant Projects		6,643,653.00		6,647,740.00
Add/(Deduct): Balance of net income/(expenditure) transferred from the Income and Expenditure Account				
As per last Account		(297,101,359.24)		(22,745,776.91)
Addition during the year		(169,805,189.93)		(241,280,544.17)
Excess Expense of Salary Transferred to Unspent		4,941,862.30		
Excess of General trf to Unspent		(13,791,028.23)		
Previous Year Provision Reversed		1,113,201.00		
Interest income on Revenue Returned to DST FY 2016-17		-		(13,739,368.44)
Endowment Surplus Transfer to Endowment Fund		-		(19,335,669.72)
BALANCE AS AT THE YEAR- END		1,429,664,941.62		1,566,353,017.55

SCHEDULE 2- RESERVES AND SURPLUS	2018-19		2017-18	
1. Capital Reserve:				
As per last Account				
Addition during the year				
Less: Deductions during the year				
2. Revaluation Reserve:				
As per last Account				
Addition during the year				
Less: Deductions during the year				
3. Special Reserves:				
As per last Account				
Addition during the year				
Less: Deductions during the year				
4. General Reserve:				
As per last Account				
Addition during the year				
Less: Deductions during the year				
TOTAL		-		-

MANOJ VATSAL & CO. M.No. 025757 D.C.C., HALDWANI

Registrar
ARIES, NAINITAL

ARYABHATTA RESEARCH INSTITUTE OF OBSERVATIONAL SCIENCES, NAINITAL

SCHEDULES FORMING PART OF BALANCE SHEET AS AT 31ST MARCH 2019

(Amount- Rs.)

SCHEDULE 3- EARMARKED/ENDOWNMENT FUNDS	FUND- WISE BREAK UP		TOTALS	
	Old Pension Fund	GPF Fund	2018-19	2017-18
a) Opening balance of the funds a)*	79,571,847.46	44,329,425.56	123,901,273.02	120,857,930.82
Reserve & Surplus			19,335,669.72	
b) Additions to the Funds:				
i. Donations/grants-Contribution(NPS)			-	4,271,614.00
ii. Income from Investments made in account of funds	-	-	-	5,741,794.00
iii. Other additions -SB Interest	-	-	-	764,676.00
iv. Interest Contribution	1,500,000.00	2,965,850.00	4,465,850.00	5,429,835.00
v. Employee Contribution/Received	-	8,387,325.00	8,387,325.00	31,789,913.20
v. Endowment Surplus			8,477,375.78	19,335,669.72
				68,333,501.92
Less: Retirement Benefits Paid		(14,514,177.00)	(14,514,177.00)	2,058,966.00
Less: GPF Withdrawal		(1,535,000.00)	(1,535,000.00)	5,987,482.00
Less: Pension	(36,835,400.90)		(36,835,400.90)	33,646,428.00
Less: Remitted to NPS			-	4,271,614.00
Less Members Interest Transferred to Reserve		(5,833,773.56)	(5,833,773.56)	
Add: GPF Advance Adjusted		313,775.00	313,775.00	
Add: Pension Payable	-		1,418,396.00	
b)	(35,335,400.90)	(10,216,000.56)	(35,655,629.68)	22,369,011.92
TOTAL (a+b)	44,236,446.56	34,113,425.00	107,581,313.06	143,236,942.74
c) Utilisation/Expenditure towards objectives of funds				
i. Capital Expenditure				
- Fixed Assets				
- Others				
TOTAL				
ii. Revenue Expenditure				
- Salaries, Wages and allowances etc.				
- Rent				
- Other Administrative expenses				
TOTAL				
TOTAL (c)	-	-	-	-
NET BALANCE AS AT THE YEAR- END (a + b - c)				

MANOJ VATSAL & CO. D.C.C., HALDWANI M.No. 423757

Registrar
ARIES, NAINITAL

ARYABHATTA RESEARCH INSTITUTE OF OBSERVATIONAL SCIENCES, NAINITAL
SCHEDULES FORMING PART OF BALANCE SHEET AS AT 31ST MARCH 2019

(Amount- Rs.)

SCHEDULE 4- SECURED LOANS AND BORROWINGS	2018-19		2017-18	
1. Central Government	-	-	-	-
2. State Government(Specify)	-	-	-	-
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		-		-
Note: Amounts due within one year				

MANOJ VATSAL & CO. M.N. 025158 D.C.C., HALDWANI

ARIES, NAINITAL

ARYABHATTA RESEARCH INSTITUTE OF OBSERVATIONAL SCIENCES, NAINITAL
SCHEDULES FORMING PART OF BALANCE SHEET AS AT 31ST MARCH 2019

(Amount- Rs.)

	2018-19		2017-18	
SCHEDULE 7- CURRENT LIABILITIES AND PROVISIONS				
A. OTHER CURRENT LIABILITIES				
Security and earnest deposits	178,151.00		4,903,151.00	
Retention and Performance security deposits	3,084,864.00		6,883,625.00	
DDO DST	76,163.00		76,163.00	
Earnest Money A/c	2,051,674.00		2,794,415.00	
Canteen Security	2,000.00	5,392,852.00	2,000.00	14,679,354.00
JIC PAR Research Project		-		52,650.00
Money received on account of other projects		19,451,116.00		20,840,342.00
Faulad Construction		20,000.00		20,000.00
Sundry Creditors		4,541,991.00		1,682,616.00
INDO-UK Seminar (DST)		(28,000.00)		(28,000.00)
Leave Encashment Payable		14,946.00		14,946.00
Astrisat Workshop Aries-IUCAA		8,286.00		8,286.00
GIS Payable		33,834.00		36,606.00
TDS Payable		931,146.28		275,659.00
GST Reverse Charege Payable		317,070.00		-
Service- Tax (F.Y. 2015-16)		3,410.00		3,410.00
Adv. For Scientific Meeting		113,000.00		-
OUTSTANDING EXPENSES & CONTRIBUTIONS*				
NPS Payable		1,121,478.00		572,703.00
Outstanding Expenses		570,626.00		100,628.00
Salary & Allowance Payable		4,829,395.00		8,109,169.00
Fellowship & Scholarship Payable		904,452.00		830,646.00
**Statutory Dues from Contractors are to be recovered				
TOTAL (A)		38,225,602.28		47,199,015.00
B. PROVISIONS#				
1.For Taxation		NIL		NIL
2.Gratuity***				
3.Superannuation GPF Intt Contribution		-		-
4.Accumulated Leave Encashment		-		-
5.Trade Warranties/Claims		NIL		NIL
6. GPF Payable		-		-
7.Pension Contibution		-		
TOTAL (B)		-		-
TOTAL (A+B)		38,225,602.28		47,199,015.00

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ARYABHATTA RESEARCH INSTITUTE OF OBSERVATIONAL SCIENCES, NAINITAL
SCHEDULES FORMING PART OF BALANCE SHEET AS AT 31ST MARCH 2019

(Amount- Rs.)

SCHEDULE 5- UNSECURED LOANS AND BORROWINGS	2018-19	2017-18
1. Central Government	-	-
2. State Government	-	-
3. Financial Institutions	-	-
4. Banks:	-	-
a) Term Loans	-	-
b) Other Loans	-	-
5. Other Institutions and Agencies	-	-
6. Debentures and Bonds	-	-
7. Fixed Deposits	-	-
8. Others	-	-
TOTAL	-	-
Note: Amounts due within one year		

SCHEDULE 6- DEFERRED CREDIT LIABILITIES:	2018-19	2017-18
a) Acceptances secured by hypothecation of capital equipment and other assets	-	-
b) Others		
TOTAL	-	-
Note: Amounts due within one year.		

MANOJ VATSAL & CO. D.C.C., HALDWANI

FORM OF FINANCIAL STATEMENTS (NON- PROFIT ORGANISATIONS)
ARYABHATTA RESEARCH INSTITUTE OF OBSERVATIONAL SCIENCES, NAINITAL
SCHEDULES FORMING PART OF BALANCE SHEET AS AT 31ST MARCH 2019

(Amount-Rs)

SCHEDULES 8- FIXED ASSETS DESCRIPTION	GROSS BLOCK					DEPRECIATION					NET BLOCK		% age
	Cost/valuation As as on 01.04.2018	Additions upto 03.10.2018	Additions after 03.10.2018	Deductions during the year	Cost/valuation As on 31.03.2019	As on 01.04.2018	Additions upto 03.10.2018	Additions after 03.10.2018	Other than addition during 2018-19	Total Dep. up to 31.03.2019	As on 31.03.2019	As on 31.03.2018	
A. FIXED ASSETS:													
1. LAND	105,850,429.00	-	-	-	105,850,429.00	-	-	-	-	-	105,850,429.00	105,850,429.00	
2. BUILDINGS:													
(i) Residential Manora- Peak	30,719,204.60	-	-	-	30,719,204.60	7,628,834.84	-	-	1,154,518.49	8,783,353.33	21,935,851.27	23,090,369.76	5.00%
(ii) Non Residential- Manora Peak	107,627,691.00	-	-	-	107,627,691.00	64,980,802.59	-	-	4,264,688.84	69,245,491.43	38,382,199.57	42,646,888.41	10.00%
(iii) Residential- Devsthal (Guest House)	1,224,022.00	-	-	-	1,224,022.00	499,567.63	-	-	36,222.72	535,790.35	688,231.65	724,454.37	5.00%
(iv) Non Residential- Devsthal	8,801,426.00				8,801,426.00	5,077,958.92	-	-	372,346.71	5,450,305.63	3,351,120.37	3,723,467.08	10.00%
(v) Building 3.60mir Telescope	34,406,873.00	-	21,506.00	-	34,428,379.00	9,547,907.26	-	1,075.30	2,485,896.57	12,034,879.13	22,393,499.87	24,858,965.74	10.00%
3. Infrastructure Dev. (Manora Peak)	15,846,082.70	224,864.00	-	-	16,070,946.70	6,610,257.69	22,486.40	-	923,582.50	7,556,326.59	8,514,620.10	9,235,825.01	10.00%
4. Infrastructure Dev. (Devsthal)	50,072,786.90	-	-	-	50,072,786.90	16,007,645.11	-	-	3,406,514.18	19,414,159.29	30,658,627.61	34,065,141.79	10.00%
5. Road at Devsthal	22,849,164.00	-	-	-	22,849,164.00	11,995,537.43	-	-	1,085,362.66	13,080,900.08	9,768,263.91	10,853,626.57	10.00%
6. Furniture & Fixture	9,715,841.70	2,800.00	24,995.00	-	9,743,636.70	5,242,320.64	280.00	1,249.75	447,352.11	5,691,202.50	4,052,434.20	4,473,521.06	10.00%
7. Office Equipment	1,729,983.25	-	-	-	1,729,983.25	1,136,473.48	-	-	59,350.98	1,195,824.46	534,158.79	593,509.77	10.00%
8. Instruments & Equipments:-													
(i) Telescope	7,454,695.55	-	-	-	7,454,695.55	2,657,313.53	-	-	719,607.30	3,376,920.83	4,077,774.72	4,797,382.02	15.00%
(ii) Telescope (Solar)	1,367,166.00	-	-	-	1,367,166.00	1,083,571.82	-	-	42,539.13	1,126,110.94	241,055.05	283,594.18	15.00%
(iii) 1.3 Mt Telescope	92,206,878.00	45,371.00	-	-	92,252,249.00	53,523,201.32	6,805.65	-	5,802,551.50	59,332,558.47	32,919,690.53	38,683,676.68	15.00%
(iv) 3.60 Mtr Telescope	1,239,739,652.00	2,056,713.00	4,600,555.00		1,246,396,920.00	341,835,651.11	308,506.95	345,041.63	134,685,600.13	477,174,799.82	769,222,120.18	897,904,000.89	15.00%
(v) Alumunising Plant (Devsthal)	39,523,736.00	-	-	-	39,523,736.00	10,967,836.74	-	-	4,283,384.89	15,251,221.63	24,272,514.37	28,555,899.26	15.00%
(vi) Public Outreach Telescope	607,295.00	-	-	-	607,295.00	412,510.04	-	-	29,202.74	441,812.79	165,482.22	194,684.96	15.00%
(vii) Schmict Telescope	10,738,623.00	-	-	-	10,738,623.00	8,210,540.77	-	-	379,212.33	8,589,753.11	2,148,869.90	2,528,082.23	15.00%
(viii) Electronic Section	9,055,749.55	5,700.00	-	-	9,061,449.55	7,612,754.55	855.00	-	216,449.25	7,830,058.80	1,231,390.75	1,442,995.00	15.00%
(ix) Work Shop	273,027.45	-	-	-	273,027.45	229,521.58	-	-	6,525.88	236,047.46	36,979.99	43,505.87	15.00%
(x) Aluminising Anodising	103,357.45	-	-	-	103,357.45	86,888.29	-	-	2,470.37	89,358.67	13,998.79	16,469.16	15.00%
(xi) Optics	27,240.80	-	427,357.00	-	454,597.80	22,899.88	-	32,051.78	651.14	55,602.80	398,995.01	4,340.92	15.00%
(xii) Instruments	168,625,443.67	-	-	-	168,625,443.67	64,392,799.15	-	-	6,634,896.68	71,027,695.83	37,597,747.84	44,232,644.52	15.00%
(xiii) Modernisation of Instruments	68,083,031.00	99,710.00	-	-	68,182,741.00	33,838,559.54	14,956.50	-	5,136,670.72	38,990,186.76	29,192,554.24	34,244,471.46	15.00%
(xiv) LIDAR	8,760,465.00	-	-	-	8,760,465.00	6,476,545.59	-	-	342,587.91	6,819,133.50	1,941,331.50	2,283,919.41	15.00%
(xv) ADFOSC (Backend instrument)	3,557,575.00	63,626.00	-	-	3,621,201.00	2,098,458.16	9,543.90	-	216,667.53	2,326,669.59	1,294,331.41	1,459,116.84	15.00%
(xvi) Solar Section	8,227.00	-	-	-	8,227.00	6,054.99	-	-	325.80	6,380.79	1,846.21	2,172.01	15.00%
(xvii) Projector (Public Outreach)	105,080.00	-	-	-	105,080.00	68,369.35	-	-	5,494.60	73,863.95	31,136.05	36,630.65	15.00%
(xviii) Planetarium (Public Outreach)	3,918,714.00	-	-	-	3,918,714.00	2,179,959.78	-	-	260,813.13	2,440,772.92	1,477,941.09	1,738,754.22	15.00%
(xix) Library Instruments	9,500.00	-	-	-	9,500.00	2,536.25	-	-	1,029.56	3,565.81	5,934.19	6,963.75	15.00%
(xx) CCTV Cameras	77,560.00	-	-	-	77,500.00	16,565.53	-	-	9,140.16	25,705.78	51,794.22	60,934.38	15.00%
(xxi) Spectrometer	1,062,951.00	-	-	-	1,062,951.00	227,205.78	-	-	125,361.78	352,567.56	710,383.44	835,745.22	15.00%
9. Vehicles	2,469,250.10	1,834,466.00	-	-	4,303,716.10	1,970,705.43	275,169.90	-	74,781.70	2,320,657.03	1,983,059.07	498,544.67	15.00%
10. Electric Installation (Manora Peak)	9,719,238.00	1,704,777.72	3,559,894.00	-	14,983,909.72	3,119,582.97	255,716.66	266,992.05	986,948.25	4,632,239.93	10,351,669.79	6,599,655.03	15.00%
11. Electric Installation (Devsthal)	2,922,165.00	-	1,313,500.00	-	4,235,665.00		-	98,512.50	110,600.04	2,393,943.94	1,841,721.06	737,333.60	15.00%

12. Computer	39,828,902.40	3,859,959.00	1,558,178.00		45,247,039.40	36,534,145.29	1,543,983.60	311,635.60	1,317,902.84	39,707,667.33	5,539,371.29	3,294,757.11	40.00%
13. Computer Software	1,405,432.00	-	297,362.00		1,702,794.00	1,400,103.07	-	59,472.40	2,131.57	1,461,707.04	241,086.95	5,328.93	40.00%
14. Library Books	51,681,798.50	690,521.00	3,570,065.00		55,945,384.50	49,320,417.00	277,408.40	714,013.00	744,552.60	51,556,391.00	4,388,993.50	1,861,381.50	40.00%
TOTAL OF CURRENT YEAR	2,092,176,117.62	10,591,507.72	15,373,412.00	-	2,118,141,037.34	759,707,034.51	2,715,712.96	1,830,844.90	176,379,135.30	940,631,926.87	1,177,509,109.70	1,332,469,083.01	
PREVIOUS YEAR											1,332,469,083.01	1,495,455,164.99	
B. CAPITAL WORK-IN PROGRSS											133,152,809.00	130,320,311.00	
C. PROJECT ASSETS*											2,762,966.00	196,916.00	
TOTAL											1,313,424,884.70	1,462,986,310.01	
(Note to be given as to cost of assets on hire purchase basis included above)													

FORM OF FINANCIAL STATEMENTS (NON- PROFIT ORGANISATIONS)
ARYABHATTA RESEARCH INSTITUTE OF OBSERVATIONAL SCIENCES, NAINITAL
Schedule 8A : Fixed Assets work in progress as on 31.03.2019

Sl.	Description of Assets	Opening balance on April 1, 2018	Addition during year	Assets completed	Balance as on March 31, 2019
1	4.00 Mt International Liquid Mirror Telescope	25,134,100.00	335,805.00	-	25,469,905.00
2	Medium Resolution NIR Spectrograph	80,456,894.00	-	-	80,456,894.00
3	TMT/GSMT	4,063,085.00	-	-	4,063,085.00
4	CWIP-Construction Work - (CPWD)	15,245,000.00	1,380,700.00	-	16,625,700.00
5	WG-02 (ASTRAD)	5,421,232.00	691,193.00	-	6,112,425.00
6	CWIP Building (Non residential Manora Peak)	-	424,800.00	-	424,800.00
	TOTAL	130,320,311.00	2,832,498.00	-	133,152,809.00

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ARYABHATTA RESEARCH INSTITUTE OF OBSERVATIONAL SCIENCES, NAINITAL
SCHEDULES FORMING PART OF BALANCE SHEET AS AT 31ST MARCH 2019

(Amount-Rs)

SCHEDULE 9- INVESTMENTS FROM EARMARKED/ENDOWMENT FUNDS	2018-19	2017-18
Investment in FDR's in Scheduled Banks (GPF A/c)*	27,404,990.00	35,000,000.00
Interest accrued on SBI FDR's (GPF A/c)*	177,361.00	1,490,984.00
Investment in UBI FDR's (Old Pension)*	69,300,000.00	-
Interest accrued on UBI FDR's (GPF A/c)*	2,119,313.00	-
TOTAL	99,001,664.00	36,490,984.00

SCHEDULES 10- INVESTMENTS- OTHERS	2018-19	2017-18
FDR-ISRO Project	11,856,024.00	8,500,000.00
Interest accrued on FDR's (ISRO Project)	430,064.00	676,482.00
FDR-STRADAR Project	6,153,606.00	-
Interest accrued on FDR's (ST RADAR Project)	124,530.00	-
TOTAL	18,564,224.00	9,176,482.00

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ARYABHATTA RESEARCH INSTITUTE OF OBSERVATIONAL SCIENCES, NAINITAL
SCHEDULES FORMING PART OF BALANCE SHEET AS AT 31ST MARCH 2019

(Amount-Rs)

SCHEDULE 11- CURRENT ASSETS, LOANS, ADVANCES ETC	2018-19		2017-18	
A. CURRENT ASSETS:				
1. Inventories:				
a) Stores and Spares	2,738,999.53		3,016,419.30	
b) Stationery Stock	551,216.96		551,422.39	
c) Computer Accessories Stock	1,942,752.47		2,704,875.01	
d) Fuel (POL)	152,280.00	5,385,248.96	10,402.60	6,283,119.30
2. Sundry Debtors:				
a) Debts Outstanding for a period exceeding six months		-		-
b) Others		-		-
3. Cash balances in hand (including cheques/drafts and imprest)		-		21,213.00
4. Bank Balances:				
a) With Scheduled Banks:				
-On Deposit Accounts -LC (includes margin money)	9,899,581.96		3,876,641.00	
-On Savings Accounts(As per Annexure I)*	83,956,056.82	93,855,638.78	172,963,968.49	176,840,609.49
b) With Scheduled Banks Project Wise				
-On Current Accounts		-		-
-On Deposit Accounts		-		-
-On Savings Accounts (Project Bank A/c)	8,899,717.29	8,899,717.29	27,596,314.25	27,596,314.25
5. Post Office- Savings Accounts		-		-
TOTAL (A)		108,140,605.03		210,741,256.04

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ARYABHATTA RESEARCH INSTITUTE OF OBSERVATIONAL SCIENCES, NAINITAL
SCHEDULES FORMING PART OF BALANCE SHEET AS AT 31ST MARCH 2019

(Amount-Rs)

SCHEDULE 11- CURRENT ASSETS, LOANS, ADVANCES ETC.	2018-19		2017-18	
B. LOANS, ADVANCES AND OTHER ASSETS				
1. Loans: (As per Annexure- 3)				
a) Staff	4,905,773.00		5,252,725.00	
b) Other Entities engaged in activities/objectives similar to that of the Entity				
c) Others	17,246,487.06	22,152,260.06	20,726,996.06	25,979,721.06
be received: (As per Annexure- 3)				
a) On Capital Account				
Advance for Capital items- fixed assets	1,169,294.00		1,115,294.00	
b) Prepayments	2,043,667.17		2,419,205.17	
c) Others	10,975,258.00	14,188,219.17	7,879,723.00	11,414,222.17
3. Income Accrued:				
a) On Investments from Earmarked/Endowment Funds				
b) On Investments - Others				
c) On Loans and Advances				
d) Others				
(includes income due unrealised- Rs.....)				
4. Claims Receivable		-		-
TOTAL (B)		36,340,479.23		37,393,943.23
TOTAL (A + B)		144,481,084.26		248,135,199.28

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ARYABHATTA RESEARCH INSTITUTE OF OBSERVATIONAL SCIENCES, NAINITAL

SCHEDULES FORMING PART OF BALANCE SHEET AS AT 31ST MARCH 2019

(Amount- Rs.)

	2018-19	2017-18
SCHEDULE 12- INCOME FROM SALES/SERVICES		
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 Services (Equipment/Property)	-	-
e) Others	-	-
TOTAL	-	-

	2018-19	2017-18
SCHEDULE 13- GRANTS/SUBSIDIES		
(Irrevocable Grants & Subsidies Received)		
1) Central Government	175,953,000.00	123,520,000.00
2) State Government(S)		
3) Government Agencies		
4) Institutions/Welfare Bodies		
5) International Organisations		
6) Others		
TOTAL	175,953,000.00	123,520,000.00

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ARYABHATTA RESEARCH INSTITUTE OF OBSERVATIONAL SCIENCES, NAINITAL

SCHEDULES FORMING PART OF BALANCE SHEET AS AT 31ST MARCH 2019

(Amount- Rs.)

SCHEDULE 14- FEES/SUBSCRIPTIONS	2018-19	2017-18
1) Entrance Fees		
2) Annual Fees/Subscriptions		
3) Seminar/Program Fees		
4) Consultancy Fees		
5) Others		
TOTAL	-	-
Note- Accounting Policies towards each item are to be disclosed		

	Investment from Earmarked Fund		Investment- Others	
SCHEDULE 15- INCOME FROM INVESTMENTS	2018-19	2017-18	2018-19	2017-18
1) Interest:				
a) On Govt. Securities				
b) Other Bonds/ Debentures				
c) FDR				
2) Dividends:				
a) On Shares				
b) On Mutual Fund Securities				
3) Rents				
4) Saving Bank Interest				
5) Others				
TOTAL				
TRANSFERRED TO EARMARKED/ENDOWMENT FUNDS				

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ARYABHATTA RESEARCH INSTITUTE OF OBSERVATIONAL SCIENCES, NAINITAL
SCHEDULES FORMING PART OF BALANCE SHEET AS AT 31ST MARCH 2019

(Amount- Rs.)

	2018-19	2017-18
SCHEDULE 16- INCOME FROM ROYALTY, PUBLICATION ETC.		
1) Income from Royalty	-	-
2) Income from Publications	-	-
3) Others	-	-
TOTAL	-	-

	2018-19	2017-18
SCHEDULE 17- INTEREST EARNED		
1) On Term Deposits:		
a) With Scheduled Banks	1,553,136.00	2,394,486.00
b) With Non- Scheduled Banks	-	-
c) With Institutions	-	-
d) Others		-
2) On Savings Accounts:		
a) With Scheduled Banks	2,245,762.00	5,418,301.00
b) With Non- Scheduled Banks	-	-
c) Post Office Savings Accounts	-	-
d) Others	-	-
3) Loans:	-	-
a) Employees/Staff		
HBA UT- I	10,020.00	57,170.00
HBA UT- II (Intt)	27,600.00	-
HBA UT- I (Intt)	96,850.00	152,100.00
OMCA , Intt	15,171.00	8,420.00
Car Advance Intt.	29,000.00	13,656.00
Computer Adv Intt. (ARIES)	27,345.00	15,764.00
b) Others Interest (LC)	1,473,708.96	-
Interest on Projects Accounts	370,658.00	5,222,107.50
Interest on Projects FDR	1,038,809.00	702,303.00
Interest on Income Tax Refund	877,274.00	17,346.00
4) Interest on Debtors and Other Receivables:	-	-
TOTAL	**7,765,333.96**	**14,001,653.50**
Note- Tax deducted at source to be indicated*		149,102.00

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ARYABHATTA RESEARCH INSTITUTE OF OBSERVATIONAL SCIENCES, NAINITAL

SCHEDULES FORMING PART OF BALANCE SHEET AS AT 31ST MARCH 2019

(Amount- Rs.)

	2018-19	2017-18
SCHEDULE 18- OTHER INCOME		
Miscelleneous Income	2,279.80	2,400.00
CSIR Travelling Reimbursement	82,945.00	-
Dispencary Receipts	-	330.00
Electricity Receipts	346,108.24	354,481.00
EMD/Security Forfieted	25,682.00	-
Guest House Rent A/c	414,060.00	348,135.00
Hostel/Shop Rent	52,680.00	86,233.00
House Licence Fee	429,352.00	440,663.00
RTI Receipt	874.00	1,464.00
Telephone Receipts	1,247.00	5,659.00
Tender Fee A/c	-	7,000.00
Water Receipts	86,805.24	61,953.00
IIFM Bhopal	396,216.00	-
TOTAL	**1,838,449.28**	**1,308,318.00**

	2018-19	2017-18
GOODS &		
a) Closing Stock		
Finished Goods	5,385,248.96	6,283,119.30
b) Less: Opening Stock		
Finished Goods	6,283,119.30	6,027,012.04
NET INCREASE/(DECREASE) [a-b]	**(897,870.34)**	**256,107.26**

	2018-19	2017-18
SCHEDULE 20- ESTABLISHMENT EXPENSES		
Salaries and Allowances	86,978,760.30	90,796,401.00
Contribution to Provident Fund	-	2,719,351.00
Contribution to NPS	6,296,500.00	4,271,614.00
Contribution to Old Pension Fund	1,500,000.00	-
Medical Reimbursement	1,930,879.00	3,062,498.00
Tuition Fee Reimbursement	1,617,145.00	1,165,494.00
Dispensary Expenses	445,015.00	253,696.00
Leveries Expenses	-	20,160.00
Honorarium	415,964.00	351,800.00
Leave Travel Concession	967,547.00	1,180,250.00
Scholorship	-	157,200.00
Fellowship	11,032,279.00	9,982,903.00
TOTAL	**111,184,089.30**	**113,961,367.00**

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ARYABHATTA RESEARCH INSTITUTE OF OBSERVATIONAL SCIENCES, NAINITAL

SCHEDULES FORMING PART OF BALANCE SHEET AS AT 31ST MARCH 2019

(Amount- Rs.)

	2018-19	2017-18
SCHEDULE 21- OTHER ADMINISTRATIVE EXPENSES ETC.		
Advertisement and Publicity	384,349.00	264,949.00
ATSOA	67,949.00	47,000.00
Auditor's Remuneration	115,168.00	115,168.00
Bank Charges	141,215.71	39,586.57
Computer Accessories & Consumable	1,160,743.00	942,826.00
Consumable Expeses	3,057,352.04	1,915,993.00
Customs clearance charges	105,101.00	-
Registration/Licence Fee	1,028,492.00	188,424.00
Gardening Expenses	328,938.00	90,079.00
Electricity Expenses	5,055,436.00	5,912,534.00
Fuel (POL)	2,277,983.48	1,467,025.00
Water Expenses	1,203,219.00	514,400.00
Insurance Expenses	335,383.00	37,656.00
Repairs and maintenance/ Instrument/AMC	1,450,419.00	2,774,247.00
Repairs and maintenance others	2,504,749.00	2,080,337.00
Repairs and maintenance Building	549,534.00	4,228,886.00
Vechicles Running and Maintenance	400,168.02	131,063.00
JEST	62,470.00	57,667.00
Observational Facilities	375,219.50	710,160.00
Telephone and Communication Expenses	269,483.00	426,015.00
Postage & Courier Expenses	76,747.00	27,795.00
Printing and Staticnary Expenses	331,829.00	584,101.00
Conveyance Expenses	3,063,932.00	4,034,163.00
Travelling Expenses	5,998,036.00	2,020,848.00
TA EXP(M/S Balmer Lawrie & co. ltd)	718,523.00	891,283.00
Expenses on Seminar/BINA/CNC Workshops	454,584.60	173,609.00
Canteen Expenses	2,893,553.00	1,742,469.00
Cleaning Work Expenses	2,904,969.23	1,796,754.13
Hospitality Expenses	64,510.00	22,510.00
Legal Expenses	703,755.00	129,750.00
Professional Expenses	341,130.00	-
Public Outreach Program -Exhibition	-	259,394.00
Security Expenses*	18,217,873.05	14,868,581.00
Consultancy fees	260,273.00	-
Sundry Expenditure	122,715.00	44,336.00
Consumable & Maintnence 3.60 Mt. Telescope	1,484,263.50	1,186,003.00
Meeting of governing council	123,160.00	661,453.00
Meeting of Other Scientific Bodies	666,039.00	2,517,180.00
Office Exp	195,214.18	328,776.00
Financial Support to IAU Symposium	-	200,000.00
IISF Expo - 2017	500,000.00	350,000.00
Training expenses	238,416.00	
Projects Expenses	7,053,843.96	3,375,600.25
TOTAL	67,286,738.27	57,158,620.95

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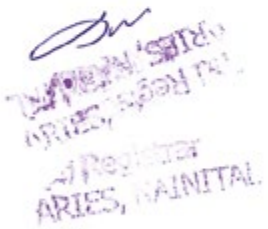
ARYABHATTA RESEARCH INSTITUTE OF OBSERVATIONAL SCIENCES, NAINITAL

SCHEDULES FORMING PART OF BALANCE SHEET AS AT 31ST MARCH 2019

(Amount- Rs.)

	2018-19	2017-18
SCHEDULE 22- EXPENDITURE ON GRANTS, SUBSIDIES ETC.		
a) Grants given to Institution/Organisations	-	-
b) Subsidies given to Institution/Organisations	-	-
TOTAL	-	-
disclosed.		

	2018-19	2017-18
SCHEDULE 23- INTEREST		
a) On Fixed Loans	-	-
b) On Other Loans (including Bank Charges)	-	-
c) Others	-	-
TOTAL	-	-



BANK BALANCES

ANNEXURE- I

PARTICULARS	2018-19	2017-18
LC No: 2016-02*	56,076.00	2,464,502.00
LC No:2016-04	1,412,139.00	1,412,139.00
LC No. 2019-0019 (MACCON)	8,197,500.00	-
Interest Accrued on LC (MACCON)	233,866.96	-
	9,899,581.96	**3,876,641.00**
Bank Balances with scheduled Banks		
On Savings Accounts		
(i) Director Account- SBI, Nainital- 10860840253	76,874,712.76	66,762,711.75
(ii) GPF Account - SBI, Nainital- 10860840300	5,029,518.30	2,219,529.00
(iii) Pension Account (Old)- SBI, Nainital- 10860840311	36,605.74	19,382,694.74
(iv) Union Bank of India, Nainital- 535	2,015,220.02	84,599,033.00
	83,956,056.82	**172,963,968.49**
Project Bank A/c		
INT/RUS/RFBR/p-167	-	4,787.00
Vikram Sarabhai Center	-	2,952,072.00
SB A/c 34024763826 SBI	177,234.00	226,943.00
Department of Space	-	20,560.00
PDF/2015/000691	-	1,394,768.00
SERB	-	2,522,780.00
SB A/c 30310168038	223,436.50	3,323,361.50
SB A/c 36065850402 -BINA	6,936.54	1,373.00
S.B.I. SB - 30192927780	295,637.50	630,370.00
S.B.I. S/B 30318931302	3,426,121.50	2,679,947.50
S.B.I. SB - 31286509555	250,250.50	241,680.50
S.B.I. S/B - 35326480158	-	366,038.00
S B I SB - 35326481538	-	625,274.00
S.B.I SB - 36065850242	-	458,601.00
S.B.I. S/B - 37039717963	295,216.50	2,575,525.50
S.B.I. S/B - 37054985887	170,763.75	338,057.75
S.B.I SB - 37265312732	301,150.00	499,714.00
S B I SB - 312845	421,003.50	406,584.50
S B I SB - 37598108567	665,540.50	1,447,200.00
ST Radar S.B.I A/C 30357703902	937,062.00	6,880,677.00
SBI A/c 38098687622	499,805.50	
SBI A/c 38098705686	1,229,559.00	
	8,899,717.29	**27,596,314.25**
TOTAL	**92,855,774.11**	**200,560,282.74**

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LOAN/ADVANCE TO STAFF

ANNEXURE- 2

	PARTICULARS	2018-19	2017-18
	(i) Motor Car	749,516.00	977,426.00
	(ii) Motor Cycle	91,840.00	124,340.00
	(iii) Computer	304,300.00	103,800.00
	(iv) House Building/Others	3,254,479.00	3,642,859.00
	(v) Festival	(10,540.00)	45,200.00
	(vi) LTC	17,078.00	13,500.00
	(vii) GPF Advance	499,100.00	345,600.00
	TOTAL	4,905,773.00	5,252,725.00

Long term loans and advances	2018-19	2017-18
(a) Advance for Capital items- fixed assets		
National Institute of Design	354,000.00	300,000.00
Material Advances (M/s Vidhyawati)	636,899.00	636,899.00
Advance for 3.60 Mtr telescope	124,262.00	124,262.00
Advances to Suppliers	2,662.00	2,662.00
Advance custom duty	51,471.00	51,471.00
(b) Advances to staff recoverable from salary (as per Annexure- 2)	-	-
TOTAL	1,169,294.00	1,115,294.00

ADVANCES- OTHERS

ANNEXURE- 3

	PARTICULARS	2018-19	2017-18
1	Intt. Earned Return DST (Recoverable)	16,195,520.56	16,195,520.56
2	Adv. To Mr A K Sharma (3.6Mt.)	27,162.00	50,001.00
3	Advance for Scientific Meeting	779,232.00	1,538,911.00
4	Travelling Advance	-	9,000.00
5	GST Receivable	-	2,596,284.00
6	Sundry Advance	244,572.50	337,279.50
	Advances to Staff (A)	17,246,487.06	20,726,996.06

1	Interest Accured Electricity Board	49,015.00	49,015.00
2	Advances for Consumable Purchase	157,197.00	157,197.00
3	Security Deposits	650,102.00	501,573.00
4	Advance for IL TP Project	27,003.00	27,003.00
5	Indo Austria Project (Dr A.K. Srivastava)	36,422.00	36,422.00
6	Advance to Uttarakhand Power Corporation	-	1,500,004.00
7	TDS Advance (Receivable)	1,294,572.00	3,657,562.00
8	Advance legal fees	50,000.00	50,000.00
9	ST Radar Project Loan A/c	1,864,642.00	1,864,642.00
10	INDO- US Project (Dr Wahab Uddin)	36,305.00	36,305.00
11	Adv Dilshad	10,000.00	
12	Deposit Paid to Income Tax Department	6,800,000.00	-
13	Other advances/ST Radar/Custom duty	-	-
	Advances and security deposits (B)	10,975,258.00	7,879,723.00
	Total (A+B)	28,221,745.06	28,606,719.06

ARYABHATTA RESEARCH INSTITUTE OF OBSERVATIONAL SCIENCES, NAINITAL
BALANCE SHEET OF ARIES EMPLOYEES ENDOWMENT TRUST AS AT 31.03.2019

LIABILITIES	FY 2018-19		FY 2017-18		ASSETS	FY 2018-19		FY 2017-18	
CORPUS					INVESTMENTS		99,001,664.00		36,490,984.00
GPF Fund A/c	44,329,425.56	34,113,425.00	36,240,035.56	35,240,532.56	FDR SBI	27,404,390.00		35,000,000.00	
Add: Employees contribution	8,387,325.00		7,046,945.00		Accrued interest	177,361.00		1,490,984.00	
Add: Interest on GPF	2,965,850.00		-		FDR UBI	69,300,000.00			
Add: GPF Advance Adjusted	313,775.00		-		Accrued interest	2,119,313.00			
Less: Member Intt. Transfer to Reserve	(5,833,773.56)		-						
Less :PF Withdrawal	(1,535,000.00)		(5,987,482.00)		LOANS & ADVANCES		499,100.00		395,600.00
Less :Retirement benefits paid	(14,514,177.00)		(2,058,966.00)		GPF Advance to Employees	499,100.00		345,600.00	
					ISRO project	-		50,000.00	
Old Pension Fund A/c	79,571,847.46	44,236,446.56	72,758,355.06	77,615,176.06	BANK ACCOUNT		7,081,344.06		106,201,256.74
Add: Pension Fund Receive	1,500,000.00		18,720,024.00		GPF SBI -300	5,029,518.30		2,219,529.00	
Less :Persion	(36,835,400.90)		(13,863,203.00)		SBI-Pension -311	36,305.74		19,382,694.74	
					UBI-535	2,015,220.02		84,599,033.00	
RESERVES & SURPLUS	-	27,813,045.50		21,690,135.12					
Opening Reserve & Surplus	19,335,659.72		17,776,709.40		GPF Fund Receivable	633,325.00			
Excess of Income over Expenditure	3,859,274.22		7,506,219.48						
Less: Previous Year Provisions	(1,215,672.00)		(3,592,793.76)		TDS RECEIVABLE	365,880.00	999,205.00	149,102.00	149,102.00
Add: Member Intt. Transfer to Reserve	5,833,773.56								
PROVISION		1,418,396.00		8,691,099.00					
Superannuation	-		2,710,484.00						
Leave encashment	-		3,105,379.00						
Pension	1,418,396.00		2,875,236.00						
TOTAL		107,581,313.06		143,236,942.74	TOTAL		107,581,313.06		143,236,942.74

For Manoj Vatsal & Co.
Chartered Accountants
Firm Regn. No. 010155C

Manoj Joshi
FCA,DISA,DIRM(ICAI)
SR. Partner
Membership No. 025757
Date-04.10.2019
Place-Nainital

Registrar ARIES

Registrar
ARIES, NAINITAL

MANOJ VATSAL & CO. M.N. 025757 C.C.C., HALDWANI

Director ARIES

निदेशक / Director
आर्यभट्ट प्रेक्षण विज्ञान शोध संस्थान (एरीज)
Aryabhatta Research Institute of Observational Sciences (ARIES)
मनोरा पीक, नैनीताल – 263 001
Manora Peak, Nainital-263 001

ARYABHATTA RESEARCH INSTITUTE OF OBSERVATIONAL SCIENCES, NAINITAL

INCOME & EXPENDITURE ACCOUNT OF ARIES EMPLOYEES EMPLOYEES ENDOWMENT TRUST FOR THE YEAR ENDED ON 31.03.2019

EXPENDITURE	FY 2018-19	FY 2017-18	INCOME	FY 2018-19	FY 2017-18
To Bank Charges	652.78	250.52	Interest earned from SBI GPF (300)	188,033.00	189,443.00
To Director Aries 253 (interest)	-	2,362,269.00	Interest earned from SBI Pension(311)	337.00	575,233.00
To Interest on GPF	2,965,850.00		Interest earned from UBI(535)	2,350,355.00	-
			By Interest earned from GPF FDR	2,157,739.00	1,640,086.00
			By Interest earned from Old Pension FDR	2,119,313.00	7,463,977.00
			By Director Aries		-
To Surplus of Income over Expenditure	3,859,274.22	7,506,219.48			
TOTAL	6,825,777.00	9,868,739.00	TOTAL	6,825,777.00	9,368,739.00

For Manoj Vatsal & Co.
Chartered Accountants
Firm Regn. No. 010155C

Manoj Joshi
FCA,DISA,DIRM(ICAI)
SR. Partner
Membership No. 025757
Date-04.10.2019
Place-Nainital

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Director ARIES
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MANOJ VATSAL & CO. M.No. 025757 D.C.C., HALDWANI

ARYABHATTA RESEARCH INSTITUTE OF OBSERVATIONAL SCIENCES, NAINITAL

RECEIPT & PAYMENTS ACCOUNT OF ARIES EMPLOYEES ENDOWMENT TRUST FOR THE YEAR ENDED ON 31.03.2019

RECEIPTS	FY 2018-19		FY 2017-18		PAYMENTS	FY 2018-19		FY 2017-18	
Opening Balance:		106,201,256.74		131,873,405.26	**PAYMENTS**		52,530,035.68		21,909,901.52
GPF 300	2,219,529.00		38,425,189.00		Bank charges	652.78		250.52	
SBI-Pension 311	19,382,694.74		14,286,317.26		Retirement Benefits paid	14,514,177.00		2,058,966.00	
UBI 535	84,599,033.00		79,161,899.00		PF Withdrawal	1,535,000.00		5,987,482.00	
					Pension (Retd. Employee)	36,480,205.90		13,863,203.00	
INTEREST RECEIVED		2,538,725.00		764,676.00	**Investments**				211,982,180.00
Interest earned from SBI GPF (300)	188,033.00		189,443.00		FDR SBI	-	69,300,000.00	35,000,000.00	
Interest earned from SBI Pension(311)	337.00		575,233.00		FDR UBI	69,300,000.00		176,982,180.00	
Interest earned from UBI(535)	2,350,355.00								
					Loans & Advances		90,600.00		395,600.00
					GPF Advance	90,600.00		345,600.00	
ISRO PROJECT	50,000.00	50,000.00			ISRO PROJECT	-		50,000.00	
FDR MATURED		10,707,123.00		184,446,157.00	**Repayments**				2,362,269.00
FDR MATURED (GPF 1787)	10,349,763.00		184,446,157.00						
intt.On FDR Matured	357,360.00				Director Aries 253 (interest)	-		2,362,269.00	
CONTRIBUTION		9,504,875.00		25,766,969.00	**Closing balance**		7,081,344.06		106,201,256.74
Employees contribution	7,754,000.00		7,046,945.00		GPF-300-SBI	5,029,518.30		2,219,529.00	
GPF Recovery	250,875.00		18,720,024.00		SBI-Pension 311	36,605.74		19,382,694.74	
Pension Fund Receive	1,500,000.00				UBI 535	2,015,220.02		84,599,033.00	
TOTAL	129,001,979.74	129,001,979.74	342,851,207.26	342,851,207.26	TOTAL	129,001,979.74	129,001,979.74		342,851,207.26

For Manoj Vatsal & Co.
Chartered Accountants
Firm Regn. No. 010155C

Manoj Joshi
FCA,DISA,CIRM(ICAI)
SR. Partner
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Date-04.10.2019
Place-Nainital

Registrar ARIES

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