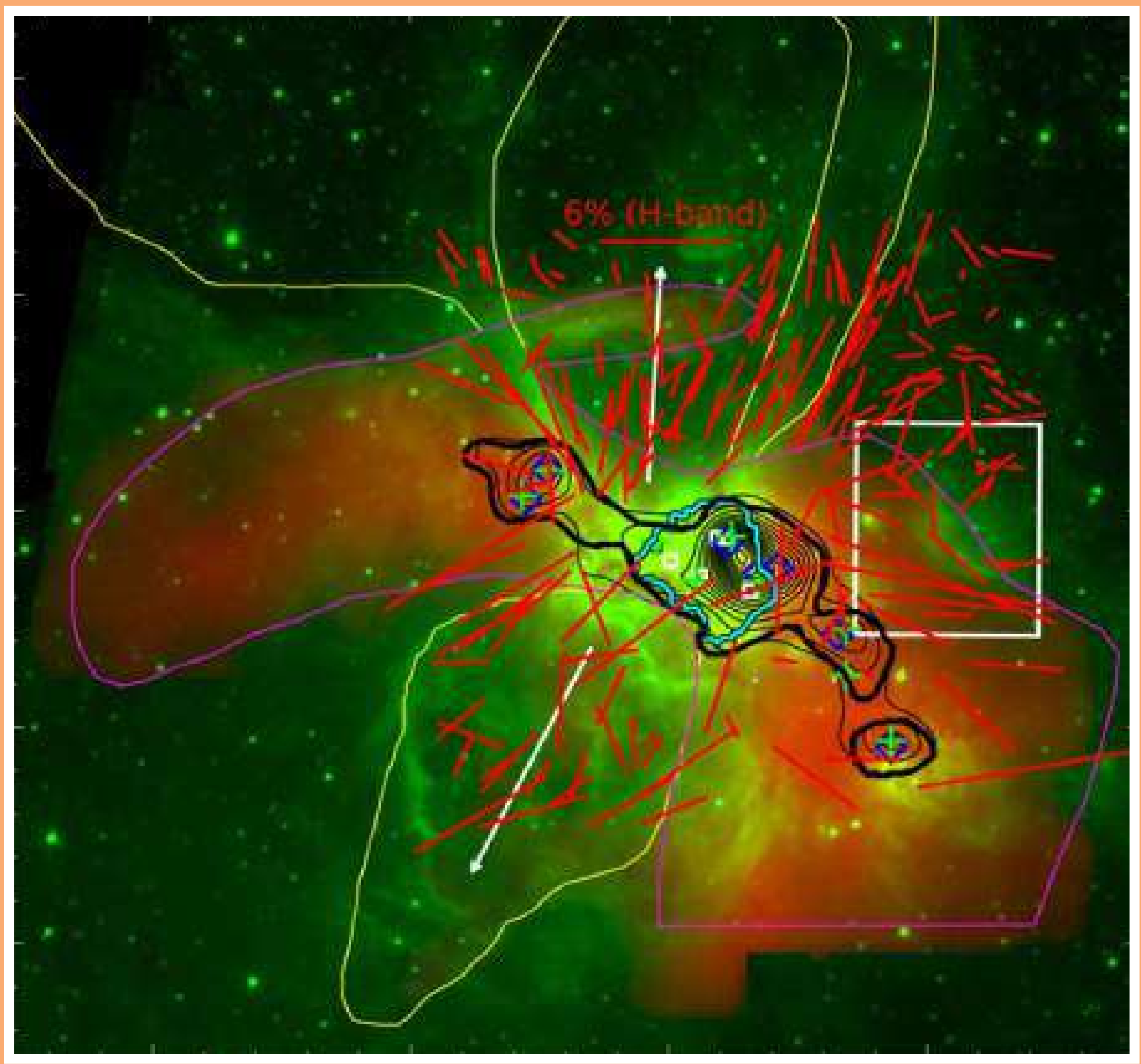
ARIES

Aryabhatta Research Institute of Observational Sciences



Annual Report 2017-18

ARIES **14th** ANNUAL REPORT 2017-18

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:

H-band polarizations (red vectors) of the 178 confirmed BG stars overlaid on the tricolor image constructed from the $^{13}CO(1-0)$ total integrated emission map (red; Purcell et al. 2009), Spitzer IRAC Ch2+Ch3 combined image (green), and SIRPOL $J+H+K_s$ band combined image (blue). Further details are given in Figure 9.

Back Cover:

(Top) The TIRCAM2 mounted at the axial port of the 3.6m DOT. (Bottom) *J, H* and *K* band magnitudes versus magnitude errors of the globular cluster M92 observed with effective exposure times of 550, 550 and 1000 s, respectively.

September, 2018

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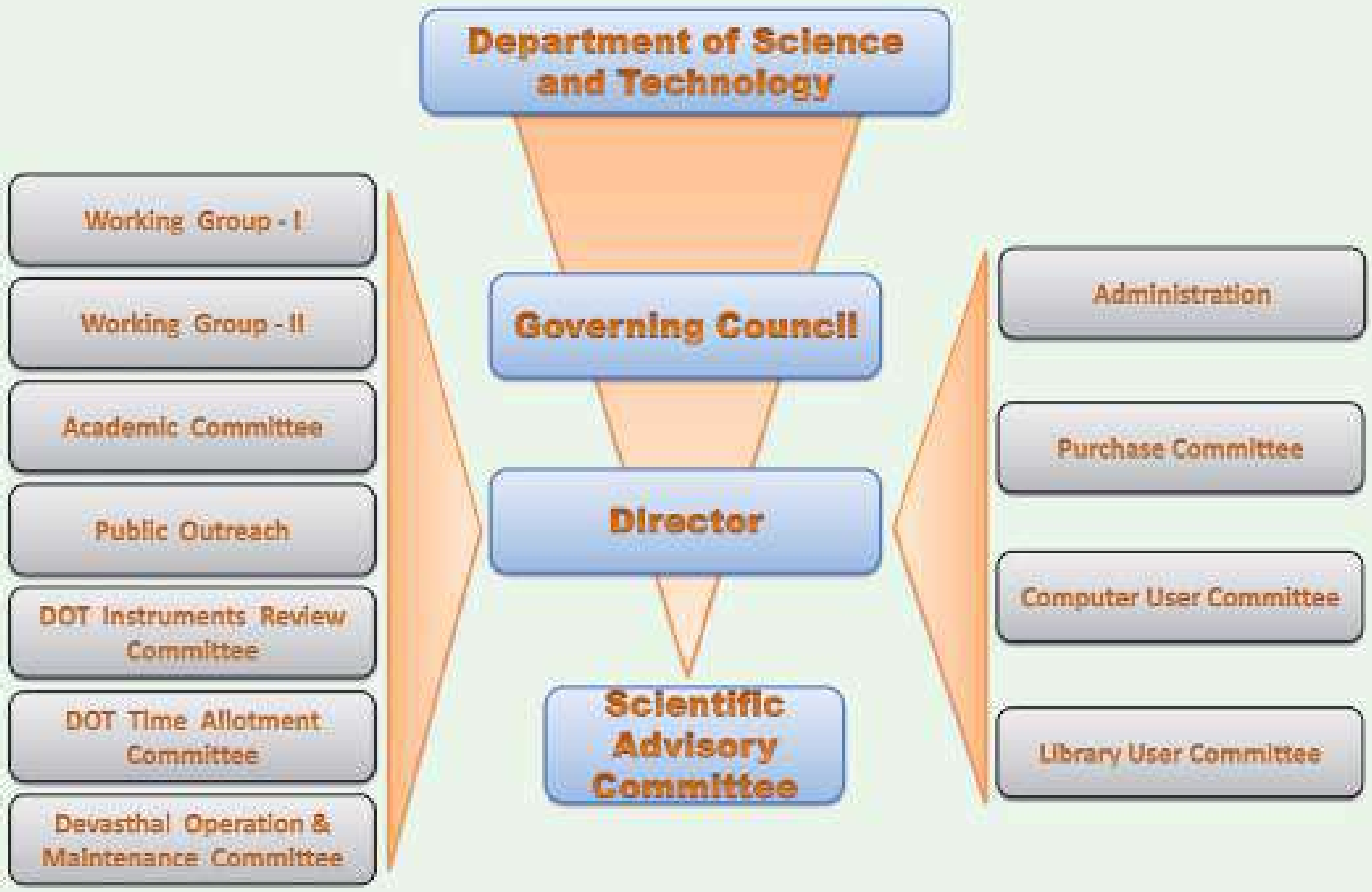

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From Director's Desk

I am content and delighted to say that during 2017-18, all the members of ARIES continued to excel in all fronts of activities related to Astronomy & Astrophysics and Atmospheric Sciences.

ARIES operates India's largest 3.6m Devasthal Optical Telescope (DOT) at Devasthal as a National facility. The DOT has state of the art back-end instruments for optical and near-infrared imaging. The Devasthal Time Allocation Committee (DTAC) announced the call for early science observing proposals with 3.6m DOT for Cycle-2017A (April-May, 2017). A total of 35 observing proposals were submitted with an over subscription factor of 1.8. The telescope performed well throughout Cycle-2017A. The regular health check-up of 3.6m DOT was carried out during the monsoon period (June-September) following the safety guidelines provided by AMOS. For Cycle 2017B (October 2017 – January 2018) DTAC received 45 proposals with an over subscription factor of 1.9.

The performance analysis of NIR Camera TIRCAM2 on 3.6m DOT revealed encouraging results. Sources in L and PAH band (~3.6 micron) have been detected. The seeing in NIR bands is of sub-arcsec order with best value of ~0.45 arcsec in K band **(Figure 1)**.

TIFR-ARIES near-infrared Spectrometer (TANSPEC), being built in collaboration with TIFR, ARIES and MKIR (Hawaii) for 3.6m DOT, will be a unique instrument which will provide simultaneous wavelength coverage from 550 to 2540 nm with a resolving power of R~2750. The instrument is expected to be available by November 2018.

I am happy to inform that a spectrograph similar to the Faint Object Spectrograph Camera, designed, developed and assembled at ARIES was tested on 3.6m DOT for various engineering and scientific programmes.

A workshop to highlight the scientific performance of 3.6m DOT was held on 5th February, 2018 at Osmania

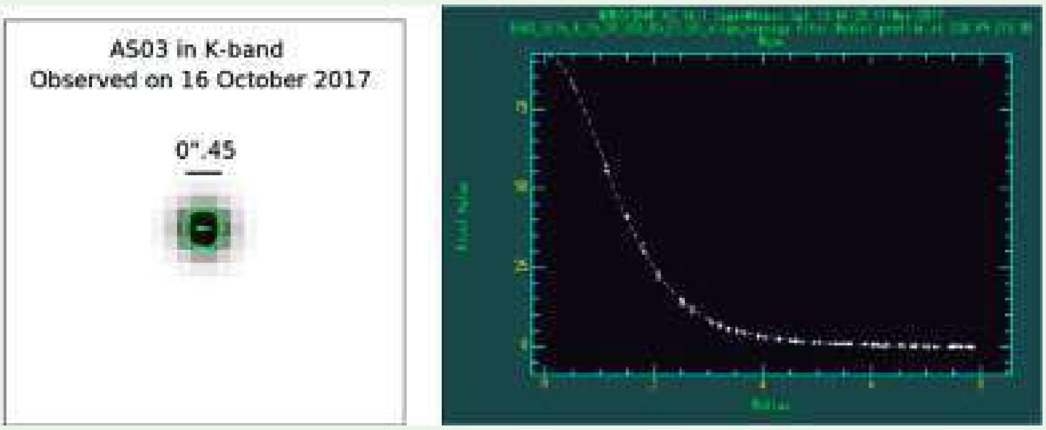

Figure 1. A seeing of ~ 0".45 was observed on 16 October, 2017.

University. The workshop received a good response and was attended by senior as well as young researchers.

The installation of clutter fencing improved the performance of ST-Radar significantly. This year ARIES independently activated 3 more clusters. Observations with 10 clusters were carried out to study the atmosphere upto a height of almost 14 Km.

The Institute continued studies to understand the Earth's atmosphere, Sun, Stars and Galaxies. The astrophysical studies were centered around Galactic and Extra-galactic astronomy. ARIES scientists contributed towards the discovery of the electromagnetic counterpart of the first gravitational wave detection from the binary neutron star merger. The studies in Solar Physics were focused on the observations of the transients (e.g. flares and associated processes).

Atmospheric science group continued to study the lower atmospheric processes which contribute to the air pollution and climate change. Observations of trace gases, aerosols and meteorological parameters have been done and modelling has also been done to understand the chemical, physical and dynamical processes.

We at ARIES also disseminated the knowledge gathered by us as a result of our academic activities to the school children and general public through lectures, popular talks as well as using the facilities available at ARIES science centre. We also organized schools/workshops to motivate young talents to take up research in Astronomy & Astrophysics and Atmospheric Science as a career.

The engineers/engineering staff at ARIES were actively involved in development of back-end instruments/ software as well as efficiently maintaining the available facilities. The 1.04m Sampurnanand telescope and 1.3m telescope are functioning well and providing excellent scientific results.

During the year of this report, ARIES staff constituted of 34 Scientists and Engineers, 13 administrative and support staff, 35 scientific and technical staff, 11 laboratory assistants, 7 post-doctoral fellows and 37 research scholars. In the year 2017, 7 new research scholars joined the institute, while 4 research scholars submitted their theses and 4 research scholars were awarded the Ph.D. degree. ARIES faculty have published 58 and 4 papers in the refereed journals of high impact factors and conferences/seminars etc., respectively. About 101 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 have taken special steps in keeping our office and premises *swachh*. All efforts are being taken to provide a constructive and essential role in building an equitable work environment by safeguarding the interests of the schedule casts and schedule tribes as well as of women. All necessary steps have been taken to maintain the national integration in the institute and to implement all the important schemes as directed by the Government of India. Continuous efforts are being made to implement the official language in the day to day administrative work.

I sincerely believe that with new upcoming facilities the institute will continue to enhance its observational capabilities which consequently will provide a way to enhance institute's academic excellence and carve a niche in the academic world.

Anil Kumar Pandey
Director

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. Galactic & Extragalactic Astronomy (Working Group – I)

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

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

Galactice & Extragalactic Astronomy

All the scientists working on topics related to Galactic and Extragalactic astronomy are the members of WG – I. The group consists of 17 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 made by the members are briefly presented below.

1. Individual Stars

Long-term photometric study of a faint WUMa binary in the direction of M31

Photometric analysis of a W UMa binary CSS_J004259.3+410629 in the field of M31 galaxy using multi-band data taken during the Nainital Micro-lensing Survey was carried out. The orbital period of W UMa binary star was found to be 0.266402 ± 0.000018 d and photometric mass ratio was estimated as 0.28 ± 0.01. The photometric light curves were analysed using the Wilson-Devinney code which yield masses and radii of the binary as $M_1 = 1.19 \pm 0.09\, M_\odot$, $M_2 = 0.33 \pm 0.02\, M_\odot$ and $R_1 = 1.02 \pm 0.04\, R_\odot$, $R_2 = 0.58 \pm 0.08\, R_\odot$, respectively. From the analysis of photometric light curves, the star is understood to be a low mass-ratio contact binary of A-subtype with a high fill-out factor of about 47%. The binary system is found to be located approximately at a distance of 2.64 ± 0.03 kpc having a separation of $2.01 \pm 0.05\, R_\odot$ between the two components. The light curves of star in R_c and I_c band along with best model fits are shown in **Figure 2**. **[Joshi, Y. C.** and Jagirdar, R. (2017). *Res. Astron. Astrophy., 17*:115**]**.

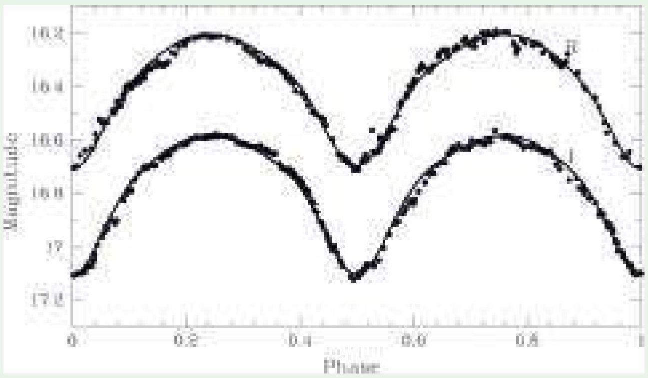

Figure 2. Light curves of the star in the R_c and I_c bands. The continuous lines show the best fits derived through the WD code.

X-ray super flares from cool active stars

Two superflares which are brightest, hottest, and shortest in duration on K7V+M3V binary stars CC Eri were studied. These super flares triggered the *Swift* Burst Alert Telescope (BAT) in the hard X-ray band on 16 October, 2008 and 24 February, 2012. It has been found that the flares decay faster in the hard X-ray band than in the soft X-ray band. The peak X-ray luminosities were found to be 1.6×10^{32} and 6.1×10^{31} erg s^{-1} in 0.3-50 keV energy band and are larger than any other flares observed previously on it. **Figure 3** shows the variation of spectral parameters like temperature and emission measures along with the X-ray luminosity and Fe Kα flux. The X-ray luminosity was found to be more than the bolometric luminosity of one of its component during its peak phase. The observed peak temperatures for both flares were found to be 174 and 128 MK, which decreased to 60 and 50 MK, respectively near the quiescent phase. The metal abundances were also found to increase 2 to 9 times than that of the quiescent state, which could be due to the heating and evaporation of the chromospheric gas, which increases the metal abundances in the flaring loop. The loop length for both flares was derived to be $\sim 10^{10}$ cm using hydrodynamic loop model. The astrocentric angle between the flare and observer has been estimated as ~90° using the derived value of Fe Kα emission flux and loop length. This shows that the region being illuminated by the flare, and thus fluorescing the photospheric iron, is located near the stellar limb. **[Karmakar, S., Pandey, J. C.,** Airapetian, V. S. and **Misra K. (2017).** *Astrophy. Jr., 840:*102**].**

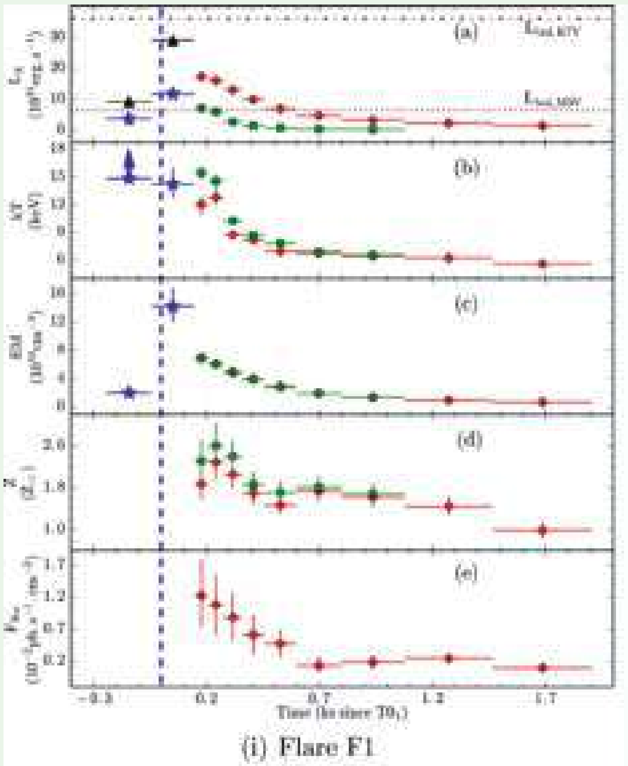

Figure 3. Evolution of spectral parameters of CC Eri during one of the super flare. Parameters derived with the *Swift* XRT, BAT, and XRT+BAT spectral fitting in all the panels are represented by the solid diamonds, solid stars, and solid squares, respectively.

Lunar occultations of Aldebaran and other late-type stars observed from Devasthal

Lunar occultations of Aldebaran (α Tau) and other ten, mostly late-type, stars were observed with the Devasthal 1.3m telescope. A detailed brightness profile for

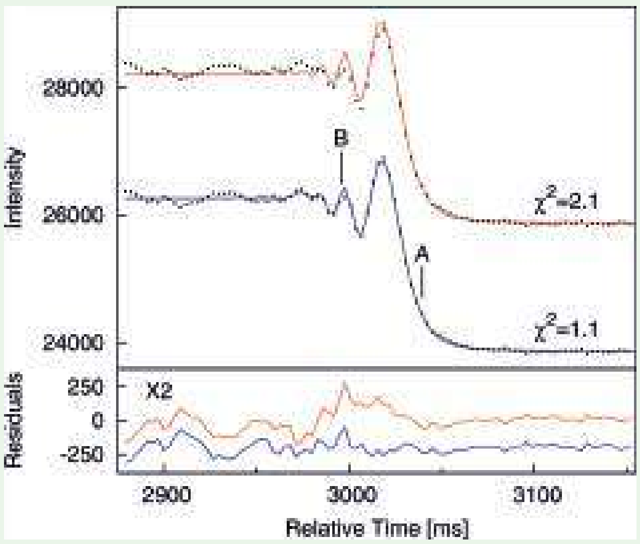

Figure 4. Top panel: light curve (dots) for WZ Psc, repeated twice with an arbitrary offset. The upper solid line is a fit by a point-like source, the lower solid line is the best fit by a binary star, as described in the text. The normalized χ2 values for the two cases are also shown. Bottom panel: the residuals for the two fits, offset by arbitrary amounts and enlarged by two for clarity.

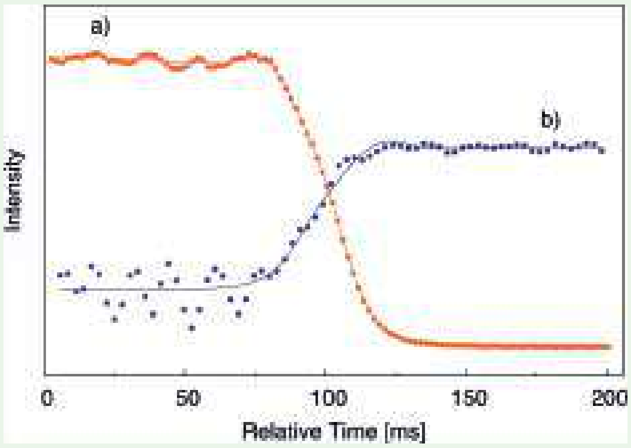

Figure 5. The light curves (dots) for the disappearance and reappearance of Aldebaran, marked a) and b), respectively. The curves have been shifted in time and re-scaled by arbitrary amounts in intensity. The solid lines are the best fits. The CAL fit was used for the a) curve, while for b) this was not possible and we show the UD fit.

Aldebaran, confirming the presence of asymmetries has been derived. The origin of such asymmetries were studied by means of simulations of the effect of scintillation on the reconstructed profiles. Angular diameters for two M giants, Z Cnc and SAO 161635 were derived. Companions around two other stars, SAO 161665 and WZ Psc, and binary, SAO 94060 were detected in this study. This is the first systematic effort to observe lunar occultation events at this facility, and demonstrates the capability to carry out milliarcsecond-level investigations on sources down to ~9 mag. This work will be continued in the coming years, eventually utilizing the 3.6m DOT telescope recently erected at Devasthal for deeper sensitivity and higher accuracy. [Richichi, A., **Sharma, S., Pandey, A. K., Pandey, R., Sinha, T.,** Norharizan, M. D. (2018). *New Astronomy, 59*, 28**]**.

2. Star Clusters

Interstellar extinction in open star clusters

Interstellar dust is an important component of the interstellar medium. It is the remnant of star formation and stellar evolution processes. It is very important to have knowledge of interstellar dust in the line of sight of the clusters. The interstellar extinction law in 20 open star clusters namely, Berkeley 7, Collinder 69, Hogg 10, NGC 2362, Czernik 43, NGC 6530, NGC 6871, Bochum 10,

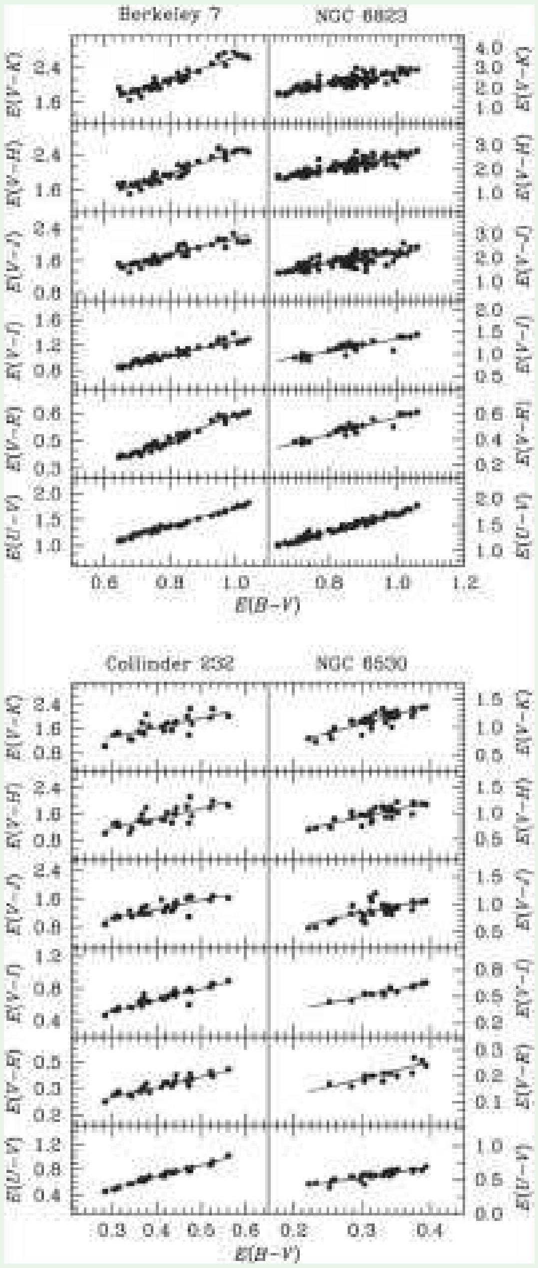

Figure 6. The colour excesses E(U − V), E(V − R), E(V − I), E(V − J), E(V − H), E(V − K) are plotted against E(B − V) for the clusters Berkeley 7, NGC 6823, Collinder 232, and NGC 6530.

Haffner 18, IC 4996, NGC 2384, NGC 6193, NGC 6618, NGC 7160, Collinder 232, Haffner 19, NGC 2401, NGC 6231, NGC 6823, and NGC 7380 has been studied in the optical and near-IR wavelengths.

The difference between maximum and minimum values of E(B − V) indicates the presence of non-uniform extinction in all the clusters except Collinder 69, NGC 2362, and NGC 2384. The colour excess ratios are consistent with a normal extinction law for the clusters NGC 6823, Haffner 18, Haffner 19, NGC 7160, NGC 6193, NGC 2401, NGC 2384, NGC 6871, NGC 7380, Berkeley 7, Collinder 69, and IC 4996. It is found that the differential colour-excess ΔE(B − V), which may be due to the occurrence of dust and gas inside the clusters, decreases with the age of the clusters. A spatial variation of colour excess is found in NGC 6193 in the sense that it decreases from east to west in the cluster region. For the clusters Berkeley 7, NGC 7380, and NGC 6871, a dependence of colour excess E(B − V) with spectral class and luminosity is observed. Eight stars in Collinder 232, four stars in NGC 6530, and one star in NGC 6231 have excess flux in near-IR. This indicates that these stars may have circumstellar material around them. [Rangwal, G., **Yadav, R. K. S.**, Durgapal, A. K. and Bisht, D. (2018). *Pub. Astronomi. Soc. Aust., 34*, 68].

3. Star Formation

Stellar contents and star formation in the NGC 7538 region

Deep optical photometric data on the NGC 7538 region were collected and combined with archival data sets from the Chandra, 2MASS and Spitzer surveys to generate a new catalogue of young stellar objects (YSOs) including those not showing infrared excess emission. This new catalogue is complete down to 0.8 $M_{\odot}$. The nature of the YSOs associated with the NGC 7538 region and their spatial distribution are used to study the star-formation process and the resultant mass function (MF) in the region. Out of the 419 YSOs, ~91 per cent have ages between 0.1 and 2.5 Myr and ~86 per cent have masses between 0.5 and 3.5 $M_{\odot}$, as derived by the spectral energy distribution fitting analysis. Around 24, 62 and 2 per cent of these YSOs are classified to be class I, class II and class III sources, respectively. The X-ray activities for the class I, class II and class III objects are not significantly different from each other. This result implies that the enhanced X-ray surface flux due to the increase in the rotation rate may be compensated for by the decrease in the stellar surface area during the pre-main-sequence evolution. The analysis shows that the O3V type high-mass star IRS 6 may have triggered the formation of young low-mass stars up to a radial distance of 3 pc. The MF shows a turn-off at around 1.5 $M_{\odot}$ and the value of its slope in the mass range $1.5 < M / M_{\odot} < 6$ is -1.76 ± 0.24, which is steeper than the Salpeter value. [**Sharma, S.**, **Pandey, A. K.**, Ojha, D. K., Bhatt, H., Ogura, K., Kobayashi, N., Yadav, R. and **Pandey, J. C.** (2017). *Mon. Not. Roy. Astron. Soc., 467,* 2943].

Star Formation in the Sh 2-53 Region Influenced by Accreting Molecular Filaments

Multi-wavelength analysis of a ~30′ x 30′ area around the Sh 2-53 region (hereafter S53 complex), which is associated with at least three H II regions, two mid-infrared bubbles (N21 and N22), and infrared dark clouds is performed. The ^{13}CO line data trace the molecular content of the S53 complex in a velocity range of 36-60 km s^{-1} and show the presence of at least three molecular components within the selected area along this direction. Using the observed radio continuum flux of the H II regions, the derived spectral types of the ionizing sources agree well with the previously reported results. The S53 complex harbors clusters of young stellar objects (YSOs) that are identified using the photometric 2-24 μm magnitudes. It also hosts several massive condensations (3000-30,000 $M_{\odot}$) that are traced in the *Herschel* column density map. The complex is found at the junction of at least five molecular filaments, and the flow of gas toward the junction is evident in the velocity space of the ^{13}CO data. Together, the S53 complex is embedded in a very similar "hub-filament" system to those reported in Myers, and the active star formation is evident toward the central "hub" inferred by the presence of the clustering of YSOs. **[Baug, T.** et al. (including **Pandey, A. K.** and **Sharma, S.**). (2018). *Astrophy. Jr., 852:*119**].**

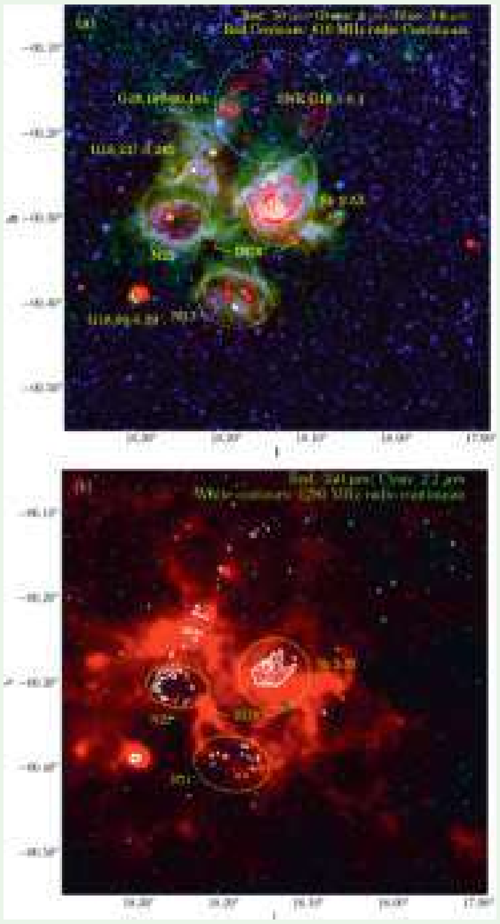

Figure 7. (a) Color-composite image (red: 70 μm; green: 8.0 μm; blue: 3.6 μm) of a 30' × 30' area around the Sh 2-53 region. The 610 MHz GMRT radio contours at levels of 3, 4, 5, 6, 8, 10, 12, 15, 20, 25, 30, and 40 mJy are also overlaid on the image. Several H ii regions, two MIR Galactic bubbles, IRDCs, and an SNR are seen along the line of sight. The positions of the bubbles and of the Sh 2-53 region and the SNR are marked by ellipses and circles, respectively. The positions of spectroscopically confirmed O stars (Paron et al. 2013) are also marked by white stars, while two more photometrically identified O stars toward the N21 bubbles (Watson et al. 2008) are marked by red stars. (b) Two-color-composite image of the region (red: 350 μm; cyan: 2.2 μm). The 1280 MHz GMRT contours at levels of 2.0, 2.5, 3.0, 5.0, 8.0, 12.0, 15.0, 20.0, 30.0, and 100.0 Jy are also overlaid on the image.

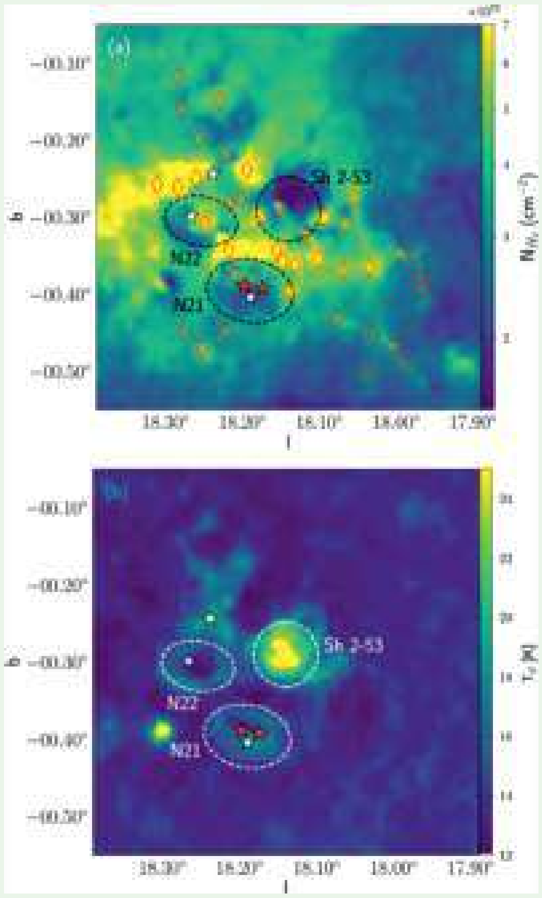

Figure 8. Herschel (a) column density and (b) temperature maps of the S53 complex. Several cold clumps are also marked (diamonds) in the column density map. The remaining symbols are similar to those in Figure 7.

Understanding the links among the magnetic fields, filament, bipolar bubble, and star formation in RCW 57A using NIR polarimetry

The influence of magnetic fields (*B*-fields) on the formation and evolution of bipolar bubbles, due to the expanding ionization fronts (I-fronts) driven by the H II regions that are formed and embedded in filamentary molecular clouds, has not been well-studied yet. In addition to the anisotropic expansion of I-fronts into a filament, *B*-fields are expected to introduce an additional anisotropic pressure, which might favor the expansion and propagation of I-fronts forming a bipolar bubble. Near-infrared polarimetric observations toward the central ~8′ x 8′ area of the star-forming region RCW 57A, which hosts an H II region, a filament, and a bipolar bubble has been performed. Polarization measurements of 178 reddened background stars, out of the 919 detected sources in the JHK$_s$ bands, reveal *B*-fields that thread perpendicularly to the filament long axis. The *B*-fields exhibit an hourglass morphology that closely follows the structure of the bipolar bubble. The mean *B*-field strength, estimated using the Chandrasekhar-Fermi method (CF method), is 91 ± 8 μG. *B*-field pressure dominates over turbulent and thermal pressures. Thermal pressure might act in the same orientation as the *B*-fields to accelerate the expansion of those I-fronts. The observed morphological correspondence among the *B*-fields, filament, and bipolar bubble demonstrate that the *B*-fields are important to the cloud contraction that

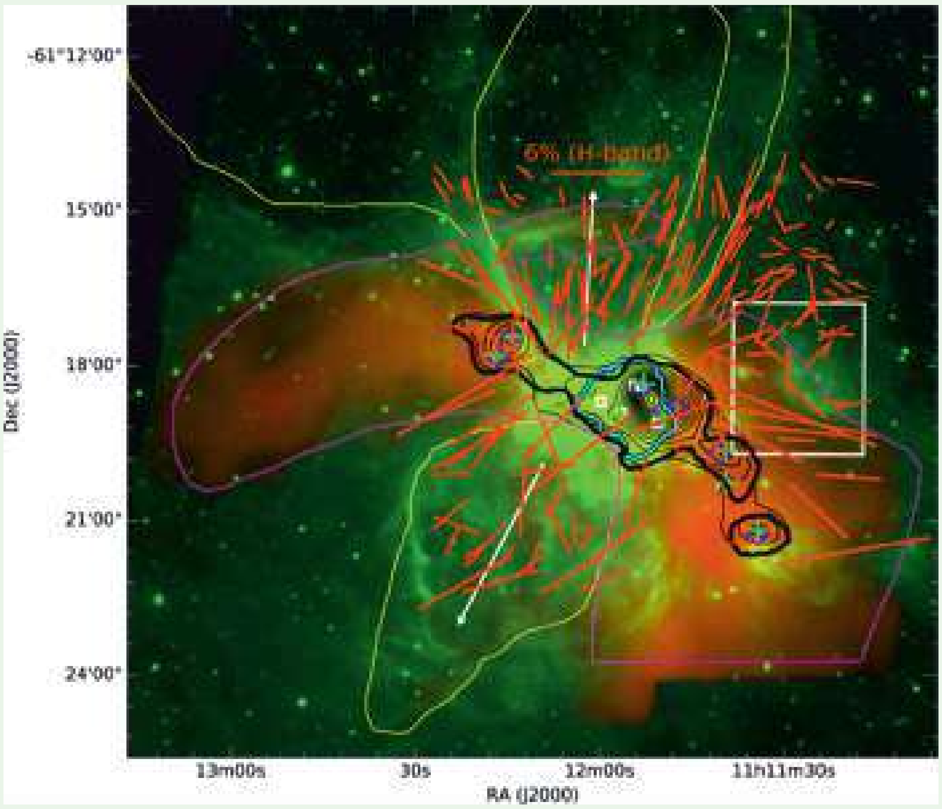

Figure 9. *H*-band polarizations (red vectors) of the 178 confirmed BG stars overlaid on the tricolor image constructed from the ^{13}CO(1 – 0) total integrated emission map (red; Purcell et al. 2009), Spitzer IRAC Ch2+Ch3 combined image (green), and SIRPOL *J*+*H*+*K$_s$* band combined image (blue). Reference vector with P = 6% and θ = 90° is plotted. The thick black contour represents SIMBA 1.2 mm dust emission (Hill et al. 2005) with a flux level of ~3 Jy beam^{-1}. The thin black contours denote ATLASGAL 0.87 mm thermal dust emission ranging from 2 Jy beam^{-1} to 22 Jy beam^{-1}(beam size of 18".2) with an interval of 1 Jy beam^{-1}. The cyan contour represents the extent of the H II region, as traced in 3.4 cm radio free–free emission (de Pree et al. 1999). Yellow contours delineate the morphology of the bipolar bubble. The magenta contour depicts the extent of the molecular cloud, as traced by ^{13}CO(1 – 0) emission using the *Mopra* telescope (Purcell et al. 2009). The white box shows the location of a bright rimmed cloud. White arrows represent possible orientations of expanding I-fronts or outflowing gas. The green plus marks and black squares distributed along the filament are the water/methanol masers and IRSs, respectively. Blue diamonds correspond to the seven massive cores (namely, S1–M1, S1–M2, S3–M4, S3–M5, S3–C3, S4–M6, and S5–M6) identified by André et al. (2008). All of the information on various contours, and the location of the masers and IRSs is extracted from Purcell et al. (2009).

formed the filament, to the gravitational collapse and star formation in it, and in feedback processes. The last one includes the formation and evolution of mid-infrared bubbles by means of *B*-field supported propagation and expansion of I-fronts. These may shed light on preexisting conditions favoring the formation of the massive stellar cluster in RCW 57A. [**Eswaraiah, C.** et al. (including **Pandey, A. K.**, **Maheswar, G.** and **Sharma, S.**). (2017). *Astrophy. Jr., 850*:195].

4. GRB and Supernovae

Rates and parameters of short GRB afterglow in coincidence with binary neutron star mergers and gravitational waves

With the recent discovery of the gravitational wave (GW) event GW 170817 and short GRB 170817A, it is proved beyond doubt that binary neutron star mergers are the most promising progenitors for short GRBs. Assuming all BNS mergers produce short GRBs, the merger rates of BNS from population synthesis studies, the sensitivities of advanced GW interferometer networks, and of the electromagnetic (EM) facilities in various wavebands were combined to compute the detection rate of associated afterglows in these bands. Using the inclination angle measured from GWs as a proxy for the viewing angle and assuming a uniform distribution of jet opening angle between 3° and 30°, light curves of the counterparts using the open access afterglow hydrodynamics package BOXFIT for X-ray, optical, and radio bands were generated. For different EM detectors, the fraction of EM counterparts detectable in these three bands was obtained by imposing appropriate detection thresholds. In association with BNS mergers detected by five (three) detector networks of advanced GW interferometers, assuming a BNS merger rate of 0.6–774 Gpc^{-3} yr^{-1} from population synthesis models, the afterglow detection rates (per year) were found to be 0.04–53 (0.02–27), 0.03–36 (0.01–19), and 0.04–47 (0.02–25) in the X-ray, optical, and radio bands, respectively. The rates represent maximum possible detections for the given BNS rate since the effects of cadence and field of view in EM follow-up observations are ignored. [Saleem, M., Pai, A., **Misra, K.**, Resmi, L., Arun, K. G. (2018). *Mon. Not. Roy. Astron. Soc.*, *475,* 699].

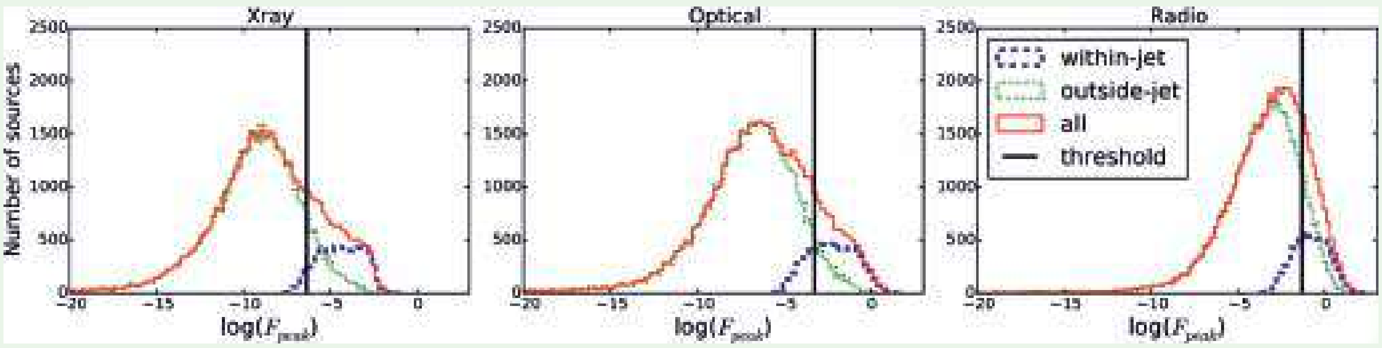

Figure 10. Afterglow peak Flux distributions in X-ray, optical and radio bands for 50 000 sources detected in GW detector network LHVKI. The black vertical lines in each panel are the detection thresholds of XRT, LSST and JVLA, respectively. X-ray and optical peak flux distributions are made up of two bell curves. The smaller one at the right are for within-jet sources (i.e. $\theta v < \theta j$) and the larger one at the left are outside-jet sources ($\theta v > \theta j$). Radio has a symmetric peak-flux distribution due to reduction in Doppler beaming at the time of typical radio peaks. These figures are made for population 1. Please note that the legends in the third panel apply to all three panels.

In conjunction with the rates of the short GRB afterglows in coincidence with BNS mergers and GWs, the parameter space of the short GRB afterglows was also explored since these are the most promising EM counterparts of BNS mergers. The afterglow emission is broadband, visible across the entire EM window from gamma-ray to radio frequencies. The flux evolution in these frequencies is sensitive to the multidimensional afterglow physical parameter space. Observations of GWs from BNS mergers in spatial and temporal coincidence with short GRB and associated afterglows can provide valuable constraints on afterglow physics. 50,000 simulated short GRB afterglow light curves were generated using the open access afterglow hydrodynamics package BOXFIT for X-ray, optical, and radio bands to systematically explore the multidimensional afterglow parameter space. These simulations were done assuming that all GW detected BNS events are associated to a short GRB jet which also produces the afterglow. A thorough investigation of how the detections or non-detections in the different frequencies can be influenced by the parameter space was also done. The afterglow parameters were estimated for a uniform to hat jet model, which would result in different detection scenarios. The rates and afterglow parameter space provides meaningful inferences on the physics of GRB afterglows from multi messenger astronomy with coincident GW-EM observations. [Saleem, M., Resmi, L., **Misra, K.**, Pai, A., Arun, K. G. (2018). *Mon. Not. Roy. Astron. Soc.*, *474,* 5340].

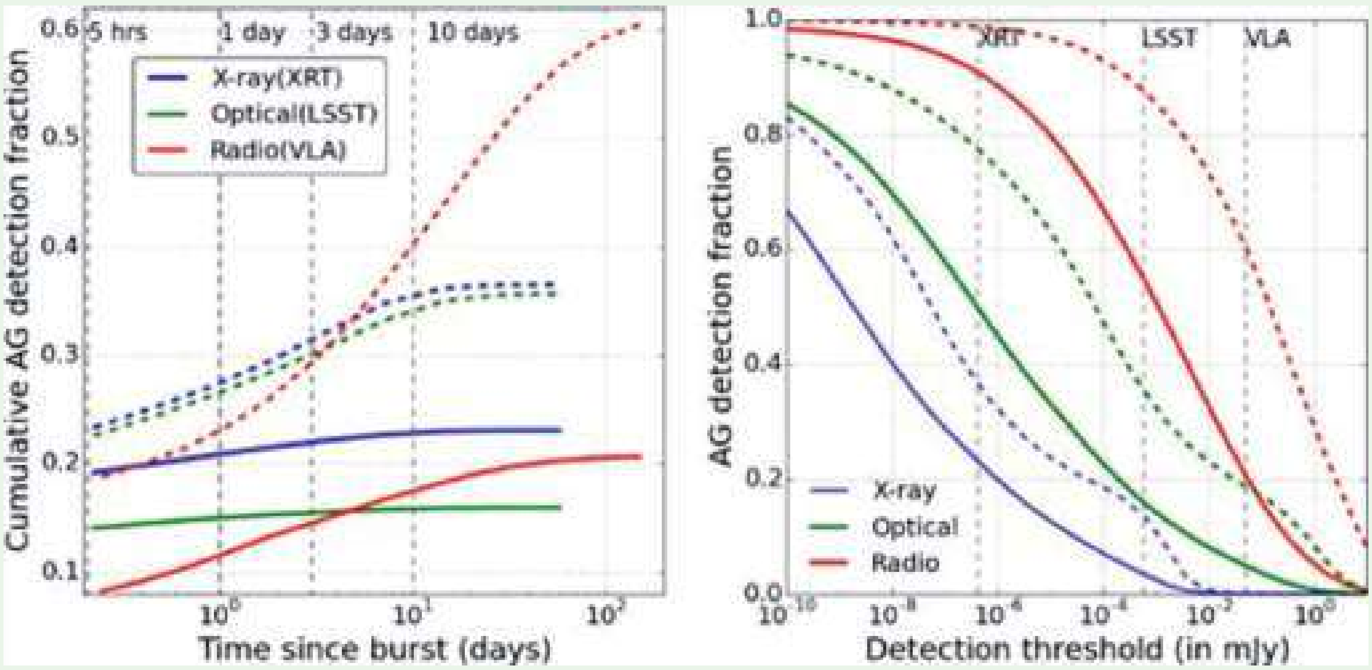

Figure 11. Left: cumulative afterglow detection fraction versus time since burst for population-1 (solid lines) and population-2 (dashed lines). Figure shows how the detection fraction of different afterglow components grows as a function of the time after the burst for a GW-detected BNS source population with five-detector network LHVKI. Right: detection fraction versus detection threshold. Dashed vertical lines mark the detection thresholds of XRT (X-ray), LSST (optical), and VLA (radio). Figure shows the sensitivity of the detection fractions on detection thresholds.

Exploring the optical behaviour of a Type Iax supernova SN 2014dt

Type IaxSNe are a peculiar sub class of hydrogen deficient type IaSNe and possess striking differences as compared to normal Type IaSNe. They exhibit a wide range of peak absolute brightness (M_B = -14 to -18 mag) with expansion velocities half (~ 4000-9000 km s^{-1}) of that of Type IaSNe (~10,000-15,000 km s^{-1}). There is no direct detection of progenitors in case of Type IaSNe whereas probable progenitors have been imaged for Type IaxSNe. During our rigorous observing campaign in 2014-2015 multi-band optical light curves of SN 2014dt were generated in M61, one of the closest (< 20 Mpc) and brightest discovered Type Iax SN, upto ~ 400 days with no secondary peak, a linear decline upto ~100 days and a significant flattening beyond 150 days. It best matches the light-curve evolution of SN 2005hk and reaches a peak magnitude of $M_B \sim -18.13 \pm 0.04$ mag with $\Delta m_{15} \sim 1.35 \pm 0.06$ mag. The early spectra of SN 2014dt are similar to other Type IaxSNe, whereas the nebular spectrum at 157 d is dominated by narrow emission features with less blending as compared to SNe 2008ge and 2012Z **(Figure 12)**. The ejecta velocities are between 5000 and 1000 km s^{-1}, which also confirms the low-energy budget of Type Iax SN 2014dt compared to normal Type IaSNe. Using the peak bolometric luminosity of SN 2005hk, the ^{56}Ni mass of ~ 0.14 $M_\odot$ was estimated . The striking similarity between SN 2014dt and SN 2005hk implies that a comparable amount of ^{56}Ni would have been synthesized in the explosion of SN 2014dt. The late detection at ~ 400 days and the excess IR flux (Foley et al. 2015) at late times suggests a bound remnant mechanism leading to the explosion and producing SN 2014dt. If SN 2014dt is detected after a few years (like SN 2008ha) a conclusive statement regarding the progenitor system can be made and will be the second such case. **[Singh, Mridweeka et al.** (including **Misra, K., Dastidar, R., Gangopadhyay, A., Kumar, Brijesh** and **Pandey, S. B.**). (2018). *Mon. Not. Roy. Astron. Soc.* ,*474*, 2551**].**

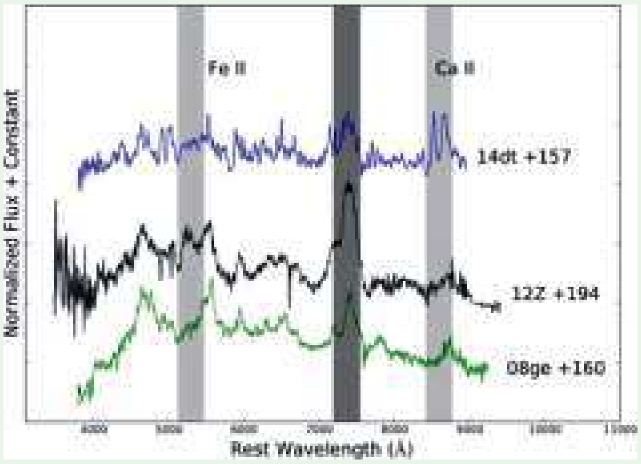

Figure 12. Comparison of the late nebular phase spectrum of SN 2014dt with SNe 2008ge and 2012Z. The most noticeable features around 7300 and 7400 Å are shown by a relatively dark shade. For SNe 2008ge and 2012Z, there are broad emission features with blending of a considerable number of ions. For SN 2014dt, there is no prominent blending so line identification is easy. The Fe II multiplet at 5200 and 5400 Å along with the NIR triplet are present in all three SNe 2014dt, 2012Z and 2008ge.

5. External Galaxies, AGN and Quasars

Multi-epoch intra-night optical monitoring of 8 radio-quiet BL Lac candidate

For a new sample of eight weak-line quasars (WLQs), a sensitive search in 20 intra-night monitoring sessions, for blazar-like optical flux variations on hour-like and longer time-scale (day/month/year-like) was carried out. The sample consists exclusively of the WLQs that are not radio-loud and either have been classified as 'radio-weak probable BL Lac candidates' and/or are known to have exhibited at least one episode of large, blazar-like optical variability. Whereas only a hint of intranight variability is seen for two of these WLQs, J104833.5+620305.0 (z = 0.219) and J133219.6+622715.9 (z = 3.15), statistically significant internight variability at a few per cent level is detected for three of the sources, including the radio-intermediate WLQ J133219.6+622715.9 (z = 3.15) and the well-known bona fide radio-quiet WLQs J121221.5+534128.0 (z = 3.10) and WLQ J153259.9-003944.1 (z = 4.62). In the rest frame, this variability is intraday and in the far-ultraviolet band. On the time-scale of a decade, three of the WLQs large brightness changes, amounting to 1.655 ± 0.009, 0.163 ± 0.010 and 0.144 ± 0.018 mag, for J104833.5+620305.0, J123743.1+630144.9 and J232428.4+144324.4, respectively was observed. Whereas the latter two are confirmed radio-quiet WLQs, the extragalactic nature of J104833.5+620305.0 remains to be well established, thanks to the absence of any feature(s) in its available optical spectra. This study forms a part of our ongoing campaign of intranight optical monitoring of radio-quiet WLQs, in order to improve the understanding of this enigmatic class of active galactic nuclei and amongst them look for a possible tiny, elusive population of radio-quiet BL Lacs. [**Kumar, Parveen**, Gopal-Krishna, Stalin, C. S., **Chand, H.**, Srianand, R. and Petitjean, P. (2017). *Mon. Not. Roy. Astron. Soc., 471*, 606].

A catalog of narrow line Seyfert 1 galaxies from the Sloan Digital Sky Survey Data Release 12

A new catalog of narrow-line Seyfert 1 (NLSy1) galaxies from the Sloan Digital Sky Survey Data Release 12 (SDSS DR12) is presented. This was obtained by a systematic analysis through modeling of the continuum and emission lines of the spectra of all the 68,859 SDSS DR12 objects that are classified as "QSO" by the SDSS spectroscopic pipeline with z < 0.8 and a median signal-to-noise ratio (S/N) > 2 $pixel^{-1}$. This catalog contains a total of 11,101 objects, which is about 5 times larger than the previously known NLSy1 galaxies. Their monochromatic continuum luminosity at 5100 Å is found to be strongly correlated with Hβ, Hα, and [O III] emission line luminosities. The optical Fe II strength in NLSy1 galaxies is about two times larger than the broad-line Seyfert 1 (BLSy1) galaxies. About 5% of the catalog sources are detected in the FIRST survey. The Eddington ratio (ξ_{Edd}) of NLSy1 galaxies has an average of $\log\xi_{Edd}$ of -0.34, much higher than -1.03 found for BLSy1 galaxies. Their black hole masses (M_{BH}) have an average of $\log(M_{BH})$ of 6.9 $M_\odot$, which is less than BLSy1 galaxies, which have an average of $\log(M_{BH})$ of 8.0 $M_\odot$. The M_{BH} of NLSy1 galaxies is found to be correlated with their host galaxy velocity dispersion. Our analysis suggests that geometrical effects play an important role in defining NLSy1 galaxies and their M_{BH} deficit is perhaps due to their lower inclination compared to BLSy1 galaxies. [Rakshit, S., Stalin, C. S., **Chand, H.** and Zhang, Xue-Guang (2017). *Astrophy Jr. Supp.*, *229*: 39].

Tidal interaction, star formation and chemical evolution in blue compact dwarf galaxy Mrk 22

The optical spectroscopic and radio interferometric H I 21 cm-line observations of the blue compact dwarf galaxy Mrk 22 were analysed. The Wolf-Rayet (WR) emission-line features corresponding to high ionization lines of He II λ4686 and C IV λ5808 from young massive stars were detected. The ages of two prominent star-forming regions in the galaxy were estimated as ~10 and ~ 4 Myr. The galaxy has non-thermal radio deficiency, which also indicates a young starburst and lack of supernovae events from the current star formation activities, consistent with the detection of WR emission-line features. A significant N/O enrichment was seen in the fainter star-forming region. The gas-phase metallicities [12 + log(O/H)] for the bright and faint regions are estimated as 7.98 ± 0.07 and 7.46 ± 0.09, respectively. The galaxy has a large diffuse H I envelop. The H I images reveal disturbed gas kinematics and H I clouds outside the optical extent of the galaxy, indicating recent tidal interaction or merger in the system. The results strongly indicate that Mrk 22 is undergoing a chemical and morphological evolution due to ongoing star formation, most likely triggered by a merger. [**Paswan, A., Omar, A.** and **Jaiswal, S.** (2018). *Mon. Not. Roy. Astron. Soc., 473*, 4566].

6. Blazars

On the incidence of Mg II absorbers along the blazar sightlines

It is widely believed that the cool gas clouds traced by Mg II absorption, within a velocity offset of 5000 km/s relative to the background quasar are mostly associated with the quasar itself, whereas the absorbers seen at larger velocity offsets towards us are intervening absorber systems and hence their existence is completely independent of the background quasar. Recent evidence by Bergeron et al. (2011, hereinafter BBM) has seriously questioned this paradigm, by showing that the number density of intervening Mg II absorbers towards the 45 blazars in their sample is nearly 2 times the expectation based on the Mg II absorption systems seen towards normal QSOs. Given its serious implications, it becomes important to revisit this finding, by enlarging the blazar sample and subjecting it to an independent analysis. The outcome of re-analysis of the available spectroscopic data for the BBM sample reproduces their claimed factor of 2 excess of d*N*/d*z* along blazar sightlines, vis-a-vis normal QSOs. By using a ~3 times larger sample of blazars, albeit with moderately sensitive optical spectra. Using this sample together with the BBM sample, the analysis shows that the d*N*/d*z* of the Mg II absorbers statistically matches that known for normal QSO sightlines. Further, the analysis indicates that associated absorbers might be contributing significantly to the estimated d*N*/d*z* upto offset speeds Δυ ~ 0.2c relative to the blazar. **[Mishra, S., Chand, H.**, Gopal- Krishna, Joshi, R., Shchekinov, Y. A. and Fatkhullin, T. A. (2018). *Mon. Not. Roy. Astron. Soc., 473*, 5154**]**.

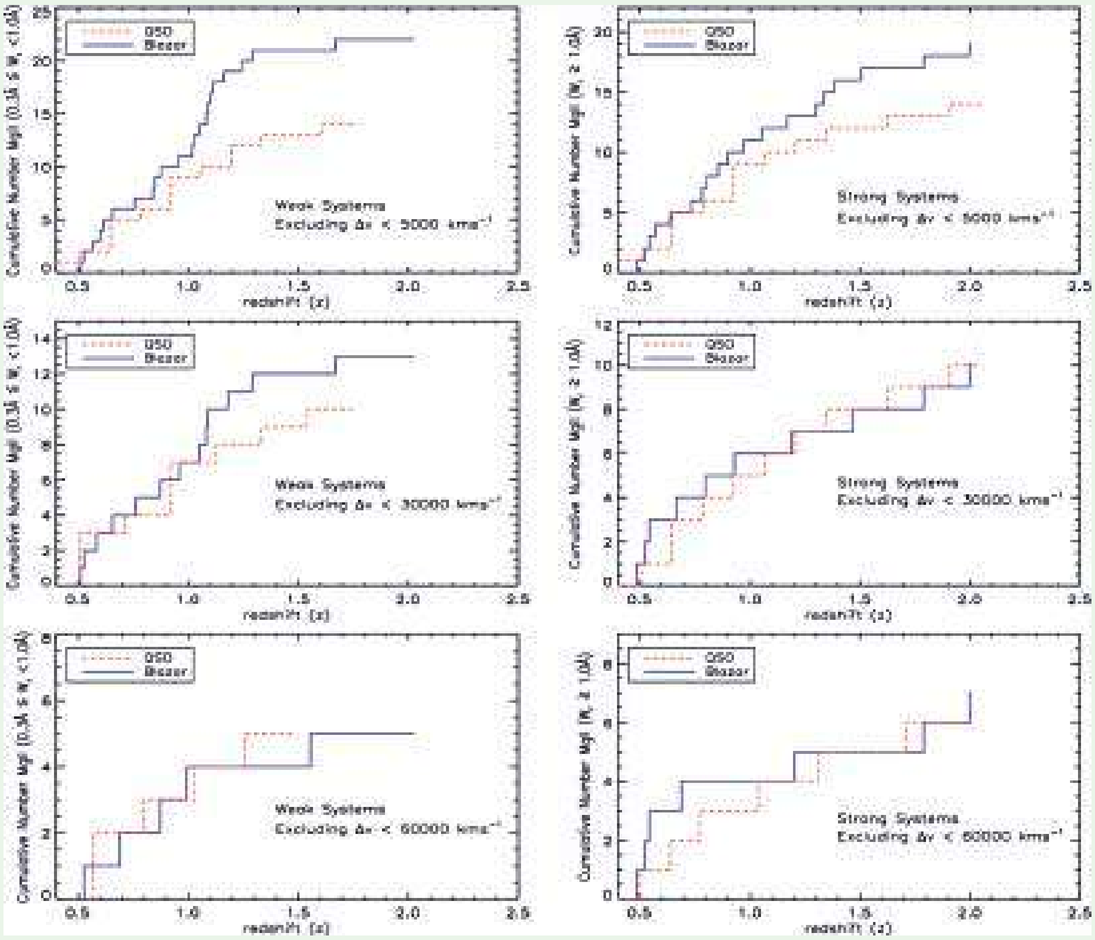

Figure 13. Cumulative number of weak (left-hand panel) and strong (right-hand panel) intervening Mg II absorption systems detected towards blazars (blue solid line) and QSOs (red dashed line), after excluding the systems with offset velocity (Δv) < 5000 km s^{-1} (top panel), Δv < 30 000 km s^{-1} (middle panel) and Δv < 60 000 km s^{-1} (bottom panel).

X-ray intraday variability of five TeV blazars with NuSTAR

40 light curves of Nuclear Spectroscopic Telescope Array (NuSTAR) of five TeV emitting high synchrotron peaked blazars: 1ES 0229+200, Mrk 421, Mrk 501, 1ES 1959+650, and PKS 2155−304 were examined. Four of the blazars showed intraday variability in the NuSTAR energy range of 3–79 keV. Using an autocorrelation function analysis, intraday variability timescales in these LCs were found between 2.5 and 32.8 ks in eight LCs of Mrk 421, a timescale around 8.0 ks for one LC of Mrk 501, and timescales of 29.6 and 57.4 ks in two LCs of PKS 2155-304. The other two blazars' LCs do not show any evidence for intraday variability timescales shorter than the lengths of those observations; however, the data were both sparser and noisier for them.

Positive correlations with zero lag between soft (3–10 keV) and hard (10–79 keV) bands for most of the LCs, indicating that their emissions originate from the same electron population. Spectral variability was examined using a hardness ratio analysis and noticed a general "harder-when-brighter" behavior. The 22 LCs of Mrk 421 observed between July, 2012 and April, 2013 show that this source was in a quiescent state for an extended period of time and then underwent an unprecedented double-peaked outburst while monitored on a daily basis during 10 - 16 April, 2013. **[Pandey, A., Gupta, A. C.** & Wiita, P. J. (2017). *Astrophs. Jr., 841*, 123**]**.

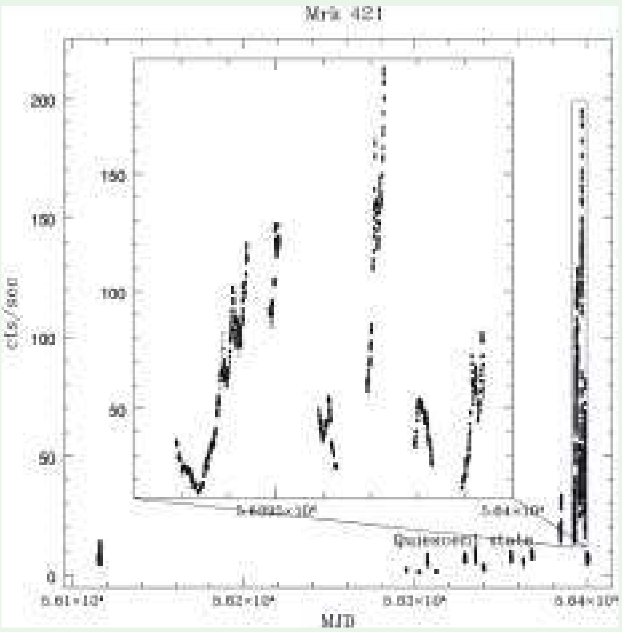

Figure 14. Short-term variability of Mrk 421.

Multiwavelength temporal and spectral variability of the blazar OJ 287 during and after the 2015 December flare: a major accretion disc contribution

In a multiwavelength spectral and temporal analysis of the blazar OJ 287 during its recent activity between December, 2015 and May, 2016, showing strong variability in the near-infrared (NIR) to X-ray energies with detection at γ-ray energies as well. Most of the optical flux variations exhibit strong changes in polarization angle and degree. All the interband time lags are consistent with simultaneous emissions. Interestingly, on days with excellent data coverage in the NIR-UV bands, the spectral energy distributions (SEDs) show signatures of bumps in the visible-UV bands, never

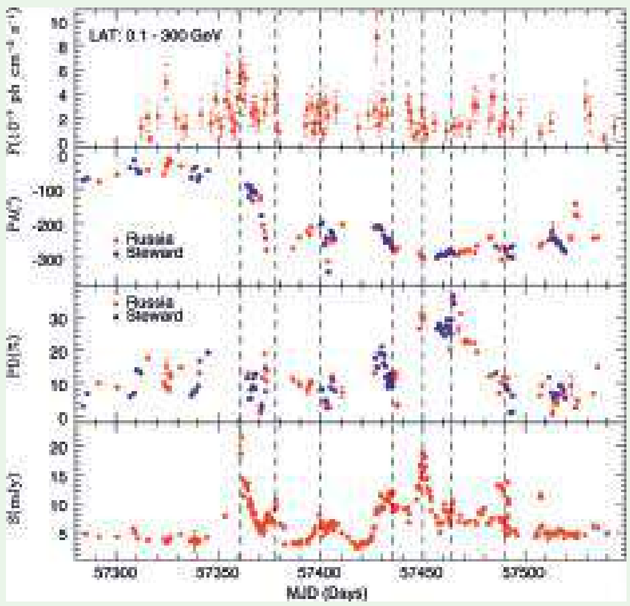

Figure 15. September, 2015 –May, 2016 optical polarization data plotted along with the γ-ray (top) and R-band (bottom) light curves of OJ 287. The dashed vertical lines note the peaks of the flares.

seen before in this source. The optical bump can be explained as accretion-disc emission associated with the primary black hole of mass ~ $1.8 \times 10^{10} M_{\odot}$ while the little bump feature in the optical-UV appears consistent with line emission. Further, the broad-band SEDs extracted during the first flare and during a quiescent period during this span show very different γ-ray spectra compared to previously observed flare or quiescent spectra. The probable thermal bump in the visible seems to have been clearly present since May, 2013 , as found by examining all available NIR-optical observations, and favours the binary supermassive black hole model. The simultaneous multiwavelength variability and relatively weak γ-ray emission that shows a shift in the SED peak is consistent with γ-ray emission originating from inverse Compton scattering of photons from the line emission that apparently contributes to the little blue bump. **[**Kushwaha, P, et al. (including **Gupta, A. C.**). (2018). *Mon. Not. Roy. Astron. Soc., 473*, 1145**]**.

A peculiar multiwavelength flare in the blazar 3C 454.3

The blazar 3C 454.3 exhibited a strong flare seen in γ-rays, X-rays and optical/near-infrared bands during 3 - 12, December, 2009 . Emission in the V and J bands rose more gradually than did the γ-rays and soft X-rays, though all peaked at nearly the same time. Optical polarization measurements showed dramatic changes during the flare, with a strong anti-correlation between optical flux and degree of polarization (which rose from ~ 3 to ~ 20 per cent) during the declining phase of the flare. The flare was accompanied by large rapid swings in polarization angle of ~ 170°. This combination of behaviours appears to be unique. Radio data in cm-band during the same period show no correlation with variations at higher frequencies. Such peculiar behaviour may be explained using jet models incorporating fully relativistic effects with a dominant source region moving along a helical path or by a shock-in-jet model incorporating three-dimensional radiation transfer if there is a dominant helical magnetic field. It is found that spectral energy distributions at different times during the flare can be fit using modified one-zone models where only the magnetic field strength and particle break frequencies and normalizations need change. An optical spectrum taken at nearly the same time provides an estimate for the central black hole mass of ~$2.3 \times 10^{9} M_{\odot}$. The other two weaker flares seen during the ~200 d span over which multiband data are available. In one of them, the V and J bands appear to lead the γ-ray and X-ray bands by a few days; in the other, all variations are simultaneous. **[Gupta, A. C.**, et al. (2017). *Mon. Not. Roy. Astron. Soc., 472*, 788**]**.

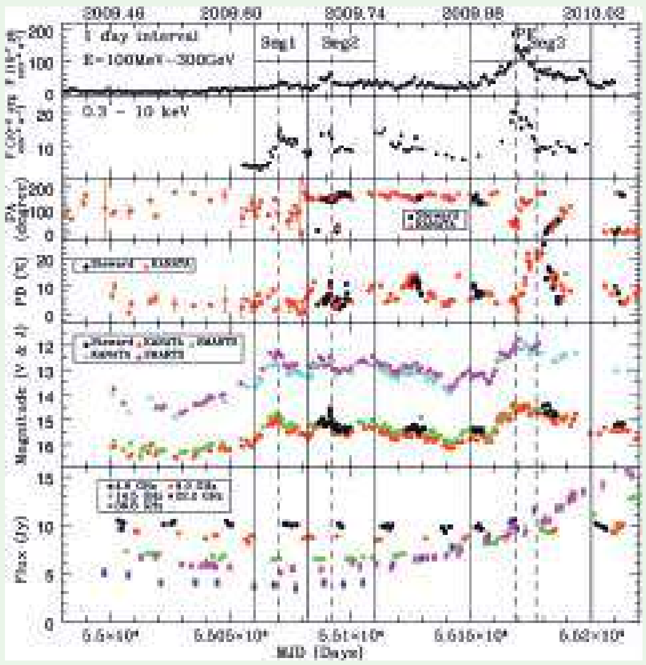

Figure 16. In the top and second panels γ-ray and X-ray fluxes from Fermi-LAT and Swift/XRT are, respectively, presented. The third panel gives optical position angle (PA) while the fourth gives the optical polarization degree (PD). In the fifth panel, we give optical V band data from KANATA, SMARTS and Steward as the lower LC along with NIR J-band data from KANATA and SMARTS as the upper one. In the bottom panel radio data are given from: UMRAO at 4.8, 8.0 and 14.5 GHz; CrAO at 22.2 GHz and Metsähovi at 36.8 GHz. Except where shown, error bars are smaller than the symbols. Solid vertical lines mark the three segments in which multiband correlations are studied and dashed vertical lines, respectively, mark the peaks of the first and second flares, the peak of the peculiar flare (PF) and a decaying phase of PF.

Origin of X-rays in the low state of the FSRQ 3C 273: evidence of inverse Compton emission

The 2.5-10 keV X-ray spectra and simultaneous observations in UV wavelengths from *XMM*-Newton between 2000 and 2015 were analysed for the luminous quasar 3C 273. The lowest flux level ever was observed in 2015. The continuum emission from 3C 273 is generally best described by an absorbed power-law but during extremely low states the addition of fluorescence from the K-shell iron line improves the fit. The spectral evolution of the source during its extended quiescent state and also the connections between the X-ray and ultraviolet emissions were studied, which have been seen in some, but not all, previous work. A possible anti-correlation between these two bands is detected during the low state that characterized 3C 273 for most of this period; however, this was not present during a flaring state. A harder-when-brighter trend for the X-ray spectrum was observed in these long-term observations of 3C 273 for the first time. The finding suggest that the X-ray emission in 3C 273 is the result of inverse Compton scattering of soft UV seed photons (emitted from the local environment of the AGN), most likely in a thermal corona. It can explain the significant temporal variation of the spectral continuum as an outcome of changing optical depth of the Comptonizing medium, along the lines of the wind-shock model proposed by Courvoisier and Camenzind. [**Kalita, N.**, et al. (including **Gupta, A. C.**). (2017). *Mon. Not. Roy. Astron. Soc., 469,* 3824].

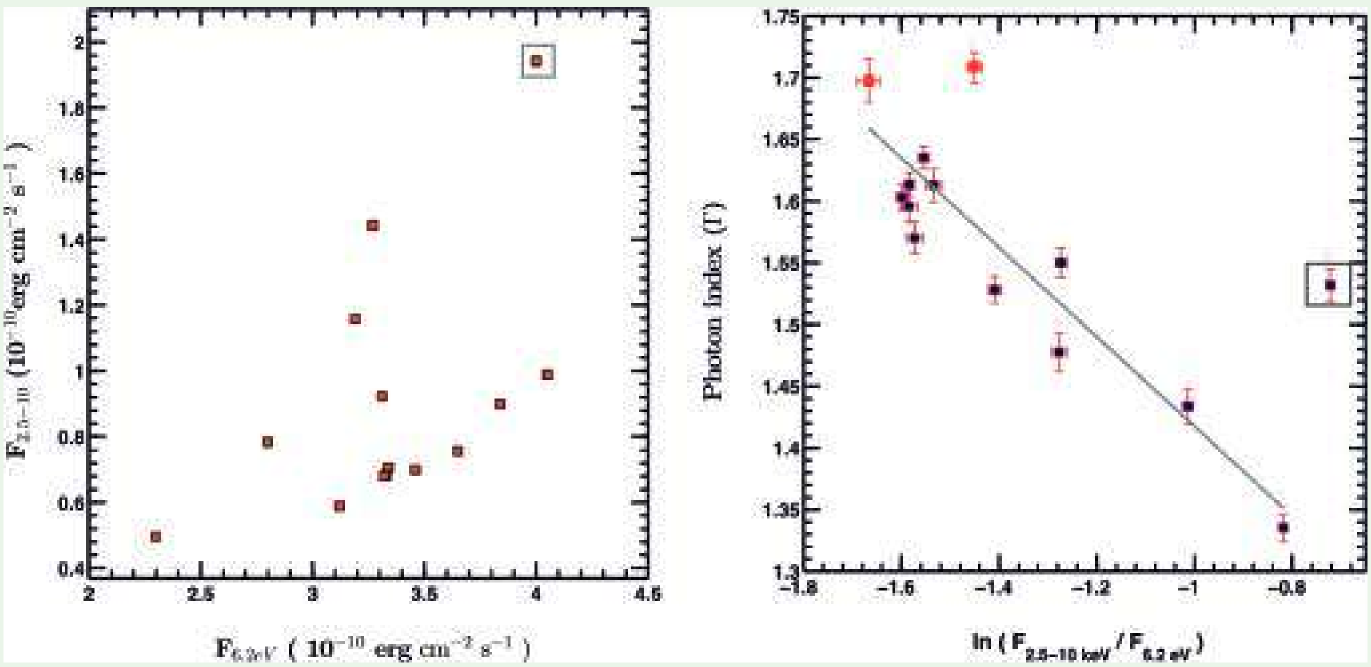

Figure 17. Left: X-ray flux in the energy range 2.5–10 keV versus ultraviolet flux at energy 6.2 eV. Error bars are smaller than the symbol size. Right: the 2.5–10 keV spectral index as a function of the logarithm of the ratio of the 2.5–10 keV to 6.2 eV UV flux shows a significant anticorrelation.

Core shift effect in blazars

The pc-scale core shift effect using radio light curves for three blazars, S5 0716+714, 3C 279 and BL Lacertae, which were monitored at five frequencies (ν) between 4.8 and 36.8 GHz using the University of Michigan Radio Astronomical Observatory (UMRAO), the Crimean Astrophysical Observatory (CrAO) and Metsähovi Radio Observatory for over 40 yr were studied. Flares were Gaussian fitted to derive time delays between observed frequencies for each flare (Δt), peak amplitude (A) and their half width. Using $A \propto \nu^{\alpha}$, α was found in the range of -16.67-2.41 and using $\Delta t \propto \nu^{1/k_r}$, $k_r \sim 1$ were found, employed in the context of equipartition between magnetic and kinetic energy density for parameter estimation. From the estimated core position offset ($\Omega_{r\nu}$) and the core radius (r_{core}), it is found that opacity model may not be valid in all cases. The mean magnetic field strengths at 1 pc (B_1) and at the core (B_{core}) are in agreement with previous estimates. The magnetically arrested disc model was applied to estimate black hole spins in the range of 0.15-0.9 for these blazars, indicating that the model is consistent with expected accretion mode in such sources. The power-law-shaped power spectral density has slopes -1.3 to -2.3 and is interpreted in terms of multiple shocks or magnetic instabilities. **[Agarwal, A.,** et al. (including **Gupta, A. C.**). (2017). *Mon. Not. Roy. Astron. Soc., 469*, 813**]**.

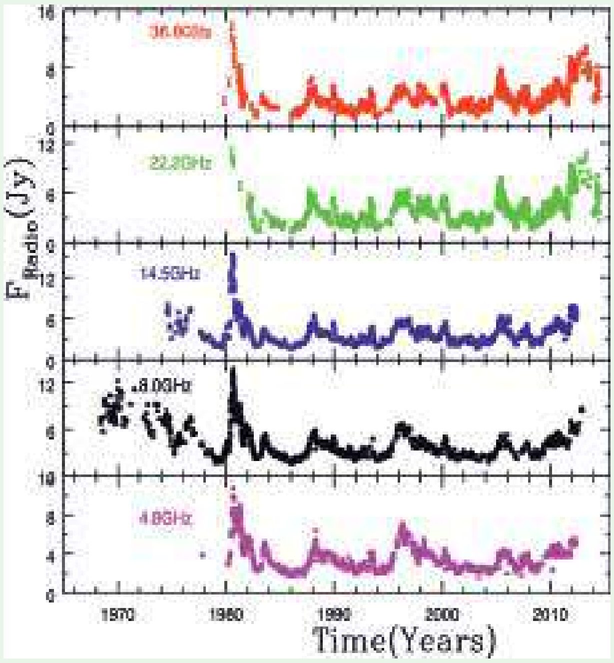

Figure 18. Long-term variability light curves of BL Lac in the 4.8–36.8 GHz frequency range.

7. Theoretical and Numerical Studies

Radiatively driven general relativistic jets

Moment formalism of relativistic radiation hydrodynamics was used to obtain equations of motion of radial jets and subsequently was solved using polytropic equation of state of the relativistic gas. In addition the curvature of space-time around black holes was considered to obtain jets with moderately relativistic terminal speeds. The radiation field from the accretion disc is able to induce internal shocks in the jet close to the horizon. Under combined effect of thermal as well as radiative driving, terminal speeds up to 0.75 (units of light speed) were obtained. **[Vyas, M. K.** and **Chattopadhyay, I.** (2018). *Jr. Astrphy. Astron., 39*: 12**]**.

Study of magnetized accretion flow with cooling processes

Shock in magnetized accretion flow/funnel flow in case of neutron star with bremsstrahlung cooling and cyclotron cooling was studied. All accretion solutions terminate with a shock close to the neutron star surface, but at some regions of the parameter space, it also harbours a second shock away from the star surface. It was found that cyclotron cooling is necessary for correct accretion solutions which match the surface boundary conditions. **[Singh, K.** and **Chattopadhyah, I.** (2018). *Jr. Astrphy. Astron., 39*:10**]**.

Estimation of bipolar jets from accretion discs around Kerr black holes

Flows around a rotating black hole were analyzed and self-consistent accretion-ejection solutions were obtained in full general relativistic prescription. Entire energy-angular momentum parameter space was investigated in the advective regime to obtain shocked and shock-free accretion solutions. Jet equations of motion were solved along the von Zeipel surfaces computed from the post-shock disc, simultaneously with the equations of accretion disc along the equatorial plane. For a given spin parameter, the mass outflow rate increases as the shock moves closer to the black hole, but eventually decreases, maximizing at some intermediate value of shock location. Interestingly, all types of possible jet solutions was obtained, for example, steady shock solution with multiple critical points, bound solution with two critical points and smooth solution with single critical point. Multiple critical points may exist in jet solution for spin parameter $a_s \geqslant 0.5$. The jet terminal speed generally increases if the accretion shock forms closer to the horizon and is higher for co-rotating black hole than the counter-rotating and the non-rotating one. Quantitatively speaking, shocks in jet may form for spin parameter $a_s > 0.6$ and jet shocks range between $6r_g$ and $130r_g$ above the equatorial plane, while the jet terminal speed $v_{j\infty} > 0.35$ c if Bernoulli parameter $\mathcal{E} \geqslant 1.01$ for $a_s > 0.99$. **[Kumar, Rajiv** and **Chattopadhyay, I.** (2017). *Mon. Not. Roy. Astron. Soc., 469,* 4221**]**.

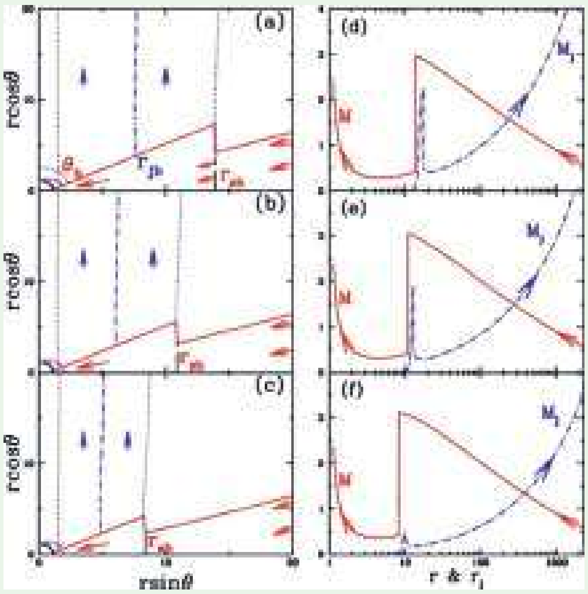

Figure 19. Self-consistent accretion-jet solutions: flow boundary (a, b, c) of accretion disc (solid, red), jet streamline (dash–dotted, blue), jet boundary (dotted, blue), horizon (solid quarter circle), ergosphere (dash–dotted quarter ellipse), the radius of the jet base r_{jb} and its polar angle θ_{jb} are shown. Accretion Mach number M (solid, red) and jet Mach number M_j (dash–dotted blue) with radial distance are plotted (d, e, f). The right-hand panels correspond to the accretion-jet solutions and the left-hand panels correspond to related geometry. Each pair of right- and left-hand panels are plotted for $\lambda = 2$ (a, d), $\lambda = 1.99$ (b, e) and $\lambda = 1.98$ (c, f). Accretion shocks are produced at $r_{sh} = 13.8308$ (a, d), $r_{sh} = 10.8179$ (b, e) and $r_{sh} = 8.2275$ (c, f). The arrows show flow direction. For all the panels, $\mathcal{E} = 1.0001$, $\xi = 1.0$ and $a_s = 0.99$.

General relativistic study of astrophysical jets with internal shocks

The possibility of the formation of steady internal shocks in jets around black holes was studied. A fluid described by a relativistic equation of state, flowing about the axis of symmetry ($\theta = 0$) in a Schwarzschild metric was considered. Two models for the jet geometry: (i) a conical geometry and (ii) a geometry with non-conical cross-section was used. A jet with conical geometry has a smooth flow, while the jet with non-conical cross-section undergoes multiple sonic points and even standing shock. The jet shock becomes stronger, as the shock location is situated farther from the central black hole. Jets with very high energy and very low energy do not harbour shocks, but jets with intermediate energies do harbour shocks. One advantage of these shocks, as opposed to shocks mediated by external medium, is that these shocks have no effect on the jet terminal speed, but may act as possible sites for particle acceleration. Typically, a jet with specific energy $1.8c^2$ will achieve a terminal speed of $\upsilon_\infty = 0.813c$ for jet with any geometry, where, c is the speed of light in vacuum. But for a jet of non-conical cross-section for which the length scale of the inner torus of the accretion disc is $40r_g$, then, in addition, a steady shock will form at $r_{sh} \sim 7.5r_g$ and compression ratio of $R \sim 2.7$. Moreover, electron-proton jet seems to harbour the strongest shock. Possible consequences of such a scenario was discussed. **[Vyas, M.** and **Chattopadhyay, I.** (2017). *Mon. Not. Roy. Astron. Soc.,* 469, 3270**]**.

8. 3.6m DOT

Scientific capabilities and advantages of the 3.6 meter optical telescope at Devasthal

India's largest 3.6m aperture optical telescope has been successfully installed in the central Himalayan region at Devasthal, Nainital district, Uttarakhand. The primary mirror of the telescope uses the active optics technology. The back-end instruments, enabling spectroscopic and photometric imaging of the celestial sky are designed and developed by ARIES along with other Indian institutes. The Devasthal optical telescope in synergy with two other highly sensitive telescopes in the country, namely GMRT operating in the radio wavebands and *AstroSat* operating in the high-energy X-ray, ultraviolet and visual wavebands, will enable Indian astronomers to carry out scientific studies in several challenging areas of astronomy and astrophysics. **[Omar, A., Kumar, Brijesh, Gopinathan, M.** and **Sagar, R.** (2017). *Curr. Sci.*, *113*, 682**]**.

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

Tata Institute of Fundamental Research (TIFR) Near Infrared Imaging Camera-II (TIRCAM2) is a closed-cycle Helium cryo-cooled imaging camera equipped with a Raytheon 512 x 512 pixels InSb Aladdin III Quadrant focal plane array (FPA) having sensitivity to photons in the 1-5μm wavelength band. Performance of the camera on the newly installed 3.6m Devasthal Optical Telescope (DOT) were recently checked based on the calibration observations carried out during 11-14 May, 2017 and 7-31 October, 2017. After the preliminary characterization, the camera has been released to the Indian and Belgian astronomical community for science observations since May, 2017. The camera offers a field-of-view (FoV) of ~ 86.5″ x 86.5″ on the DOT with a pixel scale of 0.169″. The seeing at the telescope site in the near-infrared (NIR) bands is typically sub-arcsecond with the best seeing of ~0.45″ realized in the NIR *K*-band on 16 October, 2017. The camera is found to be capable of deep observations in the *J*, *H* and *K* bands comparable to other 4m class telescopes available world-wide. Another highlight of this camera is the observational capability to observe sources up to Wide-field Infrared Survey Explorer (WISE) W1-band (3.4μm) ~9.2 magnitude in the narrow *L*-band (*nbL*; λ_{cen} ~ 3.59 μm). Hence, the camera could be a good complementary instrument to observe the bright *nbL*-band sources that are saturated in the Spitzer-Infrared Array Camera (IRAC) ([3.6] $\leqslant$ 7.92 mag) and the WISE W1-band ([3.4] $\leqslant$ 8.1 mag). Sources with

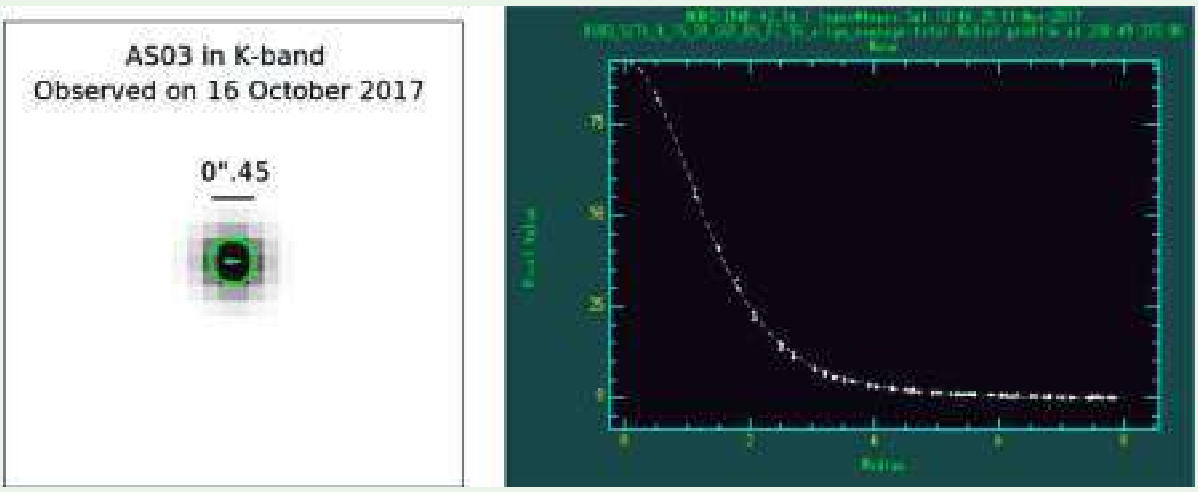

Figure 20. A seeing of ~0".45 was observed on 2017 October 16. The stellar profile of the source AS 03 and the corresponding radial profile are shown in the left and right panels, respectively.

strong polycyclic aromatic hydrocarbon (PAH) emission at 3.3 μm are also detected. Details of the observations and estimated parameters are presented. **[Baug, T.** et al. (including **Sharma, S., Pandey, A. K., Kumar, Brijesh, Ghosh, A., Reddy, B. K., Pandey, S. B.** and **Chand, H.**) (2018). *Jr. Astronomical Instrumentation*, 7, 1850003**]**.

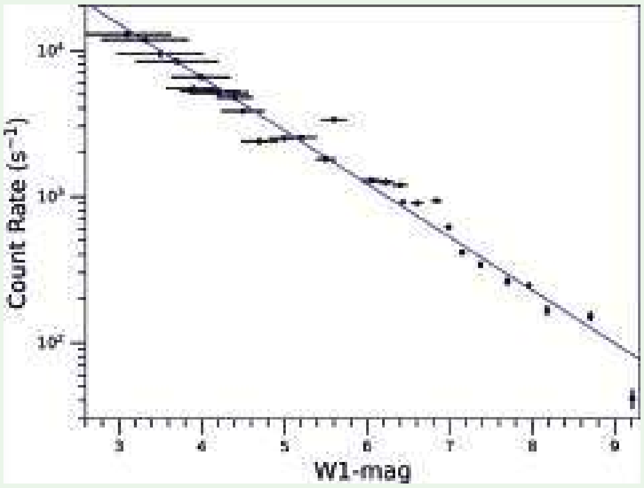

Figure 21. The TIRCAM2 count rates versus the WISE W1-band magnitudes ([3.4]), showing the linear behavior of the TIRCAM2 in the nbL-band in the given magnitude range.

Solar Physics & Atmospheric Sciences

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

Slippage of jets explained by the magnetic topology

Most of the large solar activity is somehow related to the transient phenomena as occurring in the solar atmosphere. Solar jets (transient events) are small-scale dynamic events that are observed as collimated ejections

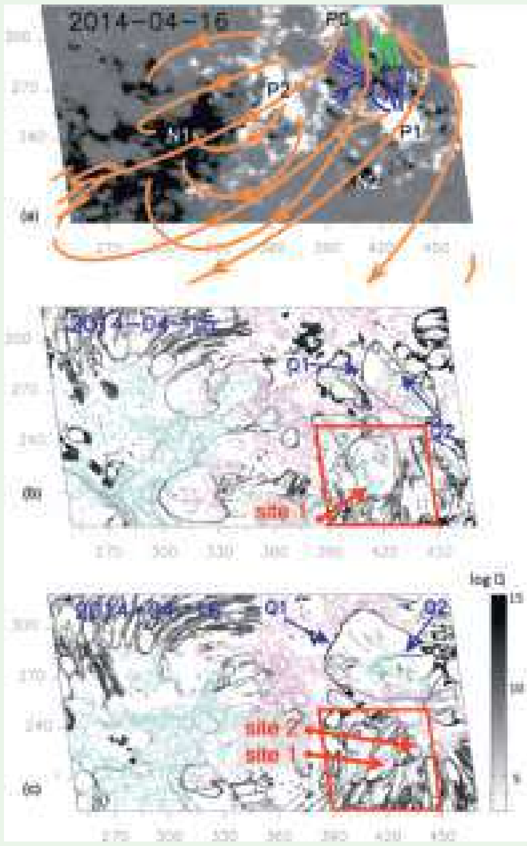

Figure 22. Magnetic field (line-of-sight component) of AR 12035 for 16 April 2014. Panel (a) shows the two leading positive polarities P1 and P2 and the following negative polarity N1. The magnetic field is overlaid by magnetic field lines obtained from a potential extrapolation. Panels (b) and (c): Contours of the magnetic field overlaid by the footprints of the QSL at z = 0.4 Mm above the photosphere for 15 April (b) and 16 April (c). Q1 and Q2 indicate the QSLs related to the flares, The magenta/cyan contours are drawn for levels of the magnetic field equal to ± 100, ± 300, ± 500, ± 700, and ± 900 Gauss. The red boxes indicate the region of the jets, site 1 on 15 April, and both sites on 16 April.

of plasma material from the lower solar atmosphere to coronal heights. Jets are particularly visible in coronal hole (CH) regions, due to regions of open magnetic fields with weaker EUV background emission. For the detailed analysis of jets, 11 recurring solar jets that originated from two different sites (site 1 and site 2) close to each other ($\approx$ 11 Mm) in NOAA active region (AR) 12035 during 15 - 16 April 2014 has been investigated. These jets were observed by the Atmospheric Imaging Assembly (AIA) telescope on board the Solar Dynamics Observatory (SDO) satellite. Two jets were observed by the telescope of the ARIES, Nainital, India, in Hα. On 15 April, flux emergence is strong in site 1, while on 16 April, flux emergence and cancellation mechanisms are involved in both sites. The jets of both sites have parallel trajectories and move to the south with a speed between 100 and 360 km s^{-1}. The jets of site 2 occurred during the second day have a tendency to move toward the jets of site 1 and merge with them. The slippage of the jets could be explained by the complex topology of the region, which included a few low-altitude null points and many quasi-separatrix layers (QSLs), which could intersect with one another. [Joshi, R. et al. (including **Uddin, W.**). (2017). *Sol. Phy., 292,* 152].

A study of a long duration small flare-CME event and associated shock

Solar Flares are the most energetic phenomenon near the solar surface and occasionally they are accompanied by filament (or prominence) eruptions and coronal mass ejections (CMEs). The association of filament eruptions with solar flares varies from small GOES B-class flares to very large GOES X-class flares. For the understanding of the association of shock with the small flare, a GOES B-class small long duration flare associated with a quiescent filament eruption has been observed, This flare was also associated with a global EUV wave and a CME on 11 May, 2011. The event was well observed by the Solar Dynamics Observatory (SDO), GONG Hα, STEREO and Culgoora spectrograph. As the filament erupted, ahead of the filament the propagation of EIT wave fronts were observed, as well as two flare ribbons on both sides of the polarity inversion line (PIL) on the solar surface. The observations show the co-existence of two types of EUV waves, i.e., a fast and a slow one. A type II radio burst with up to the third harmonic component was also associated with this event. The evolution of photospheric magnetic field showed flux emergence and cancellation at the filament site before its eruption. [Chandra, R., Chen, P. F., Fulara, A., Srivastava, A. K., **Uddin, W.**, 2018, *Advances in Space Research, 61, 705C*].

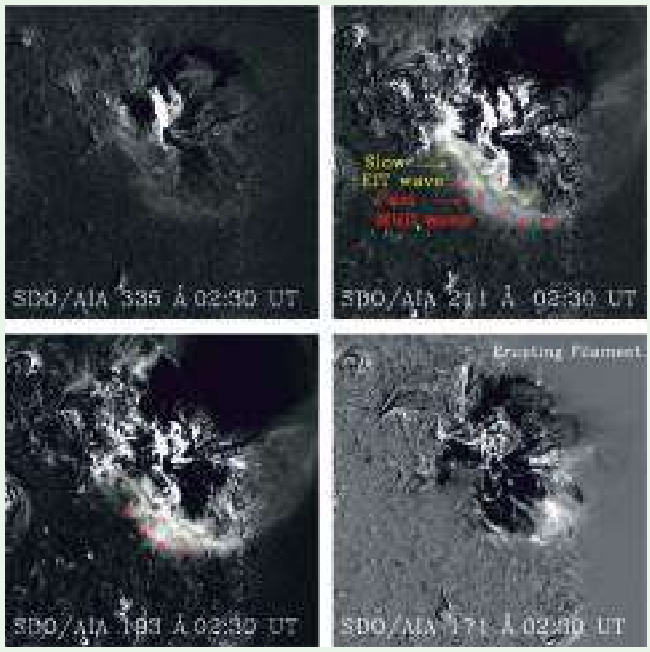

Figure 23. A snapshot of the slow and fast EUV waves visible in different AIA wavelengths. The fast and slow waves are indicated by red and yellow asterisks, respectively.

2. Atmospheric Sciences

Loss of crop yields in India due to surface ozone

This study estimates the losses of wheat and rice crop yields using surface ozone observations from a group of 17 sites, for the first time, covering different parts of India. The average ozone for 7 h during the day (M7) and accumulated ozone over a threshold of 40 ppbv (AOT40) metrics are used for the calculation of crop losses over the northern, eastern, western and southern regions of India

(Figure 24). Estimates show the highest annual loss of wheat (~ 9 million ton) in the northern India, one of the most polluted regions in India, and that of rice (~ 2.6 million ton) in the eastern region. The total all India annual loss of 4.0–14.2 million ton (4.2–15.0%) for wheat and 0.3–6.7 million ton (0.3–6.3%) for rice are estimated. The results show lower crop loss for rice than that of wheat mainly due to lower surface ozone levels during the cropping season. These estimates based on a network of observation sites show lower losses than earlier estimates based on limited observations and much lower losses compared to global model estimates. However, these losses are slightly higher compared to a regional model estimate. Further, the results show large differences in the loss rates of both the two crops using the M7 and AOT40 metrics. This study also confirms that AOT40 cannot be fit with a linear relation over the Indian region and suggests for the need of new metrics that are based on factors suitable for this region.**[**Lal, S. et al. (including **Naja, M**). (2017). *Envir. Sci. Pollut. Res., 24*, 20972-98.**]**

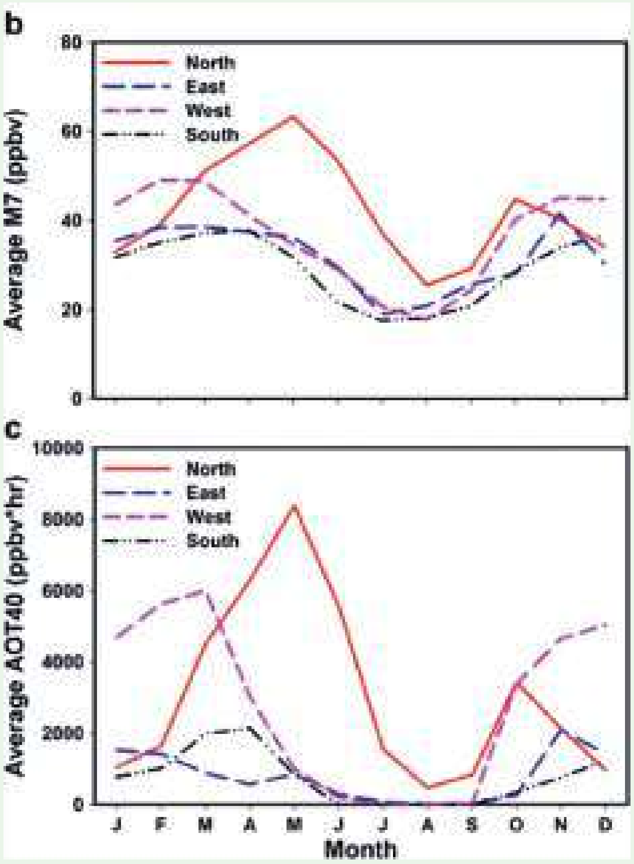

Figure 24. (b)Monthly average M7 and (c) monthly average AOT40 for the four regions of India.

Trace gases and aerosols over IGP and Indian Himalayan region

Continuous observations of gaseous and particulate air pollutants (surface ozone, NO, NO_2, CO, $PM_{2.5}$ and PM_{10}) were carried out from a network of 8 sites across Delhi-NCR. In-addition four observational campaigns were also conducted for sampling the ambient $PM_{2.5}$ and PM_{10} at multiple locations (18 sites) in the IGP, IHR, and semi-arid/arid sites. Back-air trajectories and residence time analysis are used to quantify the amount of photochemical ozone buildup. Taggingof ozone values with residence time revealed significant positive correlations indicating that ozone buildup begins when fresh air masses come into the polluted domain and is accumulated during 1–3 days, producing ozone through photo-oxidation processes. Following this, less pronounced effects are observed due to saturated and aged air masses, showing reduced photo-chemistry. The study found out that large-scale anthropogenic emissions in the surrounding regions had the strongest influence on ozone production, but long-range transport was a dominant likelihood, especially during the pre-monsoon season. Data from space-borne sensors (MODIS) were also utilized for estimating the columnar Aerosol Optical Depth at 550 nm and open burning fires in the vicinity of sampling sites. Determination of the major source regions and key transport pathways were studied using back-trajectory cluster analyses, as well as receptor models such as PSCF and CWT. Most of the back trajectories and trajectory clusters arriving at the IGP sites during the winter season were observed to originate in and mainly traverse across the IGP, leading to outflow into the BoB. [Peshin, S. K. et al., (including **Naja, M.)**. (2017). *Sustainable Cities and Society*, *35*, 740-751; Sen, A. et al. (including **Naja, M.**). (2017). *Atmos. Envir., 154,* 200-224.**]**

Unusual enhancement in tropospheric and surface ozone due to orography induced gravity waves

In this study, the causative processes responsible for the observed enhancement in the tropospheric and surface ozone during 09 - 11 December, 2008 orography induced gravity wave event over Himalayan region are investigated. The analysis is done using surface ozone measurements and satellite datasets from Atmospheric Infrared Sounder/Advanced Microwave Sounding Unit-A (AIRS/AMSU-A), COSMIC, TES and Cloud-Aerosol Lidar and Infrared Pathfinder Satellite Observation (CALIPSO). Observations depict a two fold increase in surface and tropospheric ozone during the event as compared to normal days in both AIRS and TES ozone measurements. COSMIC temperature perturbations show generation of shorter vertical wavelengths efficient for the sub-tropical tropopause folding due to orography induced gravity waves. Moreover, intense tropopause folding as evidenced by upward-downward vertical velocities couplet could trigger the intrusion of stratospheric ozone rich air into upper tropospheric ozone poor air as also confirmed by high values of potential vorticity during the observational period. Hence, present study reemphasized the importance of wave induced atmospheric dynamics on atmospheric constituents' especially tropospheric ozone over Himalayan region. [**Phanikumar, D. V.,** et al. (including **Bhattacharjee, S. and Naja, M.**). (2017). *Remote Sensing of Envir., 199,* 256-264**].**

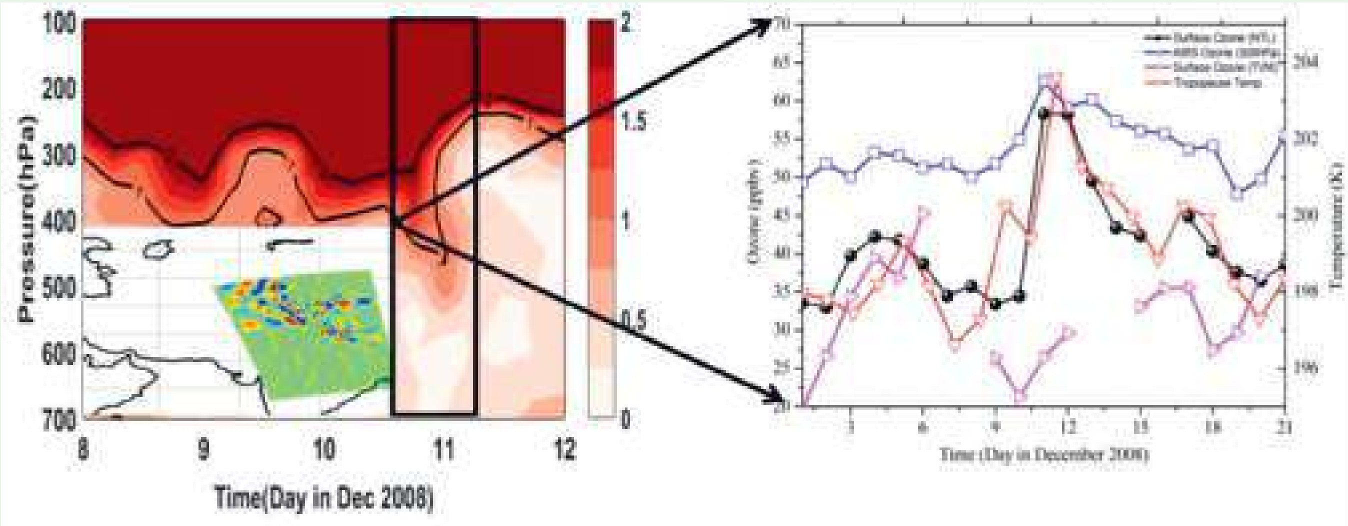

Figure 25. Unusual enhancement in ozone concentration due to mountain waves over Himalayan region.

Analysis of total column ozone, water vapour and aerosol optical thickness over Ahmedabad, India

A study on the quality of Total Column Ozone (TCO), Water Vapor (WV) and Aerosol Optical Thickness (AOT) available from satellite and reanalysis from atmospheric models along with *in- situ* observations over Ahmedabad (23.03°N, 72.5°E, 55 m amsl), India are investigated. The ground-based measurements from MICROTOPS-II Ozonometer as well as space-based satellite retrieved products from Moderate Resolution Imaging Spectroradiometer (MODIS) and Ozone Monitoring Instrument (OMI) have been analyzed during December 2014 - March 2015. The European Centre for Medium-Range Weather Forecasts (ECMWF) reanalysis Interim

(ERAI) created TCO and WV are also utilized to assess the potential of global model reanalysis over the western part of India. An increasing trend has been observed in TCO and WV parameters from winter to summer period. Investigations also showed that MODIS satellite retrieved and ERAI analyzed WV are able to capture the trends as compared to ground-based hand held MICROTOPS-II observations. Higher TCO are found in MODIS data, whereas, ERAI and OMI TCO are showing reasonably good agreement with ground-based observations and large errors are associated with MODIS AOT. Further, it is emphasized in the present study that ERAI has sufficient potential to be used for various meteorological applications over the western Indian region. Furthermore, variation of TCO, WV and AOT has been studied over the orographic region of the Mt. Abu

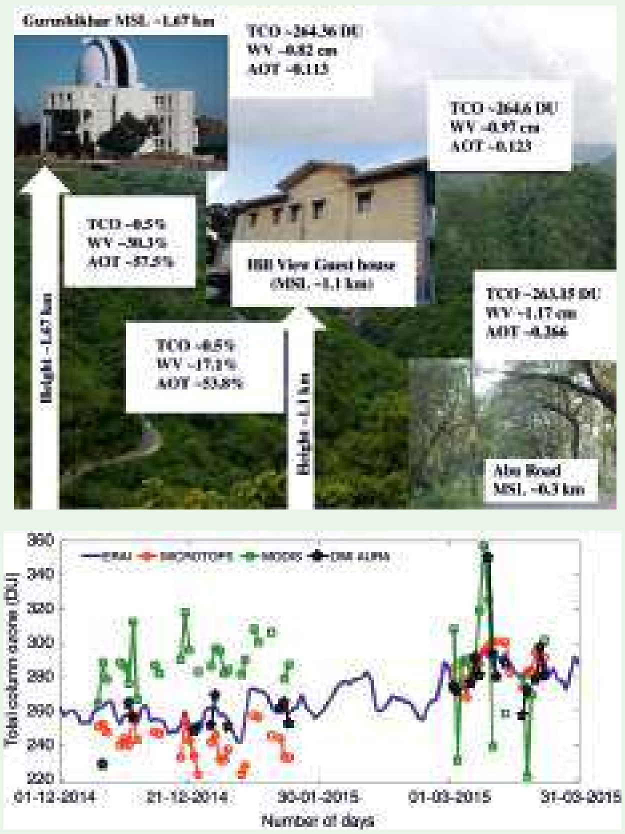

Figure 26. Variations in TCO, WV and AOT observed by the MICROTOPS II at different altitudes over Mount Abu and Rajasthan regions.

(~110 km aerial distance from Ahmedabad), located in the Aravali range of the mountains. Ground-based measurements at different altitudes (at 0.3 km, 1.1 km and at 1.67 km above mean sea level (amsl)) revealed significant variations in WV and AOT. The WV varies 17.1% (30.3%) and AOT 53.8% (57.5%) in 1 km (1.67 km), whereas, no noteworthy variations are observed in the TCO in this field campaign. [Sharma, S., Kumar, P., Vaishnav, R., Shukla, K. K., **Phanikumar, D. V.** (2018). *Meteorological Application, 25,* 33-39].

Trace gases and aerosols in the central Himalaya and its foothills region

The SusKat (Sustainable Atmosphere for the Kathmandu Valley) international air pollution measurement campaign was carried out from December 2012 to June 2013 in the Kathmandu Valley and surrounding regions in Nepal and India. Several trace gases and aerosols (physical, optical and chemical properties) observations are made during this campaign. Here, observations of two major greenhouse gases (CH_4 and CO_2), PM, BC, CO, and O_3 are discussed those are made at SusKat supersite (Bode) and Lumbini. Extended observations were also made from few sites. The observed annual average mixing ratios of CO_2 (419.3 ± 6.0 ppm) and CH_4 (2.192 ± 0.07 ppm) at Bode were higher than the levels observed at Mauna Loa, USA; Waliguan, China and at other urban/semi-urban sites in India. The enhancement in CO_2 mixing ratios during the pre-monsoon season is associated with additional CO_2 emissions from forest fires and agro-residue burning in northern South Asia in addition to local emissions in the Kathmandu Valley. Published CO & CO_2 ratios of different emission sources in Nepal and India suggested that the major sources in the Kathmandu Valley are residential cooking and vehicle exhaust in all seasons except winter. In winter, brick kiln emissions are a major source. Levels of PM, BC, CO, O_3 at Lumbini are observed to be comparable to other very heavily polluted sites in South Asia. Higher fraction of coarse mode PM was found as compared to other nearby sites in the Indo-Gangetic Plain region. The BC&CO ratio obtained in Lumbini indicated considerable contributions of emissions from both residential and transportation sectors. The 24 h average $PM_{2.5}$ and PM_{10} concentrations exceeded the WHO guideline very frequently. WRF-STEM model-simulated regionally tagged CO tracers showed that the majority of CO came from the upwind region of Ganges Valley. Nevertheless, the model estimated values were 1.5 to 5 times lower than the observed concentrations for CO and PM_{10}, respectively. It is felt that model performance needs significant improvement in simulating aerosols in the region. **[**Rupakheti, D. et al. (including **Naja, M.)**. (2017). *Atmos. Chem. Phys., 17*, 11041-11063; Mahata, K. S. et al., (including **Naja, M.)**. (2017). *Atmos. Chem. Phys., 17,*12573**].**

Present and future status of air pollution

A comprehensive suite of ozone data products from almost 10,000 measurement sites worldwide are compiled under the first Tropospheric Ozone Assessment Report (TOAR). Different metrics like focusing on human health, vegetation, and climate relevant ozone issues are made. Considerable effort was made to harmonize and synthesize data formats and metadata information from various networks and individual data submissions. Extensive quality control was applied to identify questionable and erroneous data, including changes in apparent instrument offsets or calibrations. Limitations of a posteriori data quality assurance are discussed. Exploitation of these global data allows for new insights into the global distribution, and seasonal and long-term changes of tropospheric ozone and they enable TOAR to perform the first, globally consistent analysis of present-day ozone concentrations and recent ozone changes with relevance to health, agriculture, and climate. **Figure 27** shows distribution of annual median ozone mixing ratios at 5491 sites, including Nainital and Pantnagar, along with their respective altitudes. Yet, large gaps remain in the surface observation network both in terms of regions without monitoring, and in terms of regions that have monitoring programs but no public access to the data archive. Therefore future improvements to the database will require not only improved data harmonization, but also expanded data sharing and increased monitoring in data-sparse regions. **[**Schultz, M. G., et al., (including **Naja, M.**). (2017). *Elem Sci. Anthro.*, *5*:58.**]**

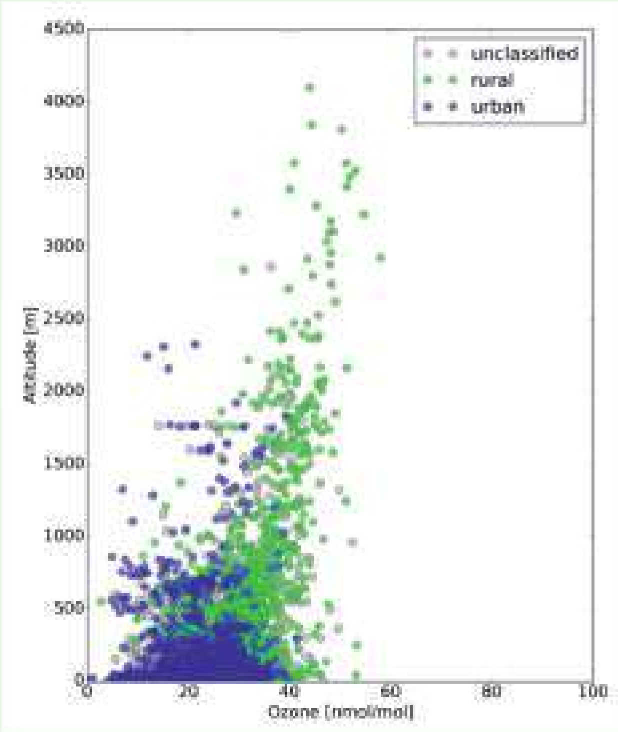

Figure 27. Distribution of annual median ozone mixing ratios at 5491 sites, including Nainital and Pantnagar, along with their respective altitudes.

Little is known about how future air quality in South Asia will respond to changing human activities. Here, the combined effect of changes in climate and air pollutant emissions projected by the Representative Concentration Pathways (RCP) 8.5 and RCP6.0 on air quality of South Asia in 2050 using a state-of-the-science Nested Regional Climate model with Chemistry (NRCM-Chem) are examined. RCP8.5 and RCP6.0 are selected to represent scenarios of highest and lowest air pollution in South Asia by 2050. NRCM-Chem shows the ability to capture observed key features of variability in meteorological parameters, ozone and related gases, and aerosols. NRCM-Chem results show that surface ozone and particulate matter of less than 2.5 μm in diameter will increase significantly by midcentury in South Asia under the RCP8.5 but remain similar to present day under RCP6.0 **(Figure 28)**. No RCP suggest an improvement in air pollution in South Asia by midcentury. Under RCP8.5, the frequency of air pollution events is predicted to increase by 20–120 days per year in 2050 compared to the present-day conditions, with particulate matter of less than 2.5 μm in diameter predicted to breach the WHO ambient air quality guidelines on an almost daily basis in many parts of South Asia. These results indicate that while the RCP scenarios project a global improvement in air quality, they generally result in degrading air quality in South Asia. [Kumar, R. et al., (including **Naja, M.**), *Jr. Geophy. Res.: Atmos., 123*, 1840**].**

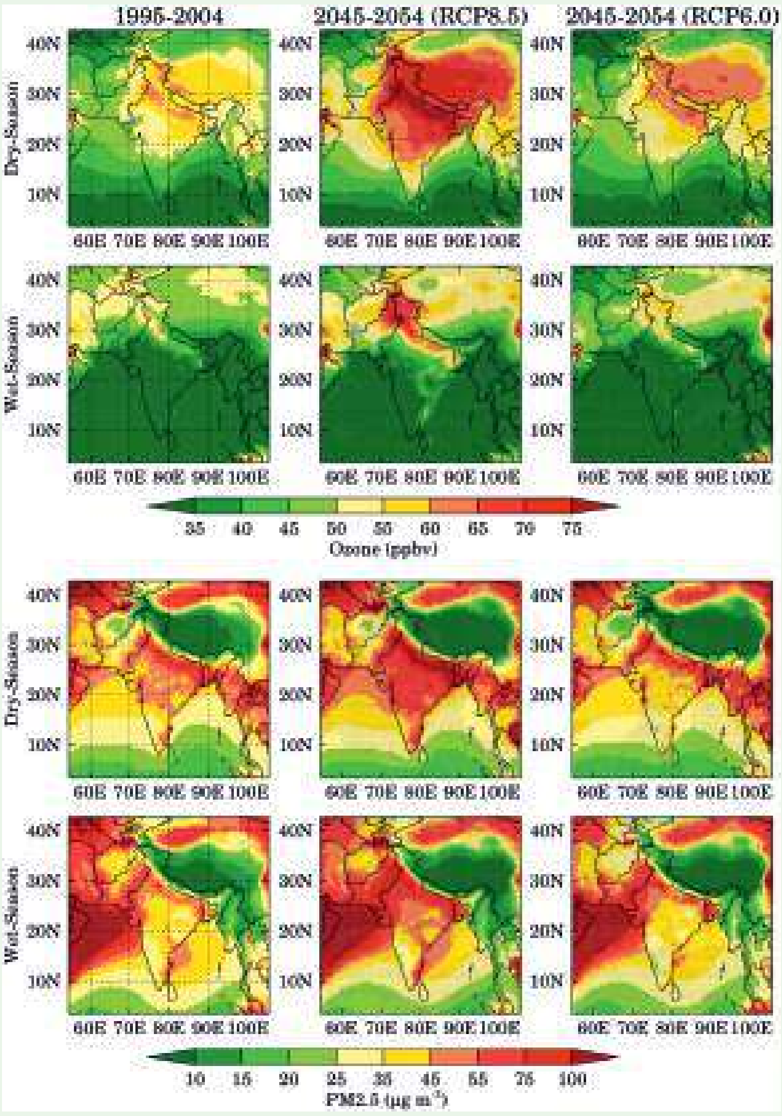

Figure 28. Dry- and wet-season daily 8 h average ozone and 24 h average PM2.5 over the parent model domain for present-day and future (RCP8.5 and RCP6.0) scenarios. Green shows areas of below the WHO limits, while yellow-red depict the areas of exceedance.

Publications

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1. Chandra, P., et al. (include **Gupta, A. C.**) (2017). Multiwavelength study of VHE emission from Markarian 501 using TACTIC observations during April-May, 2012. *New Astronomy, 54,* 42-51.

2. Kambezidis, H. D., Psiloglou, B. E., Karagiannis, D., **Dumka, U. C.** & Kaskaoutis, D. G. (2017). Meteorological radiation model (MRM v6.1): improvements in diffuse radiation estimates and new approach for implementation of cloud products. *Renewable and Sustainable Energy Reviews, 74,* 616-637.

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4. **Karmakar, S., Pandey, J. C.,** Airapetian, V. S. & **Misra, K.** (2017). X-ray superflares on CC Eri. *Astrophy. Jr., 840*: 102 (12pp).

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7. Patel, P. N., **Dumka, U. C.,** Babu, K. N. & Mathur, A. K. (2017). Aerosol characterization and radiative properties over Kavaratti, a remote island in southern Arabian Sea from the period of observations. *Science of the Total Environment, 599-600,* 165-180.

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11. Sen, A., et al. (including **Naja, M.**) (2017). Variations in particulate matter over Indo-Gangetic plains and Indo-Himalayan range during four field campaigns in winter monsoon and summer monsoon: role of pollution pathways. *Atmospheric Environment, 154*, 200-224.

12. **Kalita, N., Gupta, A. C.,** Wiita, P. J., Dewangan, G. C. & Duorah, K. (2017). Origin of x-rays in the low state of the FSRQ 3C 273: evidence of inverse Compton emission. *Mon. Not. Roy. Astron. Soc., 469,* 3824-3839.

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Book/ Book Chapter

1. Kumar, R., et al. (including **Naja, M.**) (2017). An overview of air quality modeling activities in South Asia. *Air Pollution in Easter Asia: an Integrated Perspective, ISSI Scientific Report Series, 16,* 27-47. (DOI: 10.1007/978-3-319-59489-7_2)

2. Devara, P. C., Alam, M. P., **Dumka, U. C.**, Tiwari, S. & Srivastava, A. K. (2018). Anomalous features of black carbon and particulate matter observed over rural station during diwali festival of 2015. *Environmental Pollution, Water Science and Technology Library, 77,* 293-308.

3. Pant, G. B., Kumar, P. Pradeep, Revadekar, J. V., **Singh**, **Narendra** (2018)**.** *Climate change in the Himalayas, Book, Springer International Publishing AG 2018*. (DOI 10.1007/978-3-319-61654).

Circulars/Bulletins/Conference Proceedings

1. Chakraborty, P. (2017). Design of vertical dial guide for facilitating mechanical inspection and quality control. *Proceedings ICAST*, 134-136.

2. Joshi, Y. C. (2017). Probing nearby galactic structure through open star clusters. *ASP Conf. Seri., 510*, 81-84.

3. Valeev, A. F., et al. (including **Joshi, A.** & **Pandey, J. C.**) (2017). Detection of low-amplitude photometric variability of magnetic white dwarfs. *ASP Conf. Seri., 510,* 504-506.

4. Sinha, T, Sharma, S., Pandey, R. & **Pandey, A. K.** (2017). Search for variable stars in the young open cluster stock 18. *EPJ web of Conf., 152*, 1-3.

Ph.D. Theses

Awarded

1. Multi-wavelength studies of active galactic nuclei, **Jai Bhagwan**, (Supervisor : **Alok C. Gupta**), *Pt.*

Ravishankar Shukla University, March, 2016. (Awarded 04-09-2017)

2. Study of aerosol distribution and associated meteorology over the Central Himalayas, **Raman Solaki**, (Supervisors: **Narendra Singh** and S. K. Dhaka), *Department of Physics & Astrphysics, University of Delhi,* September, 2016. (Awarded 11-09-2017)

3. Studies of nearby star forming galaxies, **Sumit Kumar Jaiswal**, (Supervisor : **Amitesh Omar**), *Pt. Ravishankar Shukla University,* August, 2016. (Awarded 28-12-2017)

4. Multi-band studies of blazars with XMM-Newton, **Nibedita Kalita,** (Supervisor & Co-Supervisor : Kalpana Duorah and **A. C. Gupta**), *Department of Physics, Gauhati University, Guwahati,* November, 2016. (Awarded 6-10-2017)

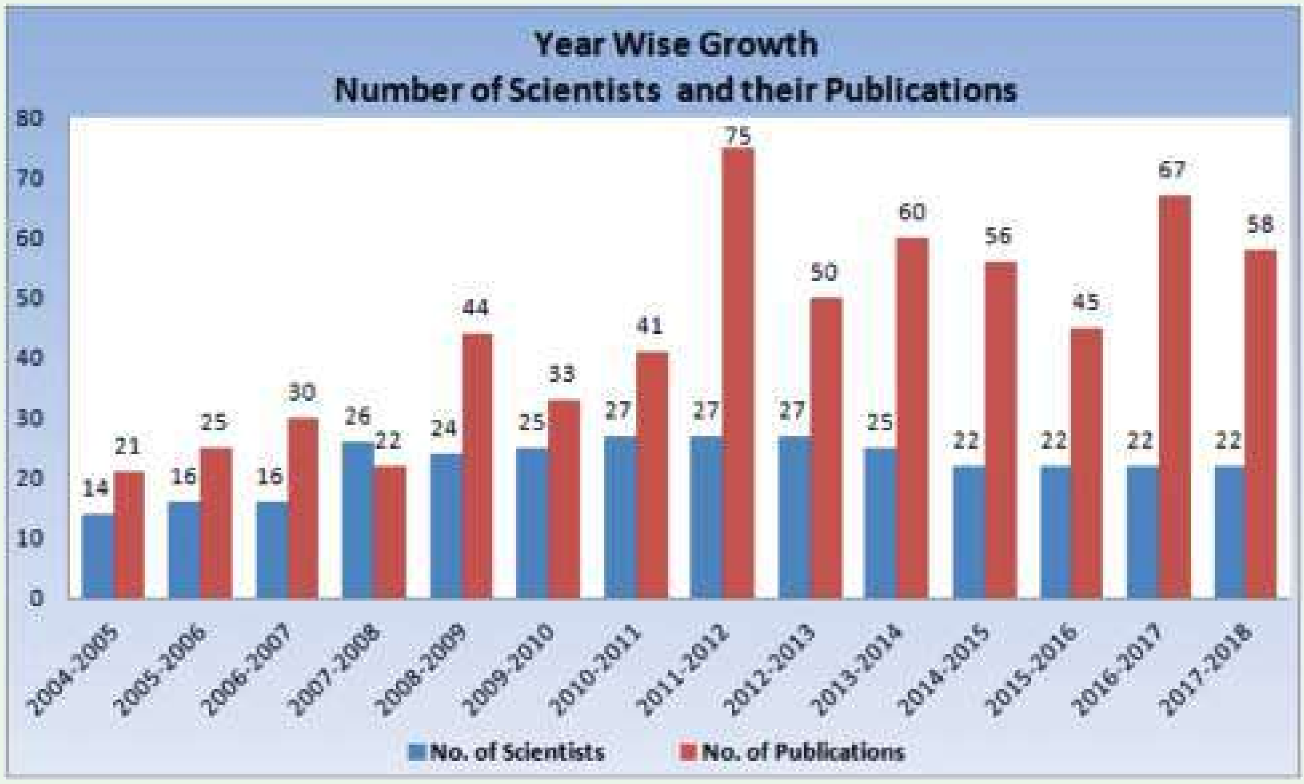
Submitted

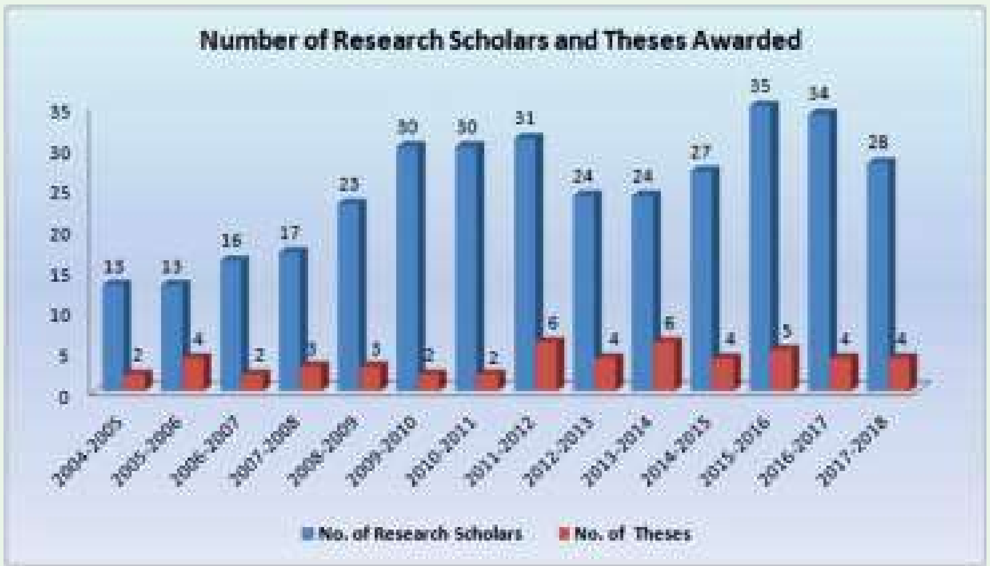
1. Study of the tropospheric trace gases over the Indian subcontinent, **Piyush Bhardwaj**, (Supervisor & Co-Supervisor: **Manish Naja** and H. C. Chandola), *Kumaun University,* July, 2016.

2. Study of galactic star forming regions and related instrumentation, **Neha Sharma,** (Supervisor : **Maheswar Gopinathan**), *Pt. Ravishankar Shukla University,* May, 2017.

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

4. Spectro-photometric studies of star-forming galaxies, **Abhishek Paswan**, (Supervisor: **Dr. Amitesh Omar**), *Pt. Ravishankar Shukla University,* January, 2018.





Summary

1.	Total Number of Publications in Refereed Journals	58
2.	Number of Publications in Circulars/Bulletin	4
3.	Book Chapter	3
4.	Ph.D. Theses Awarded	4
5.	Ph.D. Theses Submitted	4

Research Projects

In year 2017-2018 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): Anil K. Pandey / 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: Observations and analysis of stars in the Kepler field
PI (ARIES): Yogesh C. Joshi
PI of the collaborating institute: C. A. Engelbrecht, University of Johanesburg, South Africa
Funding Agency: DST, Govt. of India
Project Code: DST/INT/SA/P-02

Name of Project: Investigation of the structure and kinematics of the young population of the Galactic disk in the solar neighbourhood.
PI (ARIES): Yogesh Chandra Joshi
PI of the collaborating institute: Andrei Dambis, Sternburg Astronomical Observatory, Moscow, Russia
Funding Agency: DST, Govt. of India
Project Code: INT/RUS/RFBR/P-219

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 Agenvy: DST, Govt. of India
Project Code: INT/RUS/RFBR/P-271

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: Multi-wavelength Flux and Spectral Variability Studies of Blazars on Diverse Time Scales
PI (ARIES): Alok C. Gupta
PI of the collaborating institute: K. K. Yadav, BARC, Mumbai
Funding Agency: BRNS-DAE, Govt. of India
Project Code: 37(3)/14/17/2014-BRNS

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

Updates on the Major Facilities

4m International Liquid Mirror Telescope (ILMT)

ARIES is establishing a 4m International Liquid Mirror Telescope (ILMT) in collaboration with the Institute of Astrophysics and Geophysics (Liege University), the Canadian Astronomical Institutes from Quebec (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 LMTs located at good astronomical site can deliver the same performance as classical telescopes with much lower cost and greater simplicity of operation. The 4m ILMT will be entirely dedicated to 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). Any transient source or highly variable object can be easily detected by comparing the CCD images recorded each night with the reference images. The follow-up observations of these objects will be taken up with the 3.6m DOT. The first light of ILMT is expected before the end of 2018.

Until the last financial year 2016-2017, ILMT building, installation of compressor and installation of mechanical structure were already completed. The important milestones achieved in this financial year (2017-2018) are as follow:

Control system for pneumatic system: Prof. Paul Hickson from University of Victoria visited ILMT site during 8 - 17 May, 2017 to set up the control system for Pneumatic system along with the filter, valve and dew point sensor so that air bearing of the ILMT can get air of optimal quality to make it work more efficiently.

Figure 29. Filter, valve and dew point sensor installed for the control of pneumatic system.

Repair of the ILMT bowl and measurements of tip/tilt: The repair work of ILMT bowl was carried out during the months of May, June and October, 2017. During this year the regular measurements of vertical run-out verification to check the tip/tilt of the bowl to quantify the accuracy of its alignments were carried out. As a result the best relative orientation between the air bearing plate and the bowl was determined by using a comparator that minimizes the residual tilt. Regular measurements for the stiffness check were also done. After taking into account the above steps, the ILMT bowl is ready to pour mercury for the first light observations.

Figure 30. Alignment of the bowl for vertical run-out verification experiment.

Replacement of the motor drives of air compressors: For better efficiency of the air compressor, the existing star-delta configuration was replaced with the Variable Frequency Drives (VFD). The star-delta configuration was consuming enormous power at the beginning to start the compressor motors. The VFD will avoid this situation by varying the input frequency and voltage so as to avoid the UPS power load problem in the beginning and thus increasing the working period.

Activation of the air bearing power supply: The air-bearing system and various components of CCD detector system were activated by the AMOS team led by Er. Jean-Marc during their visit (14 – 21 March, 2018) to ILMT site. The air-bearing system is found to be working satisfactorily. A proper training was given to the newly appointed assistants to operate the air-bearing set-up of ILMT. The next mission is planned in summer of 2018.

Figure 31. AMOS team inspecting the air-bearing power setup.

ARIES ST Radar (ASTRAD)

Stratosphere Troposphere (ST) Radar (206.5 MHz) is being installed at ARIES, Nainital for observations of vertical profiling of wind. The activities during 2017-18 are given below:

- Last year the radar was operated using 7 clusters for nearly 500 hrs. The installation of clutter fencing improved the performance significantly. This year ARIES took the initiative and successfully activated 3 more clusters which resulted in 10 clusters becoming operational **(Figure 32).**
- ST Radar was operated with 10 clusters for about 178 hrs **(Figure 33)** with a height coverage of about 14 km. The hardware of remaining clusters was also ready for operation and performance tests were ongoing. TRMs and DC power supply unit in all the 12 clusters have been installed installed. The RF and CAN distribution network of 12 clusters have been laid and connected. Software modification and readiness of a 4 channel digital receiver is in progress.

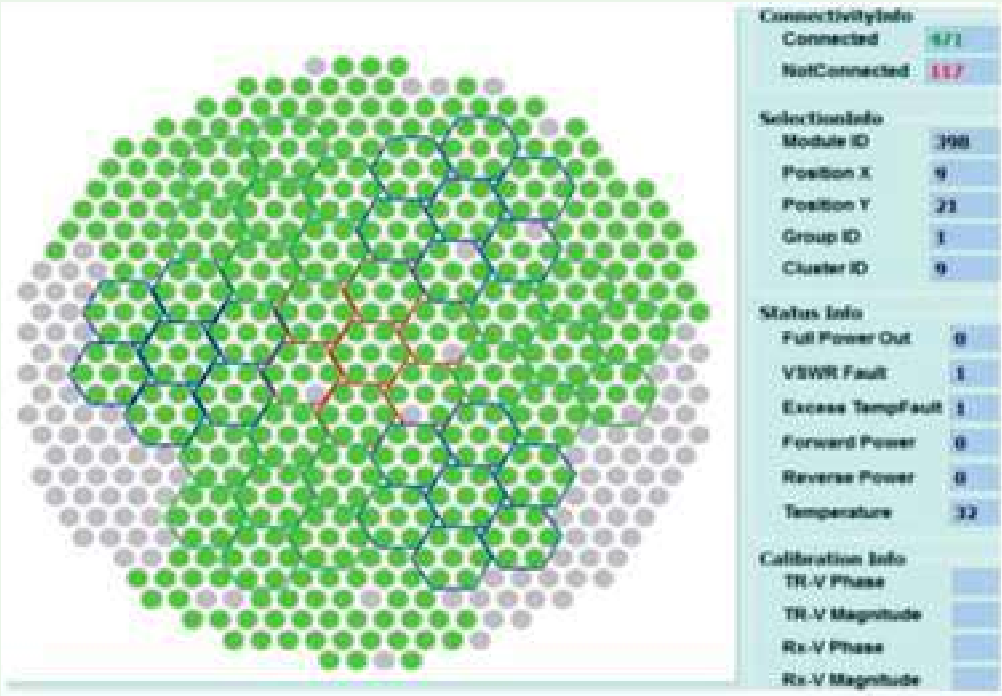


Figure 32. Screen shot from radar controller (RC), showing readiness (green) of ten clusters of ASTRAD. One cluster consists of 49 TRMs and thereby making total 490 TRMs.

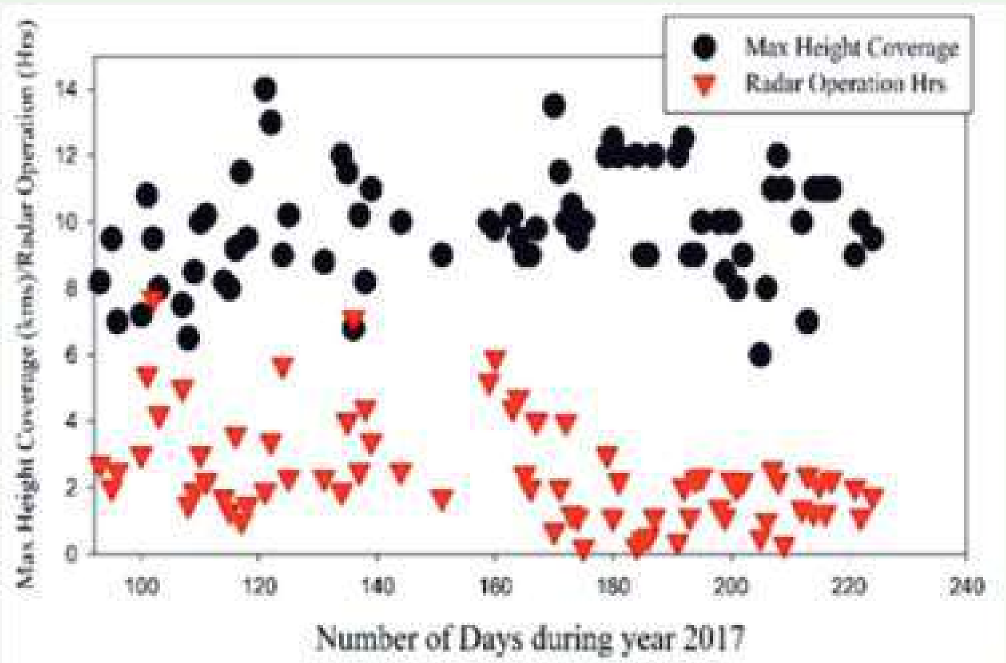


Figure 33. : Height coverage and radar operation hours of ASTRAD systems at ARIES, Nainital during year 2017 (1 April 2017 – 16 August 2017).

- **Comparison with balloon-borne radiosondes:** Wind observations from radar have been compared with the observations made using balloon-borne radiosonde, which showed a reasonably good agreement **(Figure 34)**.

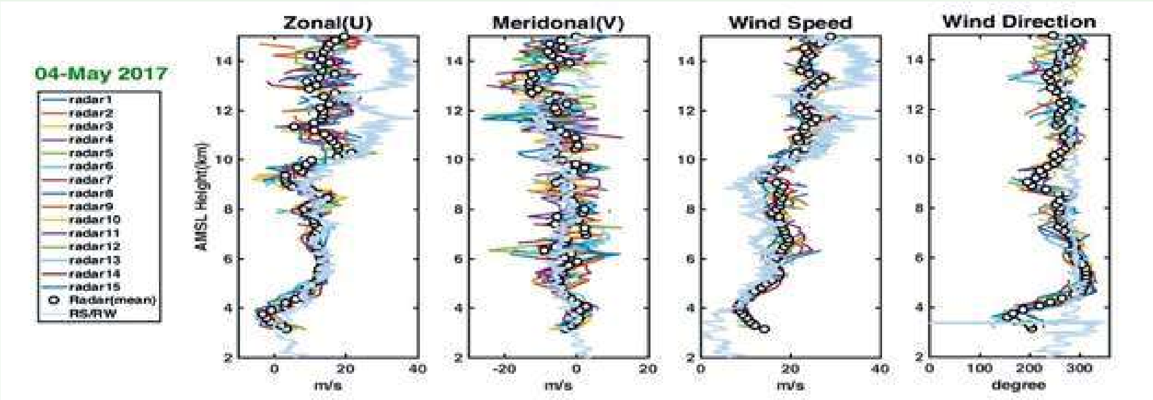


Figure 34. A comparison between winds from ARIES ST Radar (color lines and black circles) and balloon-borne radiosonde (light blue) observations on 4 May, 2017.

- **Figure 35** shows temporal variations in Zonal and Meridional wind components, wind speed and wind direction obtained from ARIES ST Radar on 28 June, 2017 using ARIES software. Higher winds could be seen at greater altitude region.

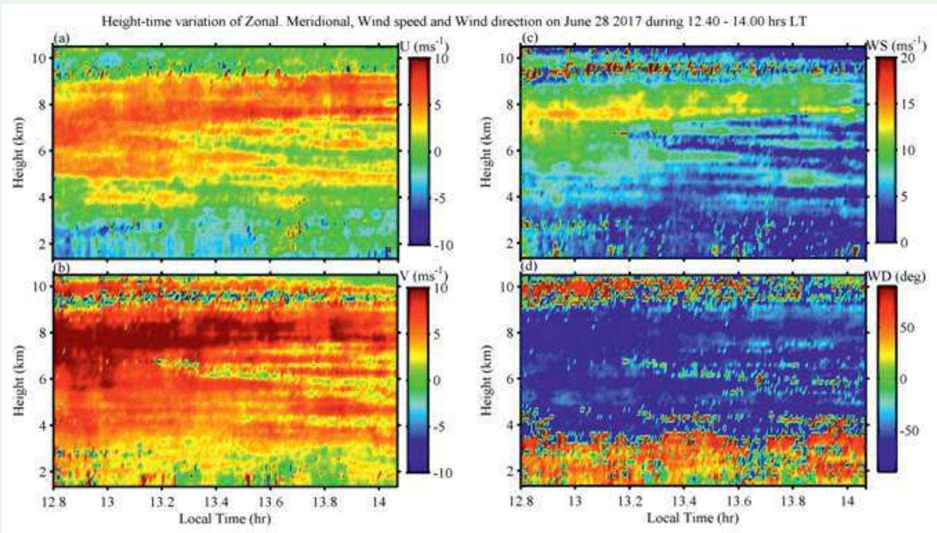


Figure 35. Temporal variations (local noon) in vertical (up to about 11 km) winds (Zonal, Meridional, speed and direction) for 28 June, 2017 have been analyzed using ARIES software.

- ARIES has completed the installation of in-line surge arrestors in all the antennae.
- In addition to regular maintenance of the network, in-house design, development and fabrication of TRM was also taken up using the existing facilities.
- Several students carried out short term projects using the ASTRAD system.

Update on 3.6m DOT back-end instruments

4K x 4K CCD Imager

The 4Kx4K CCD Imager was mounted at the axial port of the 3.6m DOT for calibration and science observation during cycles 2017A and 2017B. Several sources like optical afterglows of GRBs, supernovae, AGNs, star clusters and variable stars were observed. The observations of the central portion of the globular cluster NGC 4147 revealed several types of variable stars and the phased light curves of the newly identified variable stars are shown in **Figure 36.**

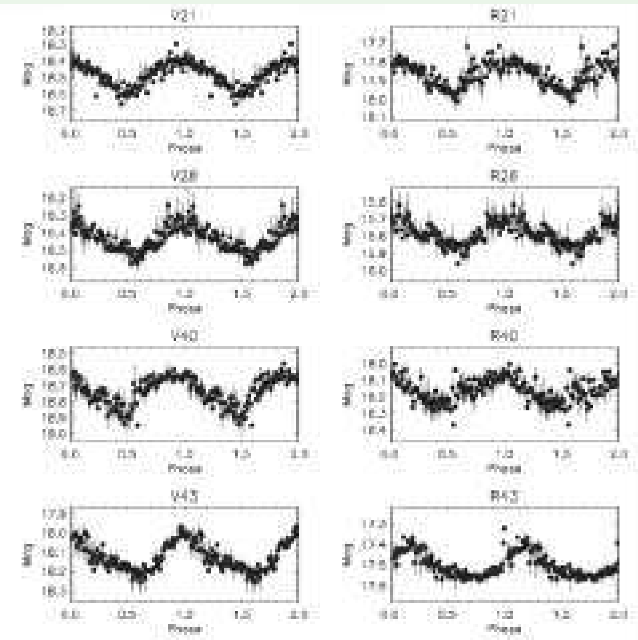


Figure 36. Phased *R* and *V*-band light curves of newly identified variable stars including RR-Lyrae stars within the central core portion of the Globular cluster NGC 4147 (Lata et al. in preparation).

A few modifications in the filter-housing and filter-retainers of the Imager were done **(see Figure 37)** to remove the partial vignetting seen towards the edges of the observed frames. The CCD attachment plate is one of the main component for assembling the CCD camera on the Imager housing. The parallelism of telescope flange to the CCD is transferred through CCD attachment plate. The plate was manufactured using the CNC machine in ARIES workshop to achieve the parallelism with an accuracy of less than 20 microns. The new attachment plate was mounted back to hold the CCD camera. **(see Figure 38).**

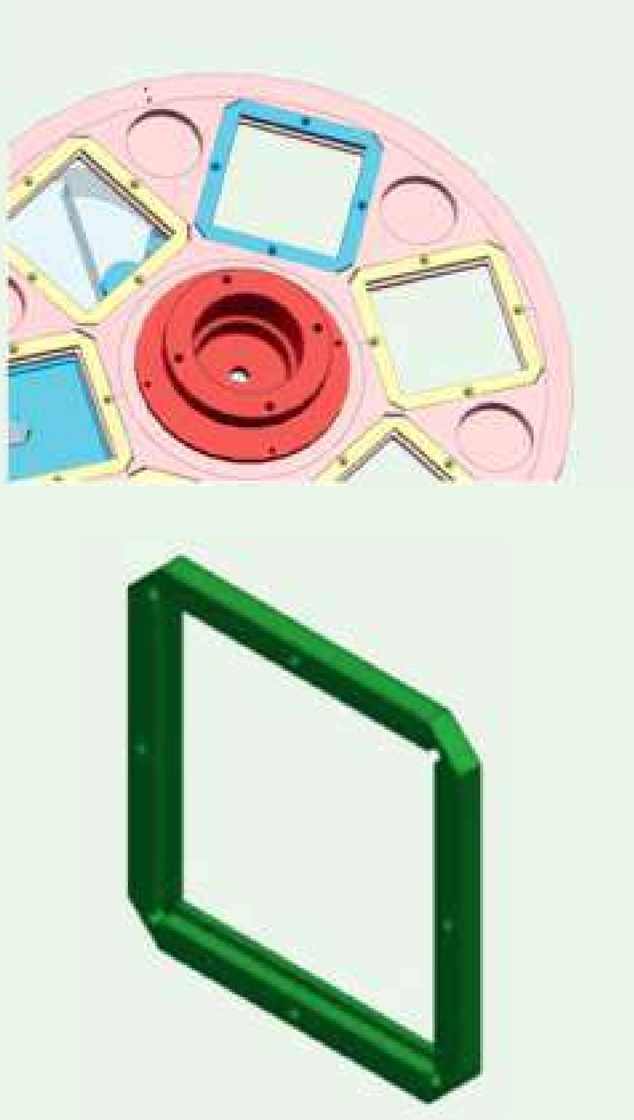


Figure 37. The filter retainers made of Teflon material are, square shaped having a clear aperture of 85 x 85mm, used for holding the filters in specified positions in the filter wheel.

Figure 38. Design of the CCD attachment plate.

A spare camera controller, cables and 125mm Bonn shutter were also procured. Procurement of a new CCD camera and use of an indigenously developed controller is also planned in near future.

Faint Object Spectrograph &Camera (FOSC) type instrument for 3.6m DOT

A spectrograph similar to *Faint Object Spectrograph & Camera (FOSC)* has been designed, developed, and assembled at ARIES, Nainital through in-house research and development activities. This instrument is a low-resolution optical spectrograph-cum-imager. The instrument's main optics consists of a collimator and focal-reducer providing an f-ratio of ~ 4. 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 instrument was used on the 3.6m DOT for various engineering tests and science verification programs. A large-format (~ 62 mm) closed-cycle cryogenically cooled 4K x 4K CCD camera for FOSC has been developed in ARIES clean room in technical collaboration with the engineers from the Herzberg Institute of Astrophysics (HIA), Canada. The following modes of the science operations are possible using this instrument: (i) Deep photometric imaging using broadband and narrowband filters, (ii) Long-slit/slit-less spectroscopy using grism/prism, and (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. The field of view available with the 4K x 4K CCD is 13'.6 x 13'.6 for broad-band filters and 11' diameter for narrow-band filters, and that with the frame-transfer CCD is 1'.8 x 1'.8. The slit length is 8' and widths are between 0".4 and 2".0. The three grisms provide dispersion at 0.23, 0.16, and 0.10 nm/pixel (15 micron). The highest resolution is ~ 1600 at 0".6 seeing. The order sorting filters BG-39 and RG-610 are also available.

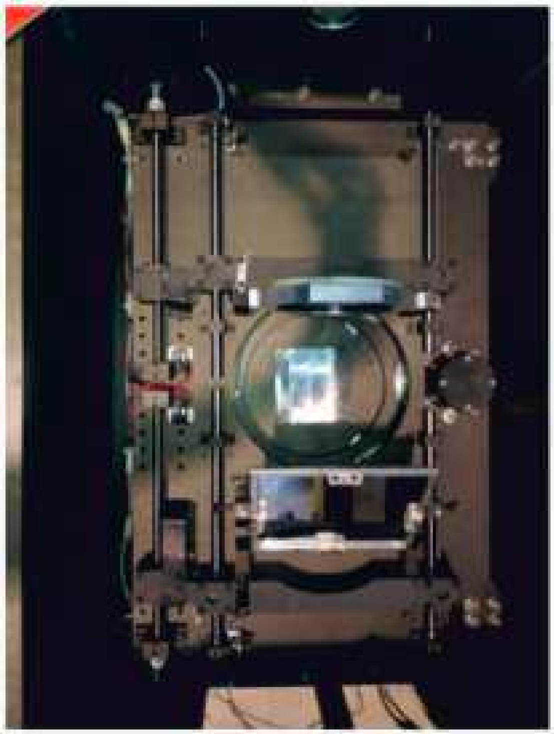


Figure 39. (left) The internal view of the fully-assembled spectrograph. (right) The top view of the Motorized spectral calibration unit.

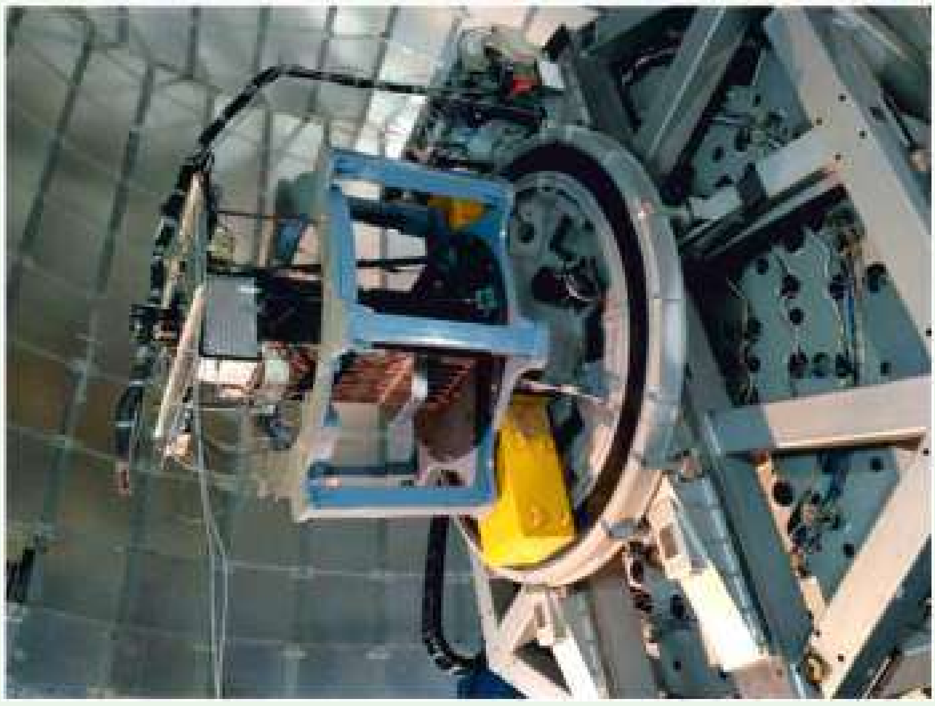


Figure 40. The spectrograph mounted on the 3.6m DOT during science verification observing runs.

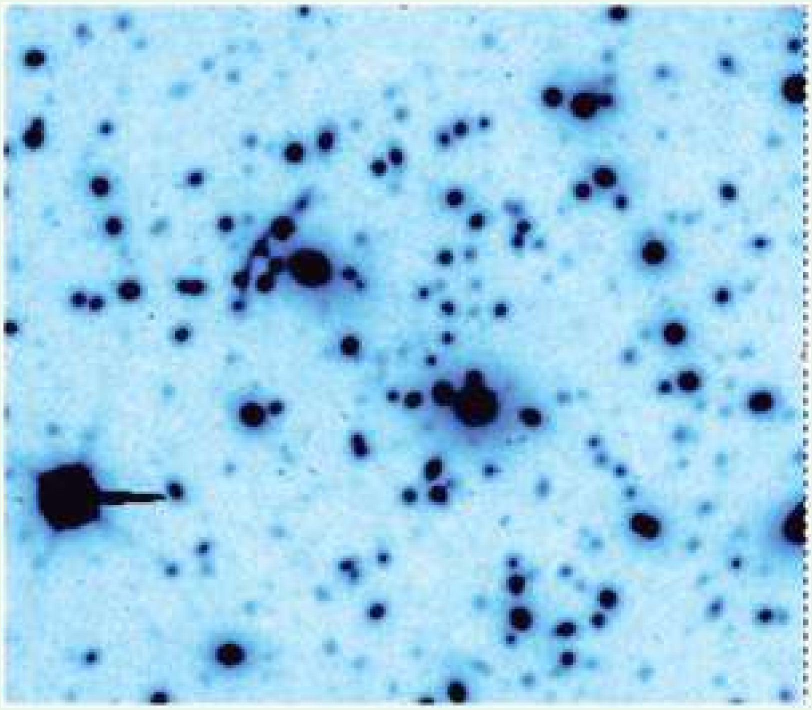


Figure 41. A 55-minute exposure deep SDSS i-band image of the Abell 370 galaxy cluster made using the FOSC on the 3.6m DOT and the in-house developed 4K x 4K CCD camera. The faintest detection is made at i ~25mag.

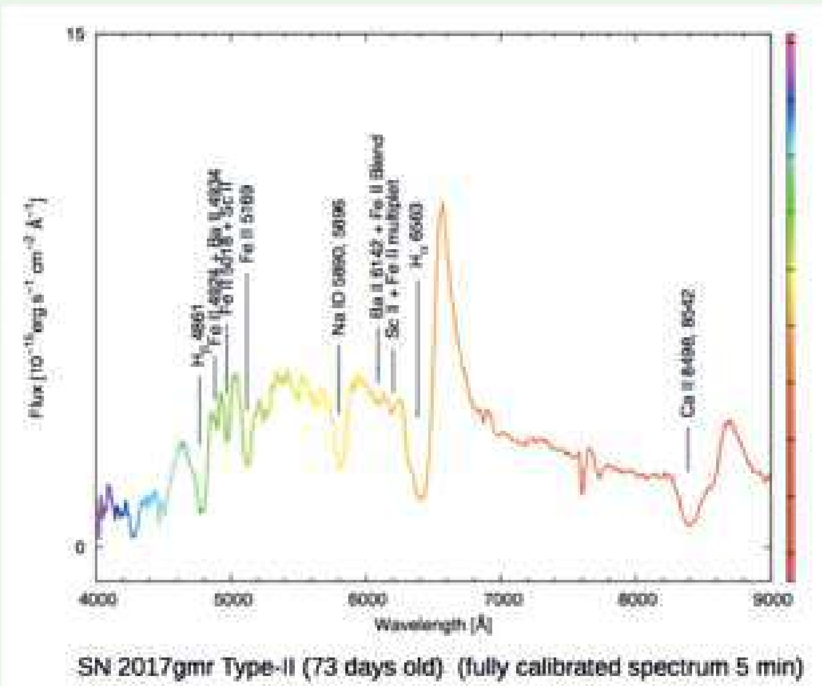


Figure 42. The optical spectrum of SN 2017gmr obtained using the FOSC on 3.6-m DOT. The prominent lines of hydrogen, calcium, sodium, iron elements are marked.

TIFR-ARIES Near Infrared Spectrometer (TANSPEC)

TANSPEC is being built in collaboration with TIFR, ARIES and MKIR, Hawaii for the 3.6 meter Devasthal Optical Telescope (DOT). It is a unique spectrograph which will provide simultaneous wavelength coverage from 550 to 2540 nm with a resolving power of R ~ 2750 and can be used for a wide range of studies from local star formation to extra galactic astronomy. The spectrograph will operate in two modes which images the spectrum on to a 2K x 2K H2RG array. TANSPEC also consists of an independent imaging camera with a 1K x 1K H1RG detector with 1 x 1 $arcmin^2$ field of view which will be used to guide the telescope as well as for imaging in broad band r', i', Y, J, H, Ks and narrow band H2 & BrG filters. It also functions as a pupil viewer for instrument alignment on the telescope. The spectroscopy sensitivity (100-σ in 1 hour, 1" seeing) is expected to be 15.4 mag (R ~ 2750), whereas in prism mode (R ~ 100) it would be 17.3 mag in the J-band.

The project was planned to be completed in three years. The overall progress of TANSPEC is on schedule. TANSPEC first cool down tests were successfully completed in January 2017. MKIR has received all parts of the instrument and the assembly of the cryostat and other mechanisms have been completed. With the successful completion of mechanism software testing and cold mechanism test, the optics and detectors have been installed. The array readout software is complete and has been tested on the warm MUXs and cold IR detectors. A few more cold tests of the complete instruments are planned by MKIR in the next few months. TANSPEC is expected to be shipped to DOT by September 2018 and will be ready for tests on telescope by the beginning of October 2018.

TIFR Near Infrared Imaging Camera-II (TIRCAM2)

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 the recently installed 3.6m DOT for near-infrared calibration of the site and for science observations during 2017-2018. 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.

TIRCAM2 was mounted on the 3.6m DOT during four observing runs in 2016 and 2017. During these runs activities related to transportation from TIFR to ARIES, installation and observations with 3.6m DOT have been carried out. After the preliminary characterization, TIRCAM2 was released for scientific observations since May 2017 to the Indian and Belgian astronomical community. Some of the important results given below are published in Baug, T. et al. (2018).

1) Best seeing of ~ 0".45 was obtained in the K-band on 16 October, 2017.

2) Observations of sources up to 19.0 mag, 18.8 mag, and 18.0 mag, with 10% photometric accuracy, in *J, H* and *K* bands, respectively, have been done with corresponding effective exposure times of 550s, 550s and 1000s.

3) Detection in the nbL-band (3.59 μm) for the sources brighter than ~9.2 mag in 125 sec of exposure has been successfully demonstrated.

4) Sky brightness and limiting magnitudes calculated with TIRCAM2 are comparable with other 4m class telescopes world-wide.

Currently, feasibility tests to mount TIRCAM2 on the side port of 3.6m DOT are being carried out and the initial test results are encouraging.

Figure 43. The TIRCAM2 mounted at the axial port of the 3.6m DOT.

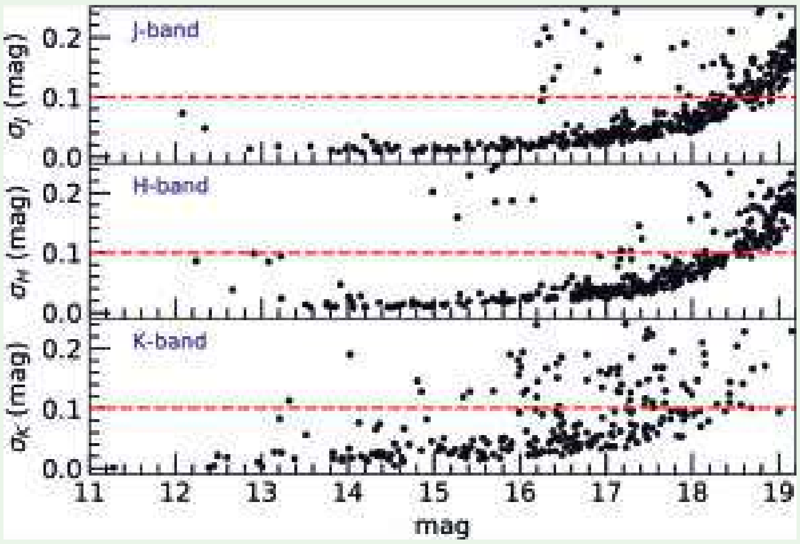


Figure 44. *J, H* and *K* band magnitudes versus magnitude errors of the globular cluster M92 observed with effective exposure times of 550, 550 and 1000 s, respectively. PSF photometry was carried out for frames in all three bands with an aperture radius of one FWHM.

Thirty meter telescope

ARIES as one of the founder PI institutes is involved towards the project since the 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 mostly involved in the 3.6m related activities. However, ARIES scientists managed to join many regular meetings and teleconferencing related to the TMT project during 2017-18 and actively participated during weekly Management Advisory Committee (MAC), India-TMT meetings. Director ARIES and co-ordinator of TMT at ARIES regularly participated in the project management board meetings to take decisions on the various technical and administrative aspects. ARIES scientists also participated during the ongoing scientific activities of several International Science Development Teams as members.

Figure 45. 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 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 technical staff of ARIES.

The major back-end instruments used at 1.04m ST are 1K x 1K CCD and ARIES Imaging polarimeter (AIMPOL). A PyLon 1300 x 1340 CCD is also used for observations. A 4K x 4K CCD has been procured and performance testing is being carried out in optics lab. The CCD will be mounted on the telescope for performance checks. The major scientific programs being carried out includes study of star clusters, young star forming regions, HII region, optical variability in AGN, optical counterpart of GRBs, supernovae and X-rays sources and polarimetric study of star forming regions and late type stars.

A total of 276 observing nights were allotted for CCD and AIMPOL in 2017-18. 138 nights were clear and data were collected by observers in the clear nights. Partial data set taken with 1.04m ST are used in two PhD theses, submitted during 2017-18.

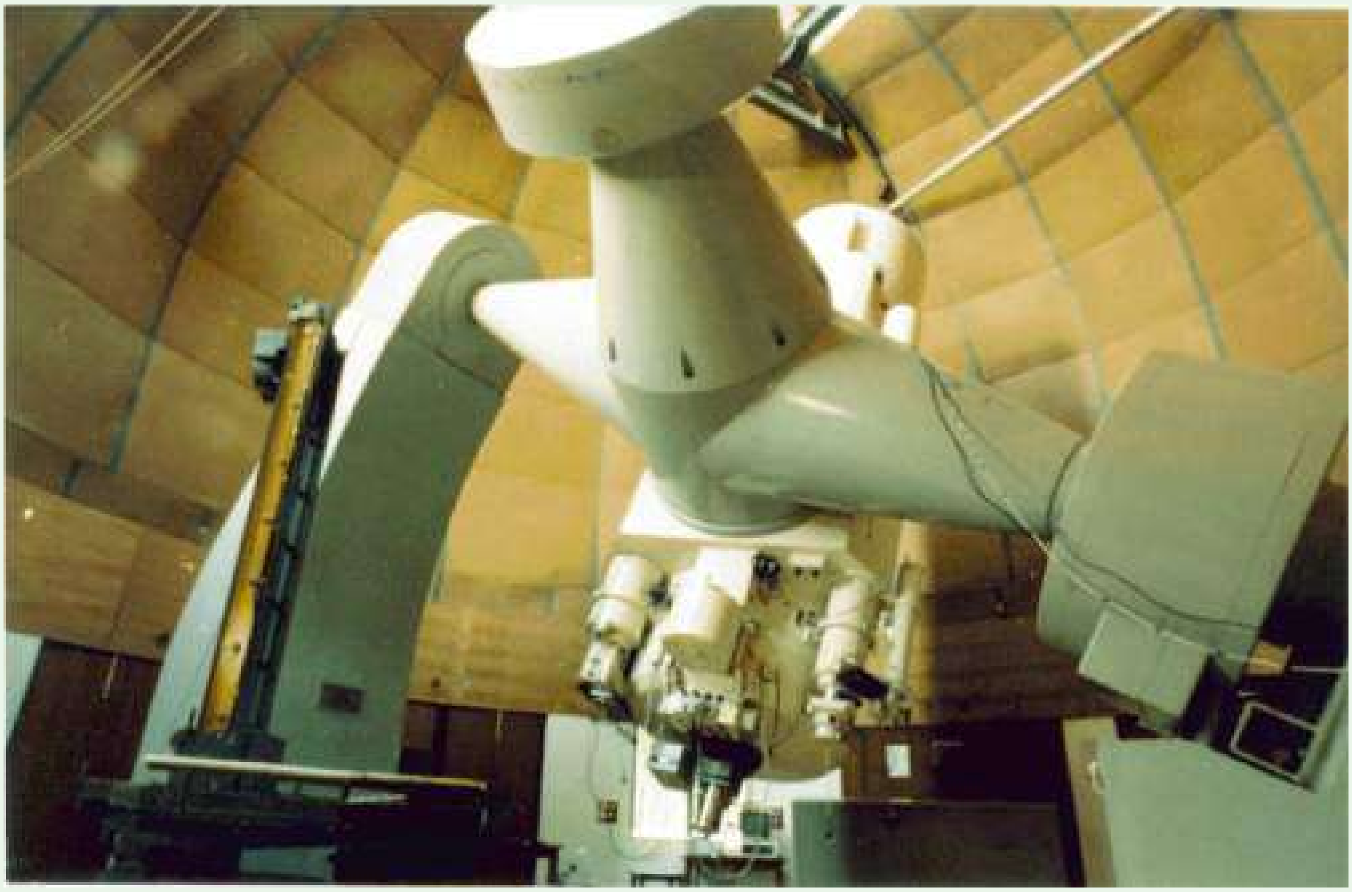


Figure 46. 1.04m Sampurnanand Telescope.

1.3m Devasthal Fast Optical Telescope (DFOT)

A team of scientific and engineering staff are involved in the operation and maintenance of the 1.3m DFOT at Devasthal, ARIES. Extra precautions have been taken during the period of heavy monsoon, high humidity, frequent lightening, and ongoing construction work. A regular maintenance/checkup of the telescope and the related cameras/instruments along with mirror cleaning and updating pointing models are routinely done.

Some new initiatives taken to improve the observing facility are listed below:

Online data archiving has been created giving graphical information about the stored data in date and cycle wise format and option to download the specific required data. It can be accessed from anywhere inside/outside the ARIES network by logging into the portal. "https://cloud.aries.res.in/index.php/login"

The motor belt of the telescope mirror flap opening, halting limit switches and the Electro-Hydraulic thurster brake of roll of roof were replaced. The driving shaft of filter unit was bent due to wear and tear which was repaired by mechaincal workshop and a new upgraded version of filter unit is under construction. The error in TCS computer system was identified and resolved by changing the motherboard. The auto-guider and all sky cameras were replaced with the new spare one.

Several steps have been taken to maintain the infrastructure at 1.3m telescope building. A number of dehumidifiers are deployed in the TCS room and telescope floor to maintain the air humidity in the required range. Insulation foam and tarpaulin between the rails and gaps of roll of roof were applied for preventive measures during the monsoon period. Previously the control cables from TCS to telescope were open and were vulnerable to any damage. The cables have been managed by routing them through metal tray so as to hide the cables and also save them from rodents and physical damages. New mounting structure for all sky camera was developed to mount the camera outside the Dome to view the sky condition even after closing the dome.

Two observing assistants have been provided to support the night observations at the telescope. This has allowed an efficient handling of the telescope with minimal down time during the observing cycle October 2017 to June 2018.

A total of 187 clear nights were observed out of 257 allotted nights during 2017-18. The data acquired with the 1.3m telescope has resulted in a total of 60 publications in referred journals.

The 3.6m Devasthal Optical Telescope

ARIES operates India's largest 3.6 meter aperture optical telescope at Devasthal as a national facility. It is used for astronomical observations at optical and near-infrared wavelengths. This facility consists of a modern 3.6 meter 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 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. 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 operational advisory committee for Devasthal (OACD) has been constituted under chairmanship of Prof. S. Ananthakrishnan and co-chairmanship of Director, ARIES, for advising on operations and maintenance of all the observational facilities at Devasthal. 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 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. Both, the PMB and DTAC met on one occasion each during the current financial year.

During the previous financial year 2016-17, the M1 coating as well as instrument test runs on the telescope were successfully performed and subsequently, the call for observing proposals for the period April-May 2017 were announced. During the current financial year April 2017 – March 2018, following activities were performed.

Successful completion of cycle 2017A (Apr-May): A total of 35 observing proposals asking nights for cycle 17A with an over-subscription factor of 1.8 were reviewed by DTAC. The DTAC allocated nights to 4K-IMAGER, the TIRCAM2 instrument and some observatory nights. oAccordingly a detailed duty schedule was prepared by DOT-Team. For about 70% of the nights, science data has been collected by various proposers in visitor mode. The telescope has performed well throughout the cycle 17A. The loss of telescope time occurred mainly due to bad weather and problem with 4k-Imager. The trouble with 4k-Imager happened in the second run for 7 nights during 24-31 May 2017. Tremendous efforts by the DOT-Team was made to make an alternative camera available for science observations. An alternative SBIG Camera was made available withing 24 hrs. A preliminary science data analysis of cycle 17A results the best FWHM of stellar PSF at K-band to be 0.6 arcsec for TIRCAM2 and detection of stars using 4k-IMAGER with B mag of 24 in 20min exposures with S/N of 10.

Upkeep and health of telescope during Monsoon (Jun-Sep) : Following safety guidelines, the 3.6m DOT is parked during Monsoon and it is not made available for science observations. The telescope needs to be protected from high humidity during Monsoon period. The gaps between rotating and non-rotating part is filled with foams and dehumidifiers are 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; need to be 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.

Observing cycles 2017B (Oct-Jan) and 2018A (Feb-May) : A total of 45 proposals were submitted for cycle 17B, asking nights with an over-subscription factor of 1.9. The DTAC reviewed and allotted nights on 4k-Imager and TIRCAM2 instruments. Accordingly the scheduling for nights observations were made. TIRCAM2 was used from 2nd October to 31st October on 3.6m DOT and Science as well as calibration observations were taken successfully. The performance analysis of the NIR camera on the 3.6-m DOT was done and encouraging results of sources detected in the L and PAH bands (~3.6 micron) were obtained. The seeing at the telescope site in the NIR bands is typically sub-arcsec with the best seeing of ~0.45 arcsec realized in the NIR K-band on 16 October, 2017. The camera is found to be capable of deep observations in the J, H and K bands comparable to other 4-m class telescopes available world-wide. The telescope was operated successfully till night of 22 November, 2017 and after that the nights were suspended till 17 March, 2018 due to unexpected technical issue with the azimuth motor of the telescope. Though the call for cycle 2018A was announced but the reviewing and scheduling process was put on hold. After a detailed investigation of the problem, the torque of azimuth motor was reset and the telescope was made operational with some precautions again from 18 March, 2018. The observations with 4k-Imager was performed with the telescope till the end of March, 2018.

Workshop on "Early science with the newly installed 3.6m Devasthal Optical Telescope" : The workshop was held on 5th February 2018 at Osmania University, Hyderabad. The rationale of the workshop was to highlight the as-built scientific performance of 3.6m DOT to the astronomical community of India. The prospects for synergy of 3.6m telescope science with that of other national facilities i.e. ASTROSAT and GMRT were also covered. Accordingly, the programs of the workshop was set. A few experts were also invited. A detailed handbook on 3.6m DOT was also prepared. This covered all the technical and scientific aspects of the facility. The handbook was given to all the participants. A total of 47 participants attended the workshop. The workshop was useful in many ways. About half a dozen senior professors from Indian astronomical community, attended the workshops. The workshop included many students who were pursuing their PhD in astronomy.

Routine 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 other repair, maintenance and tests were performed by ARIES team with remote help from AMOS. An electronics lab is being developed to cater needs of 3.6m telescope. Several telescope electronics spares were procured including drives, motion controllers, PLCs, motors, encoders, special cables, connectors, primary mirror actuator. There are many other spares which are still being procured. These components are complex, expensive and growing in number and have to be stored properly. As a part of manufacturer recommended procedure it is essential to regularly energize, update the firmware and software, program/configure and test them for their good health in a clean and controlled environment. The mirror actuators have to be carefully tested for fine leaks in valves on an optical bench.

Mechanical, structural and related : Layout and drawings of Helium lines from technical room to 11m floor of DOT were prepared for upcoming TANSPEC instrument's interface with DOT. 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. Various checks and measurements were carried out on rotating and non-rotating parts of telescope, azimuth floor and azimuth cable wrap levels. Acrylic transparent plate for replacement of protection plate was prepared and provided for inspection of azimuth motor. Technical support was provided to AMOS in various tests conducted by them for azimuth motor. Routine preventive maintenance of lateral guides, altitude brakes, cable wrap driving wheel, outer wearing plates, cooling circuit, check of pipes wear, oil flow controllers and M1 cover were carried out. Mechanical maintenance works for compressor unit, compressed air dryer, hydraulic group and chillers were carried out. Maintenance of enclosure components such as dome wheels, insulation panels, slit, wind screen, ground trolley, shutters, exhaust fan hoods, enclosure roof and wall sheets. Mechanical maintenance and certification 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 etc.

Installation of lift: This was a major activity executed by the ARIES technical (engineers and scientists) team. There was a long standing requirement for a lift of about 400 kg capacity to lift instruments and observers from the ground floor to the 11-m telescope floor. The existing lift was of lower capacity and was not technically suitable. It was challenging task. By March 2018, a hydraulic lift with 6 passenger capacity (408 kg) has been successfully installed and commissioned in the building of 3.6m telescope.

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 Indo-Belgium BINA Workshop held during 15-19 Nov 2016 at ARIES Nainital has been published in the Bulletin of the Royal Science Society of Liege.

Figure 47. Workshop on "Early science with the newly commissioned 3.6m Devasthal Optical Telescope" at Hyderabad. 5 February 2018. The first two pages of 3.6m Handbook is also shown.

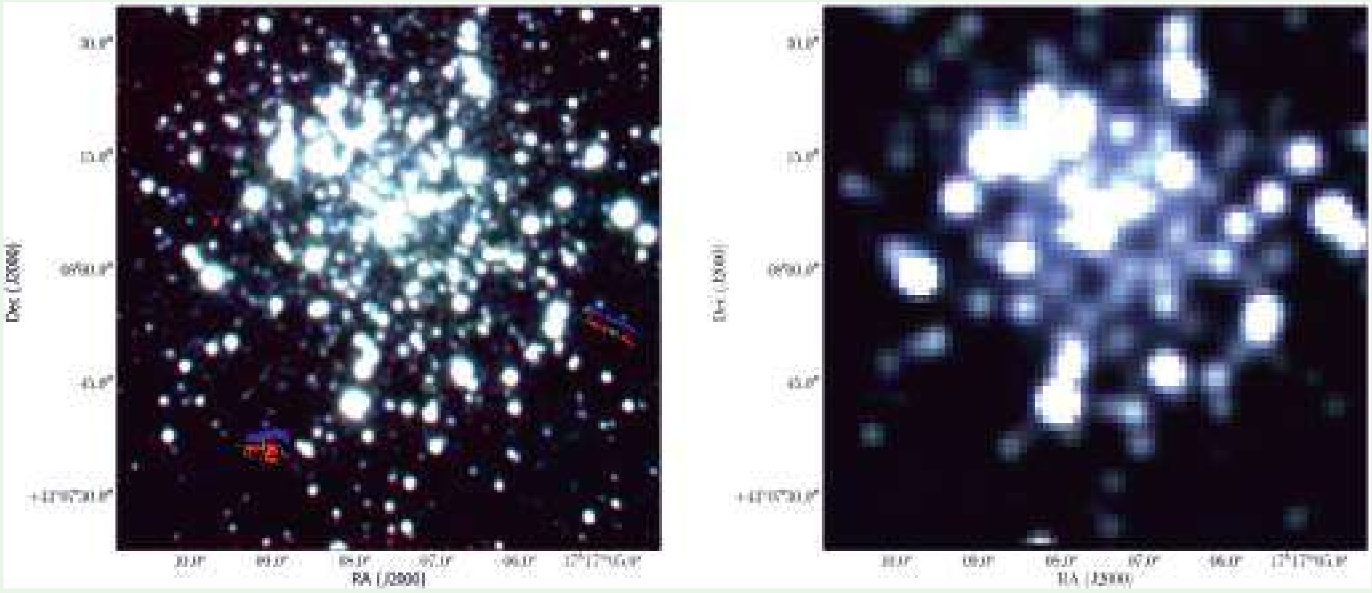


Figure 48. The color-composite image (red: K-band, green: H-band, blue: J-band) of M92, a Galactic globular cluster, constructed using the frames observed with the TIRCAM2 attached to the 3.6 m DOT (left). A color-composite image for the same area generated using the 2MASS J, H, and K band images is also shown (right) for comparison. The 3.6m DOT observation reach about six times deeper than that of 2MASS.

The 15cm Solar Telescope

The main solar observing facility at ARIES is 15-cm, 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 49. The 15cm Coude solar tower telescope for solar observations.

Report from Labs

Electronics Laboratory

The electronics laboratories (lab) at ARIES broadly cater toward instrumentation for observational astronomy and experiments in the field of atmospheric sciences. With the addition of two major facilities, the 3.6m Devasthal optical telescope (DOT) and the ARIES ST Radar, the need of two separate electronics engineering teams for focused effort arose. However, the development process in all these labs follow the same pattern which includes understanding the requirements from the scientific community, technology study and literature survey, discussions and learning from the internal and external experts, simulations, emulations, design, procurement, development, validation and commissioning. The commissioning phase is followed by training, maintenance and upgradation activities. The engineers are also encouraged to upgrade their knowledge by participating in conferences, training programs, teaching activities and to acquire higher qualifications.

The ST Radar electronics engineering group works mostly in the area of radar engineering covering related aspects like radio frequency, antenna, wave guide, signal processing etc. and the lab is equipped with specialized tools like spectrum analyzer, RF cabling and related signal generator, measurement and diagnostic tools. The labs have sufficient space for carrying out the above activities and during the last year facilities like ESD safe workbenches and SMD reworks station have been installed. The same team also caters to the electronics engineering needs of the ARIES atmospheric section and the ARIES solar section under the working group 2 (WG2).

In the area of telescopes and backend instruments several teams of scientists and engineers are working on different systems, subsystems and modules for different telescopes at ARIES. Here, the design, developmental and experimental activities related to electronics, optoelectronics, electronics, mechatronics, optical and mechanical systems are interrelated, thus have a lot of overlaps both at macro and micro levels. This requires the team members to interact frequently and understand different processes which led to the development of several small electronics labs with overlapping facilities. Thus the astronomical instrumentation work is carried out in different labs at different phases. Currently, the embedded systems lab (**Figure 50**) and the rework lab in the 1.04m telescope building is being used for development of electronic controller and power electronics boards, the fabrication lab in the 1.04m telescope building are being utilized for mechatronics and interface development work, one room in the optics building is being used as optoelectronics lab. Overall, these labs are focused on telescope instrumentation work and have facilities like ESD safe working area, embedded system lab, simulation tools, hardware in the loop platform, mixed signal oscilloscopes, function generators, SMD soldering stations, PCB design software, special workshop tools for fine cutting and fine drilling etc. As the nature of the new facilities like the 3.6m DOT and related instruments and auxiliary facilities are demanding distributed control electronics handling

Figure 50. Embedded systems lab in the 1.04m building.

multiple tasks there is a strong requirement of realtime operating systems (RTOS) and more powerful development platform rather than simple low cost microcontroller. Hence the embedded systems labs is being upgraded in a phased manner with the necessary software and hardware for implementing RTOS and tools required for FPGA and DSP based development work. DSP based platform and RTOS for existing platform have been introduced and FPGA platform with system on chip (SoC) is in procurement phase.

The 3.6m DOT employs sophisticated motion control and mirror control systems. There is an extensive list of items in the form of bill of material which requires multidisciplinary skill sets for performing tests and to develop the necessary understanding. A new humidity controlled ESD safe laboratory has been proposed 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. As an interim arrangement and for immediately catering the above needs for the critical electronics spares a ESD safe lab space has been created **(Figure 51)** which is equipped with tools like mixed signal oscilloscope, advanced function generators, programmable high accuracy power supplies, LCR meters, high accuracy bench top multimeter, vibration

Figure 51. Central electronics lab being accommodated with the 3.6m DOT lab.

free bench, serial decoder and protocol analyser, test cameras, precision drilling and cutting tools etc. along with facilities like three phase supply, industrial PC with special interfacing ports etc.

A support lab for the 3.6m telescope for repair and maintenance activities is being planned at ARIES, Devasthal base camp. This lab will be utilized for activities like maintenance of backend instruments and repair and replacement of the DOT telescope parts. Currently, part of this work is being done in the 3.6m DOT pier and in the 1.3m telescope lab.

The electronics engineers also cater towards infrastructure needs of the institute in the ARIES electrical section. The main job function here is to coordinate the electrical maintenance activities including building electrical, power and telephone cabling and distribution in office and residence premises, substation development and maintenance, UPS installation and maintenance and EPABX installation and maintenance.

1) Existing electronics / electrical lab facilities

a) **Embedded systems lab:** This facility is extensively used for developing control system (developing control algorithm, interfacing the encoders, other analog and digital sensors, actuators, design of power electronics and drive boards etc.), software, PCB design, simulations and validation.

b) **CCD lab:** This facility is being used for CCD integration, customizing, testing and maintenance.

c) **Software Lab:** Necessary software and computers with large/multiple monitors have been installed for professional level multi-layer PCB boards design and development, simulation work and multi-screen control software development (TCS, ICS etc.). Multi-threading control software for controlling various aspects of telescope and run-time plotting have been developed for the Schmidt telescope.

d) **Model fabrication lab:** This lab is in the ground floor of the 40 inch telescope building and has necessary power tools for developing wooden and aluminium models, test rigs, catering lab requirements, developing instrument enclosures etc.

e) **ST Radar electronics lab:** This lab is mainly used for working on different aspects of Radar engineering. However, it also supports the instrumentation work related to the atmospheric science section.

f) **Experimental lab in atmospheric science section:** The atmospheric science experiments are carried out in this lab and it has the necessary tools for maintaining these instruments. For larger support help is sought from the ST Radar lab.

g) **Electrical section:** This is mainly established for installation and maintenance of building electrical facilities, central UPS, EPABX and telephone facilities, electrical substations, power distribution in office and residence premises. A SCADA based substation system with suitable backup DG sets is being developed at ARIES, Devasthal for automatic load management, distribution and computerized remote control, monitoring and logging. The substation system consists of two units in master and slave mode separated by a distance of 1.5 km. Both the substations would be electrically connected and linked via LAN network. Installation, testing and verification of small capacitor panel for 750 KVA transformer has completed. This has improved the power factor of electric mains. Installation of LED tube lights, retrofit lights, wall mounted lights, LED PL lights, etc.. The retrofit lights, & LED PL lights are being fitted into the old existing fitting of conventional tube light and CFL fittings without dismantling them. Thus saving large amount of wiring, dismantling & labour cost in ARIES. The phase wise implementation of LED lights in ARIES is saving the electric energy, money and will be helpful in saving the environment as well as to comply the DST circular.

2) Upcoming electronics lab facilities

a) **New electronics lab for telescopes and instruments for integrated design and development work:** For catering towards multidisciplinary activities including electronics, optoelectronics and mechatronics required for telescopes and instruments and also for learning (programming and validation) and testing the telescope motion controllers, PLCs, active optics control system, understanding the system identification and tuning techniques and also for performing periodic functional tests on the spares we have proposed a full-fledged environment controlled lab at Manora Peak site.

b) **Electronics maintenance and support lab at Devasthal:** This lab is in final review stage and would be developed at ARIES, Devasthal base camp and will be used for maintenance of the Devasthal facilities and for remote operation of the Devasthal telescopes.

c) **Upgradation of embedded systems lab:** This lab has been upgraded during the ending financial year 2018-19 to facilitate DSP based development for time critical complex computation, RTOS implementation on the existing platform has been initiated based on open-source software stack and procurement of FPGA platform is in process. Advanced tools for developing precision real-time motion controllers have been procured and are being explored. Suitable protocols for distributed control systems required for telescopes have been explored and CAN protocol based development platform was introduced. The CAN communication boards have been successfully designed and developed. In the upcoming financial year 2018-19 CANopen and EtherCAT based developed platform will be introduced. These protocols are essential for the 3.6m DOT.

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.

1). Coating plant at Devasthal: A technical team was constituted to operate the plant once a week. Proper training was imparted to the technical team to operate the plant. A quick guide pictorial manual was prepared mentioning the operation procedure. Proper schedule with detailed operational manual for running the coating plant is in place and activity log is being maintained. As the performance of the coating plant was below par in terms of reflectivity, so a thorough inspection of the entire system was carried out. Various ports of the vacuum chamber were replaced by dummy flanges (Four Dummy flanges, five KF-50 flanges and o rings etc.) to test minor vacuum leakage in the system. During testing, we found a minute leak at the pneumatic cylinder (using for shutter operation) situated on the top lid. The pneumatic cylinder is reinstalled with new 'O' rings and improvement in the chamber vacuum was observed ($3X10^{-6}$ mbar). 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. Radial dependency of reflectivity values was observed. Further fine tuning of parameters and alignment of magnetron assembly is in process to improve system performance.

The aluminium enclosure for protecting the coating plant from humidity and dust has been completed. The enclosure has a rolling roof for carrying out operational and maintenance activity.

2). Cleaning of 1.3m DFOT primary mirror: Annual in situ cleaning of primary mirror of 1.3m telescope was carried out on 22 September, 2017. The measured reflectivity values of primary mirror before cleaning were 67% @ 365nm & 70 % @ 970nm. After a thorough cleaning process reflectivity values were improved to 81% @ 365nm & 90% @ 970nm. During the cleaning process mirror was not moved in the cell, hence mirror alignment was not necessary after this particular process.

Figure 52. Cleaning of primary mirror with cotton pads (left), Reflectivity value (right)

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 (*ugriz*) and *UBVRI* filters were also cleaned.

3). Optical alignment of 1.3m telescope:

- Optical analysis of 1.3m telescope is carried out using zemax software. The analysis was aimed to assess the positioning accuracy of secondary mirror (M2) of 1.3m telescope. This analysis is carried out at 6000Å wavelength and for 9 fields. The cases for ideal collimation, different values of decentre and tilt in secondary mirror, combinations of errors, focused and in/out focused images were discussed and analysed.

- Secondary mirror movement was done by using four screws at the back plate of secondary support. A laser was mounted at the primary mirror cell and reflection of laser spot from the collimation mirror mounted at secondary mirror was seen to adjust the secondary location. After doing the coarse adjustment in secondary mirror laser attachment was removed and 2K x 2K CCD was attached to the telescope. Image quality testing by taking focused and in/out focused images of the star was done. Fine adjustment in secondary mirror was done by analyzing the defocused images. Analysis shows that the image quality of telescope has improved due to better optical alignment. We explored the possibility to use large area CCD with 1.3m telescope to utilize the wide field capacity of telescope. A preliminary zemax analysis was carried out that shows a large diameter filter will be required for this and hence present filter and guiding wheel attachment will need to be modified. Further analysis will be carried out in due course of time.

4). 3.6m DOT:

- After a few days of observations in October 2017, on one particular night it was observed that the telescope image quality has suddenly degraded. The images of the stellar sources have drastically changed from circular to elliptical shape. After investigation by our team it was observed that one of the axial fixed point location required a shim to be placed to fix the issue. A shim of 1100 micron thickness as suggested by AMOS was inserted very carefully between axial fixed point needle/definer No. 3 and axial pad glued on M1 Mirror. After fixing the issue, telescope alignment using M2 hexapod was carried out. A bright star image was taken using guider. Wavefront sensor loop was closed and wavefront error was allowed to converge up to 63 nm. The new open loop offset parameters are updated.

Figure 53. Shim of thickness 1100 micron placed at axial definer 3.

- **CO_2 snow cleaning of primary mirror:** In-situ cleaning of 3.6m primary mirror is carried out once a month using CO_2 snow cleaning apparatus. Top portion of ARISS is covered using a thin foam sheet to protect it from dust or CO_2 snowflakes during the operation. Hydraulic trolley is used to get access to the mirror height. CO_2 snow gun system is connected with the liquid CO_2 cylinder and tested at the floor level. Cleaning operation is performed with primary mirror in horizontal position and only half of the mirror is accessible from one position. After cleaning first half of the mirror, trolley is placed at the diametrically opposite location and cleaning of other half of the mirror is performed in similar way.

- In situ cleaning of pick off mirror and side port fold mirror was also carried out and their respective reflectivity values were measured using reflectometer. Optical cleaning of entire telescope structure was carried out few times. Centre piece of telescope was covered using plastic sheets to protect primary mirror during monsoon.

5). 4K x 4K CCD Imager

- The filters (SDSS and Bessel) were cleaned before mounting the imager to the telescope. The dewar was evacuated using turbo molecular pump in mounting condition of CCD. LN2 was filled in CCD mounting condition and given proper training to telescope operating staff.

- Filters were cleaned again and transmission of filters was measured using stellarnet hand held spectrometer by setting up a collimating beam. There was a change of around 2% in transmission is observed.

- Ghost analysis was carried out to ensure that there is no unwanted light due to multiple reflections from filters/window. No vignetting was observed due to filter/wheel. Ghost due to filters and CCD window is negligible and cannot be visible with the original image. Zemax file is made with as built specifications of the telescope and image plane kept at its best focus for the field of 6'.52 x 6'.52 to cover full CCD chip size of 61.44 x 61.44 mm. Filter and CCD window is kept in optical path of the telescope. The effect of Ghost on CCD Chip is analysed due to filter and CCD window. Filter (Fused silica) with 5 mm thickness and CCD window (Fused silica) of thickness 4mm is considered for this analysis. Ghost focus generator from zemax is used for ghost analysis and the given results are analyzed. Double bounce (2 reflections) ghosts are generated until CCD chip considering telescope primary, secondary mirrors, filter and CCD window.After the analysis it is observed that the most critical ghost is due to CCD window and filter. The ghost focalised point due to CCD window is around 5.14mm before from the CCD image plane. The ghost focalised point due to Filter is around 6.51mm before from the CCD image plane. 99% anti reflection coating is considered for filter, CCD window and CCD chip. So the ghost image diameter due to window on CCD chip is around 570 microns which is 360 times greater than the characteristic size of image spot (that is size two pixels). It means that the ratio between the lightening Eimage/Eghost is 360/.0001 which is 3.6 x 10^6. These ghost images due to CCD window or filter are completely negligible and these are not visible with original image.

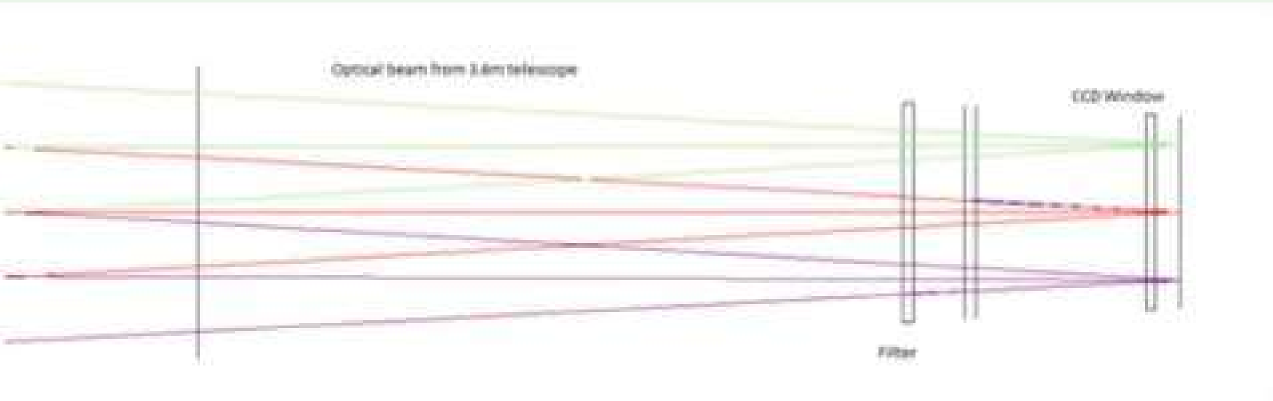


Figure 54. Optical layout of the imager system.

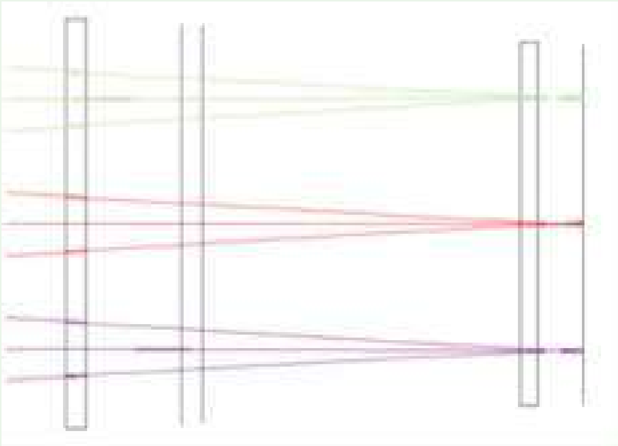



Figure 55. Ghost image due to internal reflections of CCD window.

6). ARIES-Devasthal Faint Object Spectrograph Camera (ADFOSC)

- **Calibration Unit:** Optical design of calibration unit was carried out and optical components related to calibration unit were procured. Optical design was finalized using the as built design specifications. Integrating sphere for uniform illumination was made inhouse in optics laboratory. Barium sulphate coating was applied to inner surface of sphere to produce diffuse multiple reflection. By using integrating sphere developed at ARIES lab, we were able to achieve less than 8% of variation in light uniformity. Calibration unit set up was established at optics laboratory and extensive tests were carried out. Later on the unit was mounted on FOSC instrument. Further alignment and tests were carried out with spectral sources with instrument and 4K x 4K CCD.

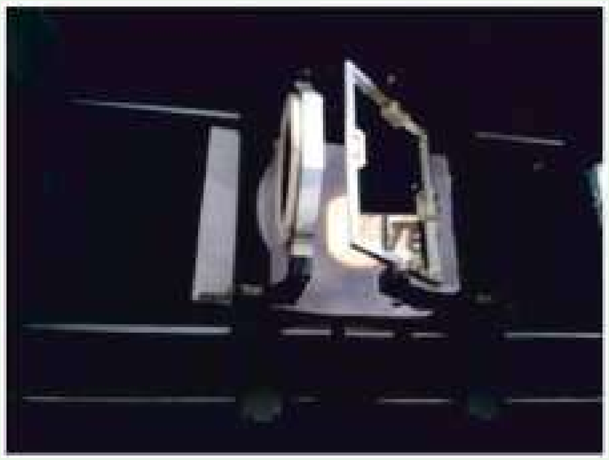



Figure 56. Calibration unit ; top view (left), side view with sources (right).

- Optical components e.g. filter and grisms, slit were tested for their response curves. CCD evacuation was carried out.

- Optical design for measuring seeing (using principal of DIMM) using FOSC was carried out. Prism required for this test has already been procured and the set-up needs to be tested in the next observing run. Optical design for conducting multiband fast photometry using the small dispersion property of a wedge prism was carried out. Wedge prism required for this test was procured and the set-up needs to be tested.

Figure 57. Grism (left), filter (center) and slit (right) in their respective mechanical holders

7). Optics team also carried out following activities:

- *UBVRI* filters were procured and their response curves were tested at optics laboratory.
- Edward turbo molecular pump was procured installed and tested.
- 1.04m primary mirror cleaning was executed inside the tube.
- CCD evacuation of 1K x 1K and 4K x 4K CCDs were done using Edwards TMP and the characterization was done in the optics laboratory.
- TIRCAM instrument was mounted on 3.6m DOT and made ready for science observations.
- Automatic filling liquid nitrogen instrument was tested.

Mechanical Engineering Section

To fulfill the stringent requirements of astronomical and atmospheric instrumentation a fairly well equipped mechanical section has been established at ARIES. Mechanical section is actively involved in design, development and maintenance activities viz. 3.6m telescope related activities, development of IMAGER and ADFOSC subsystems, 1.3m telescope maintenance, 1.04m telescope dome automation, CCD attachments, encoder mountings, optical alignment and modernizing the existing facilities.

The mechanical section is equipped with CNC machine and conventional machines, portable CMM inspection, vertical machining centre (VMC), lathe, milling, radial drilling, surface grinder, mechanical power hacksaw, tool grinder, air compressor, carpentry related machine, power tools, single phase and three phase welding machine, gas cutter equipment, TIG welding etc. Engineers are well familiar with ProE, Unigraphics, Auto Cad, Ansys and Master cam softwares for design, simulation and computer aided manufacturing of mechanical systems.

Major Contibution

1). Installation of lift in 3.6m telescope enclosure building:

A new lift for 3.6m telescope building has been procured and the same is installed in place of the old lift. The lift is a hydraulic unit and was supplied and installed by GMV authorized dealer IEE lifts Punjab. The mechanical section was actively involved in the procurement and installation of the lift.

2). Transmitting and Receiving Module (TRM) Box for ASTRAD:

TRM unit is a main electronic unit in ASTRAD which houses the electronic cards, signal receivers and transmitters etc. The TRM requires critical machining accuracy to mount microelectronic circuits and connector. The TRM components are very sensitive to thermal and radiation load tests. The TRM units are designed and fabricated with the CNC machine using master cam software. **(Figure 58 and 59)**

Figure 58. The TRM unit with different pockets.

Figure 59. The TRM unit with holes.

3). ADFOSC Calibration Unit:

The design and fabrication of the calibration unit for ADFOSC instrument was done in-house successfully. The calibration unit was tested at lab. It was critical to fit the calibration unit in ADFOSC and great care was taken to complete the job precisely. The calibration unit has been mounted with the instrument.

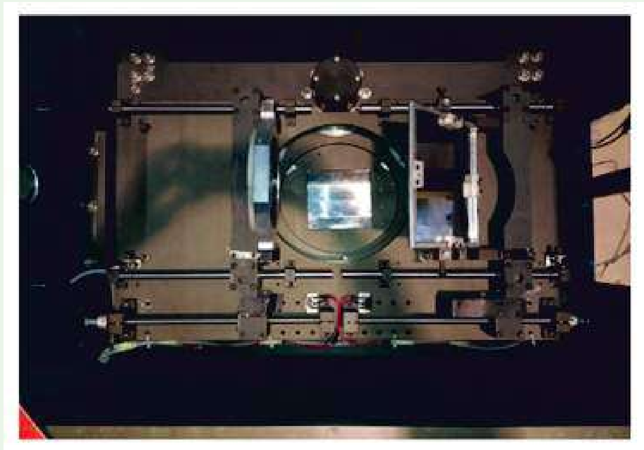


Figure 60. Calibration unit fitted in ADFOSC.

4). 1.04m 4K x 4K filter unit:

The design and development of filter disc unit, which houses broad band filters, for 4K x 4K CCD mounted on 1.04m telescope were carried out in-house using CNC and conventional machines.

Figure 61. Filter wheel unit.

5). Trolley to mount TANSPEC instrument:

A trolley to mount/dismount the TANSPEC instrument with 3.6m DOT was designed in-house. The trolley has a capacity of 2 Ton and has 3 axis movements.

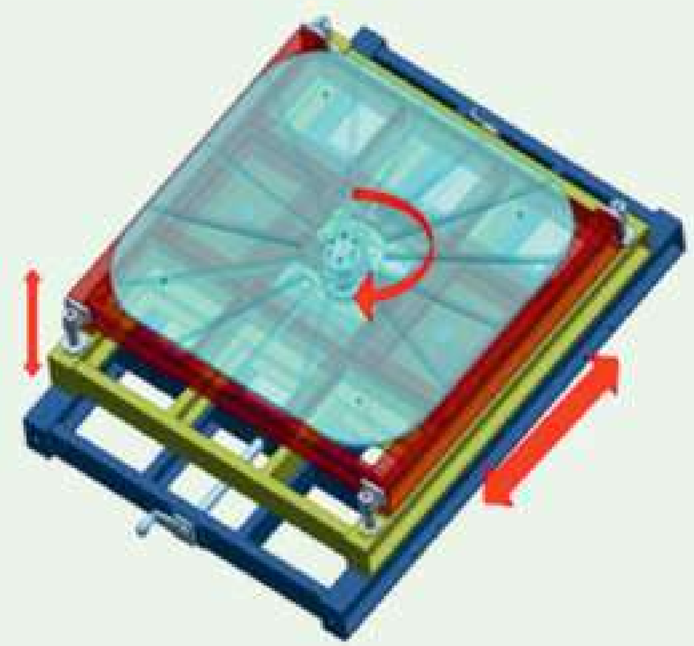


Figure 62. Schematic diagram of the trolley.

Computer Lab:

Computer division is the backbone of ARIES which provides various computing and network services through Information & Communication Technologies (ICT) 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, guest house and residences.

The division manages servers, storage device, Work Stations, desktop and laptop computers, printers, plotters, scanners, projectors, video-conference, DSLAM, bio-metric, CCTV, 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 , 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 Internet Leased Line (ILL) connection from BSNL. Institute 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. A Point to Point microwave link between Nainital & Devasthal is also operation. Internet & Telephone facilities are being provided at Devasthal using this link. Recently A new 10Mbps ILL at Devasthal was also commissioned.

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
- Design and Maintenance of Intranet
- Network Security
- Web Services include Website (Website Development, Administration and Maintenance)
- Management of Point to Point link(Microwave link) between Nainital & Devasthal.
- Management of Bio Metric Attendance System at Nainital & 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.

Major Activities of 2017-18:

- A new ~30TB centralized data storage system has been installed at Devasthal. This will be used for storing data safely for all facilities running at Devasthal.
- IP based CCTV surveillance system at Nainital & Devasthal has been implemented for security and proper monitoring of activities.
- With the help of Electronics section, a new UPS with higher back up time has been installed to minimize downtime of servers/internet services in case of power failure.
- Solution against Ransom ware Attacks has been implemented in ARIES Network.
- Infrastructure procurement (Desktop/Laptop, Multi Functional Printers) for 3.6M DOT, 1.3M Telescope, ILMT and other facilities.

Further Plan

- 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.
- Data Back up solution using External Tape Drives. We are planning to have LTO technology capable of storing data in TeraBytes per cartridge.
- Smart Class room for Seminar/workshop/ training schools /Skype/ WebEx etc.

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 2017 – 2018, the following information resources were added:

Books	:96
Subscription to Journals	:74 (Print + Online) + Full Text Databases
Publications in refereed journals	: 58
Theses awarded	: 04

The collection at the end of the period is

Books	: 10,992
Bound volumes of Journals	: 11,205

Apart from books and journals, non-book 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 on 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 63. 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 2017-2018 are listed below:

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 2018 examination at Nainital centre and exam was conducted on 18 February, 2018.

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 3-7 July 2017. 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. In the year 2017, 8 students have joined ARIES as JRFs.

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.

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 2017-2018, 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] Krishan Chand

[2] Arpan Ghosh

[3] Alaxender Panchal

[4] Priyanka Srivastava

[5] Sadhana Singh

PhD Thesis awarded:

As many as four students of ARIES defended their PhD thesis during April 2017-March 2018. And they are:

[1] Jai Bhagwan

[2] Raman Solanki

[3] Nibedita Kalita

[4] Sumit Kumar Jaiswal

Apart from these, four students submitted their PhD thesis.

[1] Piyush Bhardwaj

[2] Neha Sharma

[3] Subhajeet Karmakar

[4] Abhishek Paswan

Post Doctoral Fellows:

All the applications (till 9 February 2017) related to postdoctoral fellows are processed by AC under the guidance of the Director. Following postdocs are at ARIES during 2017-2018:

[1] Dr. Alka Mishra

[2] Mr. Abhishek Paswan

[3] Dr. Sarvan Kumar

[4] Dr. Tapas Baug

[5] Ms. Neha Sharma

[6] Dr. Srabanti Ballav

[7] Mr. S. Karmakar

Annual Review of Students:

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 2017 the following students have been promoted to SRF after the review process:

[1] Rakesh Pandey

[2] Gaurav Singh

[3] Priyanka Jalan

[4] Tirthendu Sinha

[5] Shilpa Sarkar

[6] Bharti Arora

Orientation Programme 2017:

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 2017 was conducted on 23 August, 2017 **(Figure 64)**.

Figure 64. Group photo with newly joined JRF and pass out JRF of Pre PhD course work during orientation programme conducted on 23 August,2017.

Public Outreach Activities

The Department of Science and Technology (DST) supports the public outreach activities to increase general awareness about astronomy and basic sciences among the common people. ARIES has an active public outreach programme dedicated to the students of Nainital and nearby areas. The science centre in ARIES consists of a lecture hall equipped with a projector and can accommodate about 30 students. A few science models and posters are displayed in the exhibition hall of the science centre. In addition to this a small 14-inch telescope has been installed to facilitate live night sky viewing for the general public. The centre also hosts a 5m planetarium to exhibit popular full dome science movies and programmes of general awareness in astronomy.

The observatory also attracts dozens of visitors per day on a regular basis and 3-4 educational tours per month. Popular science talks and interaction sessions are organized for the visitors on educational tours. On the occasion of interesting astronomical events like eclipses, planetary events etc., a large number of visitors and students visit ARIES and enjoy sky watching and other programmes. Popular talks and interaction with scientists are also arranged for students of nearby schools and colleges. Apart from these, print and electronic media is used to communicate information on astronomical events as and when required.

This year about 8,500 visitors visited ARIES science centre, out of which ~ 60% were students from various schools/colleges throughout the country. During the year, around 1000 visitors attended the night sky watching programme hosted by ARIES science center.

Following major activities were organized for science popularization through the science center of ARIES.

Brahmand Darshan- season 2 and light/air pollution awareness program:

Brahmand Darshan season-2 was jointly organized by Dainik Jagaran , Uttarakhand Tourism Department, association of Hotels in Kumaun and ARIES during 17 19 February, 2018 to promote astronomy/astrophotography in Uttarakhand. In this programme about 35 selected participants across the country participated at the venue in NaukuchiaTal, Nainital and a number of activities were conducted as a part of this programme. A science quiz was organized for the students of local schools and colleges. A dedicated session was also organized to discuss the contribution of Indian scientists and philosophers towards ancient astronomy. The importance of astrophotography in attracting more tourists in the hills of Uttarakhand was also discussed. The prize distribution ceremony was hosted at ARIES.

A full session was dedicated to increase awareness about effects of light and air pollution for the world class astronomical observing facilities like Devasthal where India's largest 3.6m optical telescope has recently been established. On this occasion, a team of scientists led by Director ARIES, Dr. A. K. Pandey, and media personals interacted with local villagers and students to educate them about air and light pollution and the possible ways to minimize this. It is well-known that forest fires caused due to several reasons and the amount of dust and smoke reduces the optical visibility. The street lamps and un-wanted lights in local villages could also effect the overall performance of the 3.6m DOT. This was a successful program and it was decided to follow it up in near future and if possible also provide tools to local villages to reduce the light pollution in order to maintain the international standards of the Devasthal observing station.

ARIES Training School in Observational Astronomy (ATSOA)

ATSOA is an annual training school in observational astronomy conducted by ARIES. About 30-40 post graduate science students were selected from different universities/institutions. With the continuous addition of new observing facilities, more and more young students need to be trained to exploit the enormous volume of scientific data. ATSOA, held during 19-28 March, 2018, is aimed at training the students in optical data analysis. About two dozen pedagogical lectures on basic astronomy were delivered by ARIES faculty members. The students also participated in night sky observations with the 1.04m telescope and acquired hands-on experience in analyzing the data under the able guidance of ARIES Ph.D students. ATSOA students presented the project work carried out during the school and were given the participation certificates.

Public Outreach Day

As a precursor programme of India International Science Festival (IISF) 2017, ARIES conducted a one day programme for Govt. School Students on 11 September 2017 in which 75 students participated. During this program, the students were told about basics of astronomy, a visit to the 1.04m Sampurnanand telescope, a science movie show at the planetarium and interaction with scientists were held.

Participation in Science Exhibitions

ARIES participated in four major science exhibitions in different parts of the country during the year including (1) Bhartiya Vigyan Sammelan, Pune, 11 May, 2017, (2) Govt. Achievement & Schemes Expo, Pragati Maidan, New Delhi, 14-16 July, 2017, (3) Exhibition for Members of Parliament, Sansad Bhavan, New Delhi, 28 July – 11 August, 2017 and (4) India International Science Festival (IISF), Anna University, Chennai, 13-16 October, 2017.

Figure 65. ATSOA 2018.


दूरबीन के लिए प्रदूषण है बड़ा खतरा

Figure 66. Quiz competition (left) and awareness about light and air pollution program (right) as hosted by ARIES during Brahmand Darshan - season 2.

Figure 67. Dr. Narendra Singh interacting with visitors during Bharitiya Vigyan Sammelan in Pune.

Figure 68. ARIES stall at Govt. Achievement & Scheme expo at Pragati Maidan, New Delhi.

Figure 69. Students visiting ARIES stall during IISF-2017 in Chennai.

Figure 70. Public Outreach Day Celebration.

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 also made tie-up with SAI Hospital, Haldwani (Dist.- Nainital), Brijlal Hospital, Haldwani (Dist. - Nanital) and Krishna Hospital and Research Centre, Haldwani (Dist.- Nainital) on cashless basis and with through which bills on expenses are reimbursed as per CGHS rates. One doctor is engaged by the ARIES who pays visit to the institute twice in 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 itself 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 is also having a departmental store which serves employees and their family members who are living 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 Govt. of India from time to time.

Prevention of Sexual Harassment of Women at Work Place:

Necessary mechanisms have been placed 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 (21)

Anil K. Pandey
(Director)
Alok C. Gupta
Brijesh Kumar
Indranil Chattopadhyay
Maheswar Gopinathan *(till 21-07-2017)*
Ramakant Singh Yadav
Saurabh
Wahab Uddin
Amitesh Omar
D. V. Phanikumar
Jeewan C. Pandey
Manish Naja
Santosh Joshi
Snehlata
Yogesh C. Joshi
Biman J. Medhi *(till 21-03-2018)*
Hum Chand
Kuntal Mishra
Narendra Singh
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
Shobhit Yadava
Chandra Prakash
Mukeshkumar B. Jaiswar
Sanjit Sahu
Tarun Bangia

Administrative and Support (13)

Ravinder Kumar
(Registrar)
Abhishek Kumar Sharma
Mahesh Chandra Pande
Praveen Solanki
Vijay Kumar Meena *(till 28-02-2018)*
Bharat Singh
(Asstt. Registrar)
Anand Singh Bisht
Manjay Yadav
Rajeev Kumar Joshi
Virendra Kumar Singh
Hansa Karki
Mohan Singh Bisht
Rajendra Prasad Joshi

Scientific and Technical (35)

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

Laboratory Assistant/Attendants (11)

Ashok
Laxman Singh Kanwal
Ram Ashish Ram *(till 31-08-2017)*
Shyam Lal
Basant Ballabh Bhatt
Mohan Singh Rana
Ramdayal Bhatt
Suresh Chandra Arya
Harish Chandra Arya
Rakesh Kumar
Shyam Giri

Post Doctoral Fellows/Research Associate (07)

Dr. Alka Mishra *(till 03-05-2017)*
Dr. Tapas Baug *(from 11-07-2017)*
Mr. S. Karmakar *(from 05-09-2017)*
Mr. Abhishek Paswan *(from 16-03-2018)*
Ms. Neha Sharma *(from 31-07-2017)*
Dr. Sarvan Kumar
Dr. Srabanti Ballav

Research Scholars (37)

Ms. Abha Monga
Mr. Alazender Panchal
Mr. Ankur Ghosh
Mr. Ashwini Pandey
Mr. Gaurav Singh
Mr. Krishan Chand
Ms. Mridweeka Singh
Mr. Pankaj Sanwal
Mr. Prajjwal Singh Rawat
Mr. Rakesh Pandey
Ms. Sapna Mishra
Mr. Tirthendu Sinha
Mr. Vinit Dhiman
Mr. Abhishek Paswan *(till 15-03-2018)*
Mr. Amit Kumar
Mr. Arpan Ghosh
Ms. Bharti Arora
Mr. Jayanand Maurya
Mr. Kuldeep Singh
Ms. Neha Sharma *(till 30-07-2017)*
Mr. Parveen Kumar
Ms. Priyanka Jalan
Ms. Raya Dastidar
Mr. Subhajeet Karmakar *(till 04-09-2017)*
Mr. Vibhore Negi
Mr Aditya Jaiswal
Ms. Anjasha Gangopadhyay
Ms. Arti Joshi
Ms. Ekta Sharma *(till 03-11-2017)*
Mr. Jaydeep Singh
Mr. Mohan Singh
Mr. Mukesh K. Vyas
Ms. Piyali Sah *(till 03-11-2017)*
Ms. Priyanka Srivastava
Ms. Sadhana Singh
Ms. Shilpa Sarkar
Mr. Vineet Ojha

Visits by ARIES Members

International Visits

Dr. Yogesh Joshi	Capetown, South Africa Nice, France Royal Observatory of Belgium	01-03 Apr., 2017 24-28 Apr., 2017 03-16 October, 2017
Mr. Parveen Kumar	Univ. of Padova, Padova, Italy	01 - 10 Apr., 2017
Dr. U. C. Dumka	Fudan University in Shanghai, China	20 Apr. – 19 Oct., 2017
Dr. Amitesh Omar	Taipei, Taiwan	03 – 07 July, 2017
Dr. A. K. Pandey	Taipei, Taiwan	03 – 07 July, 2017
Dr. Phani Kumar	AOGS, Singapore	06 – 11 Aug., 2017
Dr. S. B. Pandey	Univ. of Leicester, UK	06- 16 August, 2017
Dr. A. C. Gupta	SAO, Shanghai, China Guangzhou University, Guangzhou, China Jagiellonian University, Krakow, Poland and NCAC, Warsaw, Poland	01 Apr. – 26 May, 2017 14 – 17 May, 2017 11- 26 Sept., 2017
Mr. Ashwani Pandey	Jagiellonian University, Krakow, Poland	11- 26 Sept., 2017
Ms. Aabha Monga	Ilia State Univ., Tbilisi, Georgia The Catholic University of America	25 - 29 Sept., 2017 01 - 04 Augt., 2017
Dr. Santosh Joshi	Observatorie de la Cote d' Azur, Nice, France Royal Observatory of Belgium and Univ. libre de Bruxelles, Belgium	04 - 06 Oct., 2017 08-22 Oct., 2017
Dr. Manish Naja	South Durras, NSW, Australia	06 - 08 Nov., 2017
Dr. T. S. Kumar	Gold Coast, Australia	17 - 20 Dec., 2017
Dr. I. Chattopadhyay	Capetown, South Africa	03 - 08 Dec., 2017
Ms. Mridweeka Singh	The Hebrew University of Jerusalem	27 Dec., 2017 - 05 Jan., 2018
Dr. Saurabh	IOA, Univ. of Tokyo, Japan	17 Feb., - 03 Mar., 2018
Mr. Gaurav Singh	FIAP Jean Monet, Paris	26 Feb., - 02 Mar., 2018

National Visits

Mr. Chandra Prakash	Fergusson College, Pune Anna University, Chennai	11 – 14 May, 2017 13 - 16 Oct., 2017
Dr. Brijesh Kumar	DST, Delhi	14 May 2017 18 Sep 2017 26 Mar., 2018
	IIA, Bengaluru	06 - 08 Sept., 2017 16 Nov., 2017
	IUCAA Pune	17 Feb., 2018
	DSB Campus, Kumaun Univ., Nainital	28 Mar., 2018
Mr. Sarvan Kumar	IITM Pune SAC, Ahmadabad NARL, Tirupati	23 - 26 May, 2017 07 - 10 Nov., 2017 01 - 03 Feb., 2018
Dr. I. Chattopadhyay	IIST, Trivendrum	04 - 07 June, 2017
	Bose Institute, Kolkata and Osmania Univ., Osmania	06 – 16 Feb., 2018
	SINP, Kolkata	04 - 11 Mar., 2018
Mr. Mukesh Kr. Vyas	IIST, Trivandrum	05 - 07 June, 2017
Ms. Shilpa Sarkar	IIST, Trivendrum Osmania Univ., Hyderabad	05 - 07, June, 2017 05 - 09 Feb., 2018
Mr. Kuldeep Singh	IIST, Trivendrum	05 - 07 June, 2017
Mr. Ashwani Pandey	IIST, Trivendrum	05 - 07 June, 2017
Dr. Kuntal Misra	NCRA, TIFR, India Anna Univ., Chennai, India Infosys Campus, Mysuru Osmania Univ., Hyderabad	04 - 07 July, 2017 13 - 16 Oct., 2017 07 - 09 Nov., 2017 05 - 09 Feb., 2018
Dr. A. C. Gupta	Pt. R S. Univ., Raipur BARC, Mount Abu Univ. of Calicut, Kerala	23 – 25 July, 2017 16 – 18 Nov., 2017 27 – 30 Nov., 2017
Ms. Bharti Arora	NCRA, Pune	28 Aug. – 08 Sept., 2017
Ms. Priyanka Jalan	IUCAA, Pune	11 - 15 Sept., 2017 11 - 15 Dec., 2017 11 - 18 Feb., 2018
Dr. Hum Chand	IUCAA, Pune, India	11 - 15 Dec., 2017

		18 - 21 Dec., 2017
	Mysore, India	06 - 09 Nov., 2017
	IIT Roorkee	27 - 29 Nov., 2017
Dr. Saurabh	IUCAA, Pune	10 - 12 Jan., 2018
	Osmania Univ., Hyderabad	06 - 08 Feb., 2018
Ms. Aabha Monga	Birla auditorium, Jaipur	19 - 24 Feb., 2018
Dr. D. V. Phanikumar	New Delhi	13 - 17 July 2017
	IIRS, Dehradun	May, 2017
		November 2017
Dr. Y. C. Joshi	New Delhi	08 – 12 Aug., 2017
		27 Mar., 2018
	Bangalore	07 – 09 Sept., 2017
	Mysore	07 – 09 Nov., 2017
	IUCAA, Pune	21 – 24 Jan., 2018
	Osmania Uni., Osmania	04 - 10 Feb 2018

Visitors at ARIES

From Abroad

Prof. Jean Surdej	Liegue Univ., Belgium	13 – 15 Apr., 2017 02 May – 01 Jun, 2017 17 – 19 Oct., 2017 07 – 16 Jan., 2018 13 – 21 Feb., 2018 29 Mar. – 01 Apr., 2018
Mr. Krishna PrasadVadrevu	NASA, USA	06 – 08 May, 2017
Dr. Chris Justice	Univ. of Maryland, USA	06 – 08 May, 2017
MS. ChristunaJusticw	Univ. of Maryland, USA	06 – 08 May, 2017
Mr. Bikram Pradhan	Liegue Univ., Belgium	30 May – 07 Jun., 2017 07 – 09 Oct., 2017 17 – 19 Oct., 2017 20 – 31 Jan., 2017 29 Mar. – 02 Apr., 2018
Mr. Aditya Pandey	North Eastern Univ., Massachusetts, USA	20 – 22 June, 2017
Mr. AshutoshTripathi	Fudan University, Shanghai, China	21 – 24 Aug., 2017
Dr. Pankaj Kushwaha	Univ. of Sao Paulo, Brazil	30 Oct. – 10 Nov., 2017
Dr. Ronald Macatangay	NARIT, Thailand	09 – 10 Nov., 2017
Dr. Raman Solanki	NARIT, Thailand	09 – 10 Nov., 2017
Prof. Y. Itoh	Univ. of Hyogu, Japan	30 Jan. – 01 Feb., 2018
Ms. Mai Tsakaw	Univ. of Hyogu, Japan	30 Jan. – 01 Feb., 2018
Ms. MayuKarita	Univ. of Hyogu, Japan	30 Jan. – 01 Feb., 2018
Prof. N. Kobayashi	Tokyo, Japan	10 – 16 Feb., 2018
Prof. Katsuo Ogura	Japan	04 – 10 Mar., 2018
Prof. E. Semkov	IANAO, Sofia, Bulgaria	14 – 27 Mar., 2018
Prof. Roumen Bachev	IANAO, Sofia, Bulgaria	14 – 27 Mar., 2018
Prof. A. Strigachev	IANAO, Sofia, Bulgaria	14 – 27 Mar., 2018

From other Indian Institutions

Dr. S. Mondal	SN Bose, Kolkata	16 – 17 Apr., 2017
Mr. S. Ghosh	SN Bose, Kolkata	16 – 17 Apr., 2017 18 – 19 June, 2017 29 – 30 Oct., 2017

Dr. K. Pawar	IIST, Trivandrum	22 – 30 Apr., 2017
Dr. V. Khaire	NCRA, Pune	24 – 30 Apr., 2017
Ms. Garima Yadav	HNBGU, Srinagar	26 – 31 Apr., 2017
Dr. K. D. Purohit	HNBGU, Srinagar	01 – 04 May, 2017
Prof. Ashok Raja	Bangalore	01 – 05 May, 2017
Dr. V. Mohan	Pune	01 – 16 May, 2017
Mr. Hem Chandra	HNBGU, Srinagar	03 – 10 May, 2018
Mr. Yogesh Kant	IIRS, Dehradun	06 – 07 May, 2017
Prof. J. K. Garg	IP Univ., Delhi	06 – 08 May, 2017
Dr. Vandana Mittal	DRDO, Delhi	07 – 10 May, 2017
Prof. R. Srinivasan	IIA, Bengaluru	14 – 17 May, 2017
Prof. T. P. Prabhu	Bengaluru	14 – 17 May, 2017
Prof. A. Prmesh Rao	NCRA, Pune	14 – 19 May, 2017
Mr. Sanjay Gupta	Arybhatta Foundation, Bhopal	15 – 19 May, 2017
Prof. S. Ananthakrishnan	Pune	11 – 17 May, 2017
Dr. Nand Kumar Chakradhari	Pt. RS Univ., Raipur	18 May – 12 June, 2017
Prof. S. Choudhary	AISECT Univ., Bhopal	19 – 21 May, 2017
Mr. R. Gupta	IUCAA, Pune	20 – 24 May, 2017
Prof. U. C. Joshi	PRL, Ahmedabad	22 – 27 May, 2017
Dr. V. Singh	PRL, Ahmedabad	30 May – 02 June, 2017
Prof. Shyam Lal	PRL, Ahmedabad	05 - 08 June, 2017
Ms. Malu S.	Osmania Univ., Hyderabad	17 – 19 June, 2017
Mr. AlikPauja	SN Bose, Kolkata	20 – 22 June, 2017
Mr. Raghu Prasad M.	Osmania Univ., Hyderabad	06 – 13 Aug., 2017
Mr. Varsha K. R.	IIA, Bengaluru	07 – 11 Aug., 2017
Prof. P. C. Agrawal	Mumbai Univ., Mumbai	07 – 08 Aug., 2017
Prof. T. Shivarani	IIA, Bengaluru	07 – 09 Aug., 2017
Prof. B. Eswar Reddy	IIA, Bengaluru	07 – 09 Aug., 2017 21 – 24 Feb., 2018

Prof. R. Misra	IUCAA, Pune	08 – 12 Aug., 2017
Prof. Jagdev Singh	IIA, Bengaluru	10 – 18 Aug., 2017 26 – 27 Feb., 2018 25 – 28 Mar., 2018
Mr. R. V. Swami	NCRA, Pune	04 – 06 Sept., 2017
Dr. P. K. Pal	IIRS, Dehradun	30 Sept. – 01 Oct., 2017
Mr. Ashik Paul	IRPE, Kolkata	03 – 05 Oct., 2017
Mr. Pratik	IUCAA, Pune	11 – 12 Oct., 2017
Mr. Dhrimadri	SN Bose, Kolkata	29 – 30 Oct., 2017
Prof. D. K. Sahu	IIA, Bengaluru	12 – 16 Dec., 2017
Dr. Vinay Kumar	Delhi Univ., Delhi	17 – 27 Dec., 2017
Ms. G. Choudhary	Aasam Univ., Aasam	21 – 24 Dec., 2017
Prof. Binoy Krishna Patra	IIT, Roorkee	22 – 27 Dec., 2017
Dr. Ritaban Chatterjee	Presidency Univ., Kolkata	02 – 05 Jan., 2018
Mr. Tathagata Saha	Presidency Univ., Kolkata	02 – 05 Jan., 2018
Mr. Mr. Anwesh Majumdar	Presidency Univ., Kolkata	02 – 05 Jan., 2018
Prof. H. P. Singh	Delhi Univ., Delhi	30 Jan. – 01 Feb., 2018 22 – 24 Feb., 2018
Ms. Susmita Das	Delhi Univ., Delhi	30 Jan. – 01 Feb., 2018
Dr. Parul Rishi	IIFM, Bhopal	05 - 06 Feb., 2018
Prof. S. K. Ghosh	NCRA-TIFR, Pune	21 – 24 Feb., 2018
Prof. D. K. Ojha	TIFR, Mumbai	21 – 24 Feb., 2018
Prof. R. Srianand	IUCAA, Pune	22 – 24 Feb., 2018
Prof. B. Paul	RRI, Bengaluru	23 – 24 Feb., 2018
Prof. T. R. Seshadri	Delhi Univ., Delhi	27 – 29 Mar., 2018
Mr. Arkadipta Sarkar	DHEP, TIFR, Mumbai	05 - 09 Mar., 2018

Abbreviations

2MASS	Two Micron All-Sky Survey
ADOT	Astronomer In-charge, Devasthal Optical Telescope
AGN	Active Galactic Nuclei
AIA	Atmospheric Imaging Assembly
AIMPOL	ARIES Imaging Polarimeter
AIRS	Atmospheric Infrared Sounder
AMOS	Advanced Mechanical and Optical Systems
AMSU-A	Advanced Microwave Sounding Unit - A
AOT	Aerosol Optical Thickness
ATSOA	ARIES Training School in Observational Astronomy
BAT	Burst Alert Telescope
BNS	Binary Neutron Star
BoB	Bay of Bengal
CCD	Charged Coupled Device
CME	Coronal Mass Ejection
COSMIC	Constellation Observing System for Meteorology, Ionosphere and Climate
CWT	Concentration Weighted Trajectory
DOMC	Devasthal Operation and Maintenance Committee
DOT	Devasthal Optical Telescope
DSP	Digital Signal Processing
DTAC	Devasthal Time Allotment Committee
EIT	Extreme Ultraviolet Imaging Telescope
EM	Electromagnetic
EOT	Electric Overhead Travelling
ERAI	European Centre for Medium-Range Weather Forecasts (ECMWF) reanalysis Interim
ESD	Electrostatic Discharge
EUV	Extreme Ultraviolet

FOSC	Faint Object Spectrograph and Camera
FPGA	Field Programmable Gate Array
FWHM	Full Width at Half Maximum
GATE	Graduate Aptitude Test in Engineering
GMRT	Giant Metrewave Radio Telescope
GOES	Geostationary Operational Environmental Satellite system
GONG	Global Oscillation Network Group
GRB	Gamma Ray Burst
GW	Gravitational Wave
ICS	Instruments Control System
IGP	Indo-Gangetic Plains
IHR	Indian Himalayan Region
ILL	Internet Leased Line
ILMT	International Liquid Mirror Telescope
IRAC	Infrared Array Camera
IRDC	Infrared Dark Clouds
IRS	Infrared Sources
JEST	Joint Entrance Screening Test
JRF	Junior Research Fellows
JVLA	Jansky Very Large Array
LAT	Large Area Telescope
LC	Light Curve
LHVKI	Livingstone-Hanford-Virgo-Kagra-India
LMC	Large Magellanic Cloud
LSST	Large Synoptic Survey Telescope
MF	Mass Function
MIR	Mid-Infrared
MODIS	Moderate Resolution Imaging Spectroradiometer

NET	National Eligibility Test
NIC	National Informatics Centre
NIR	Near-Infrared
NKRC	National Knowledge Resource Consortium
NLSy1	Narrow-Line Seyfert 1
NOAA	National Oceanic and Atmospheric Administration
NRCM-Chem	Nested Regional Climate model with Chemistry
NuSTAR	Nuclear Spectroscopic Telescope Array
OMI	Ozone Monitoring Instrument
PCB	Printed Circuit Board
PLC	Programmable Logic Controller
PSCF	Potential Source Contribution Function
PSF	Point Spread Function
QSL	Quasi-Separatrix Layers
QSO	Quasi-Stellar Object
RCP	Representative Concentration Pathways
SED	Spectral Energy Distribution
SDO	Solar Dynamic Observatory
SDSS	Solan Digital Sky Survey
SMARTS	Small and Moderate Aperture Research Telescope System
SMD	Surface-Mount Device
SNR	Supernova Remnant
ST	Stratosphere Troposphere
ST	Sampurnanand Telescope
STEM	Sulfur Transport and dEposition Model
STEREO	Solar Terrestrial Relations Observatory
SusKat	Sustainable Atmosphere for the Kathmandu Valley
TANSPEC	TIFR-ARIES Near Infrared Spectrometer

TCO	Total Column Ozone
TCS	Telescope Control System
TES	Tropospheric Emission Spectrometer
TIFR	Tata Institute of Fundamental Research
TIRCAM2	TIFR Near Infrared Imaging Camera - II
TMT	Thirty Meter Telescope
TOAR	Tropospheric Ozone Assessment Report
TRM	Transmitting and Receiving Module
UMRAO	University of Michigan Radio Astronomical Observatory
UV	Ultraviolet
VFD	Variable Frequency Drives
WD	Wilson-Devinney
WHO	World Health Organization
WISE	Wide-field Infrared Survey Explorer
WLQ	Weak-Line Quasar
WR	Wolf-Rayet
WRF	Weather Research and Forecasting
WV	Water Vapor
XMM	X-ray Multi-Mirror Mission
XRT	X-Ray Telescope
YSO	Young Stellar Object

Audit Statements of Account
(2017-2018)

MANOJ VATSAL & CO
CHARTERED ACCOUNTANTS

ARIES-SPECIAL AUDIT REPORT FY 2017.18

We have audited the accompanying financial statements of Aryabhatt Research Institute of Observational Sciences, Manorma Peak, Naini Tal, Uttrakhand ("the Institute"), which comprise the Balance Sheet as at 31st March 2018, Statement of Income and Expenditure and Receipt & Payments for the year then ended and a summary of Significant Accounting Policies and other explanatory information

Management Responsibility for the Financial Statements

"The Institute's" is responsible for the preparation of these financial statements that give true and fair view of the financial position and financial performance of "the Institute" in accordance with the accounting principles generally accepted in India, including the applicable Accounting standards.

This responsibility includes the maintenance of adequate accounting records in accordance with the provisions of the applicable Act, for safeguarding the assets of the Society and for preventing and detecting frauds and other irregularities; selection and application of appropriate accounting policies; making judgments and estimates that are reasonable and prudent; and design, implementation and maintenance of adequate internal financial controls, that were operating effectively for ensuring the accuracy and completeness of the accounting records, relevant to the preparation and presentation of the financial statement that give a true and fair view and are free from material misstatement, whether due to fraud or error

Auditors' Responsibility

Our responsibility is to express an opinion on these financial statements based on our audit. We have 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 of "the institute" 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 upon our judgment, including the assessment of the risks of materials misstatement of the financial statement, whether due to fraud or error.

In making those risk assessments, we consider internal control relevant to "the Institute's" preparation and fair presentation of the financial statements that give a true and fair view 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 the 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 for our audit opinion on the financial statements.

Hall 1D, II Floor Durga City Centre, Haldwani (263141) Uttarakhand
Land Line 05946-228558, Cell- 09837170947, E-mail: manojvatsalca@gmail.com
Office:- • HALDWANI • DEHRADUN • NEW DELHI • LUCKNOW

ARIES-SPECIAL AUDIT REPORT-2018.19

Basis for Matter of Emphasis

(I) The Institute was transferred with Assets in 2004 from the then UP State Govt and was thereafter registered under the Society Act in Uttrakhand as an autonomous Institution under DST. The by- laws were to be laid out and the Executive Committee would consist of the GC members .**Since 2015,the new list of GC members has not been intimated to the Society Office, nor have the decisions and minutes of Meetings been communicated. Restrictive clauses in the By laws relating to Posts, Pay, Fixation and Recruitment, policy remain to be implemented.**

(II) The Institute needs to introduce a **system of recognizing Expense/Asset/Project Liability**, based on Bills received periodically, of the Indents raised for the items that make up the Bill of Material, based on which the Budget is prepared.

(III) **Revenue Grants** and other Receipts are taken as income, as and when stated to be utilized /spent.

(IV) Basis on the guidelines of the GC and FC ,**Interest income on Core Grant** is to be transferred to DST

(V) **Balances appearing under Debtors, creditors, advances received/paid are subject to confirmation /reconciliation** and consequential adjustments, the impact which on these financial statements are not quantifiable by us.

(VI) **Liability for Outstanding dues to Suppliers** on account of 10% Security deposit or on account of **unpaid liability ,ECIL(ST Radar) has not been accounted** and provided for in the Books of Accounts(Rs 281.30 lacs)

(VII) **Internal Controls systems & procedures are to be further strengthened** in respect of programs executed by "the Institute", there are no RECORDS maintained serially and every Indent has an independent file. Registers as prescribed by the Financial Rules 2017, are not maintained. Proper documentary formats are also not maintained .Hence there is no control on indenting, purchasing. There is no standard operating procedure and hence every transaction is accounted, as what the handling operative feels is correct. There is no Serial document control register.
There are shortcomings in timely obtaining of the Bills and compliances to deductions of tax at source in payments of consultancy charges, service charges and terminal benefits of retiring employees.

(VIII) **Since the Liability register and Budget registers are not being maintained, there is every possibility of double payment** of Expenses in the Books of Aries and Project.eg. Travel expenses booked thru Balmer & Laurie .Paid invoices are not being retained in Original nor are the Invoices being stamped PAID

(IX) **On account of non maintenance of Control registers, there is no control on repetitive expenses, like AMC, Security, Conveyance etc.** For Devasthal, there is (1)an independent Vehicle contract (2),the existing Bus is also used and (3)individual conveyance expenses claimed with DA, when some Engineers and Project heads have been posted at the Project.

MANOJ VATSAL & CO. C.A. HALDWANI

ARIES-SPECIAL AUDIT REPORT-2018.19

(X) The **scope of internal audit coverage needs to be enhanced**, particularly in the areas of expenditure incurred on various programs and also timely compliances of the internal audit observations. A Bill of Material should support the Budget and every Indent, Purchase Order, Invoice, must refer to the Budget.
Currently no Budget control is being exercised.

(XI) **Physical verification of Inventory is not carried out periodically**. The Inventory is not categorized for slow and obsolete Stocks. Since no entry is being made, when any Material enters the Institute, we are not able to certify the correctness of the physical inventory. **There is presence of a large value of obsolete stock that needs to be identified and written off. No provision for the same has been provided for in the Books.**

(XII) According to the information and explanations given to us, **physical verification of the assets of "the Institute" was not carried out during the year.** In the absence of the reconciliation between the physical records and book records, we are not in position to comment on the differences/ discrepancies and their impact on the financial statements.
Project assets have neither been declared, nor verified or certified

(XIII) **During the last Inventory of Library books, Rs 3.38 lacs worth of Journals and Books were found missing.** This amount needs to be written off from the value of Library assets, but **no provision has been created for writing off the loss of Assets**

(XIV) The Institute's (Employer's) contribution to provident fund is being made at 12% of maximum wages as per clause 24 of the Employees provident fund rules of the Institute. In the **absence of detailed calculation employee wise, the impact of which on these financial statements are not quantifiable by us.**

We cannot verify or compute the actual Corpus balance that should be at credit in favour of the Employees as on 31.03.18.We cannot verify the Interest paid/payable on these balances.

We further **cannot verify the Advances and Withdrawals made by employees from their Provident Fund.**

(XV) As referred to the liability towards **gratuity payable of Rs. NOT DETERMINED and Leave encashment of Rs. NOT DETERMINED has not been quantified and no provisions have been made** in the accounts. As the same is not determined based on an actuarial valuation, we are unable to quantify the Liability.
Provision has also not been made for Leave encashment and Gratuity payable (Rs 20.00 lacs for Government employees from 1.01.2016)

(XVI) A demand has been raised **by the Income Tax Department is for Rs 328.00 Lacs, for** the period AY 2016.17. **No provision for the same** has been made in the accounts, by "the Institute". " The Institute" has not filed appeals before Hon'ble Income Tax In the absence of any provision for the same in the accounts, we **are not in a position to comment on the ultimate liability payable** along with interest, penalties and other offences as per the provisions of Income Tax, that may arise at any later date. This liability will have adverse effect on the functioning of the institute and sizeable impact on the financial statements

(XVII) **TDS has not been deducted** from payments made to:

a) Pensioners
b) AMC payments
c) Service bill payments
d) Legal payments

We are **not in a position to comment on the ultimate liability payable** along with interest, penalties and other offences as per the provisions of Income Tax, which may arise at any later date. This liability will have adverse effect on the Income Tax assessment of the institute and sizeable impact on the financial statements

e) **Earlier short deductions of TDS of Rs 29.81 lacs** from Pensioners, Works Contractors, and Service providers, identified by the CAG audit also have not been recovered.
We are not in a position to comment on the ultimate liability payable along with interest, penalties and other offences as per the provisions of Income Tax that may arise at any later date. This liability will have adverse effect on the Income Tax assessment of the institute and sizeable impact on the financial statements.

Payments made to Legal Consultants, Freight, and Manpower services, Car lease are covered under "reverse charge mechanism" but GST has not been paid by the Institute. There are no threshold limits of GST in these cases.

We are not in a position to **comment on the ultimate liability payable along with interest**, penalties and other offences as per the provisions of Income Tax that may arise at any later date.. No provision of the same is also made in the accounts.

(XVIII) **Manpower outsourced for Security, Housekeeping, Gardening, Maintenance, Utility, AMC etc have not been budgeted** for. There are several agencies engaged (a) Maa Naina(b)BIVA(c)Devki Nandan(d)Hina Travels (e)Rana Securties (f)MG Security(g)UPNL(h)Daily wagers(i)Sun Infosys(j)Creative Tecnologies(k)Gurusons etc.

There has been a sharp increase in Expenses (a) Security by 145% (b) Electricity by 25% (c)Conveyance & Travel by 35%accounting for the diversion of Capital funds for General utilization **ie NON PRODUCTIVE. by 80%**

The Income tax Act as amended, disallows Cash expenses in excess of Rs 10,000.However, during the year, Rs 16.38 lacs were paid in Cash through the Petty Cash. These expenses are not eligible for deduction as per the Income Tax Act.

We are **not in a position to comment on the ultimate liability** payable along with interest, penalties and other offences as per the provisions of Income Tax that may arise at any later date. This liability will have adverse effect on the Income Tax assessment of the institute

ARIES-SPECIAL AUDIT REPORT-2018.19

(XIX) 26 **Posts were created without the approval of MoF** in violation of Fundamental Rules. This has resulted in irregular payment of Pay and allowances to the employees, recruited in excess against the sanctioned strength /posts. The adverse impact of this unauthorized policy and promotion of 14 scientists were irregularly promoted, resulting **in admissible payment of Rs 65.42 lacs. The excess transaction so paid has not been accounted for**

(XX) **Unauthorized up-gradation of Pay scales** were made in the past, without approval of MoF,in violation of the GOI Rules, resulting in irregular payment of Pay and Allowances. **The excess transaction of Rs 43.73 lacs, so paid has not been accounted for.**

(XXI) **Statutory dues remain un- recovered. Labour cess Rs 20.82 lacs, WCT Rs 83.29 lacs** remain unrecovered. **The liability has not been accounted for.**

(XXII) **Unauthorized grant of Advance increments** were made without obtaining approval and in violation of Fundamental rules .The financial transaction has not been accounted for.

(XXIII) The PF contributions **are being accounted for under an "unauthorized Provident and Pension Fund"**.
No proper assessment for Corpus of an appropriate size has been actuarially valued.
Under the Income Tax Act, contributions to an "unauthorized PF trust" are ineligible for Tax deduction as Expenses. Even the employee is ineligible to claim his contribution, for tax deduction under Sec 80 C.

We are not in a position to **comment on the ultimate liability payable along with interest, penalties and other offences as per the provisions of Income Tax that may arise at any later date**. No provision of the same is also made in the accounts.

(XXIV) It is the policy of the Institute to first recover the principal Advance and then the Interest on the Advance. **Interest is not being computed annually on the balance,** leading to notional loss of accrued Interest income. Non computation may even lead to a position where the employee may retire without paying the amount of Interest.
We cannot identify or quantify the loss of Interest income if any.

(XXV) **The institute has not been able to furnish for our verification, records of original copies of the documents of landed properties held in its name.** It is stated that total landed area of 32.30 hectares was donated to "the Institute", at Manorma Peak by the State Govt(PV of Rs 850.00 lacs). and 4.49 hectares at Devasthal was purchased for Rs 66.50 lacs(PV of Rs 100.50 lacs). The value recorded of Land at in the Books is Rs 1058.50 lacs (PV Rs 950.50 lacs)"PV=present value". We could not find a corresponding RESERVE in Liability for the PV value.

(XXVI) **The sponsored Project funds are still being operated by the PI** (Principal Investigator).There is lack of financial oversight by ARIES and therefore in the funds being utilized by the PI .The Bank account is

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MANOJ VATSAL & CO. HALDWANI

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not linked to ARIES and therefore is not monitored regularly. Hence Project Assets, Expenses and Interest earned are not accounted in real time.
We cannot quantify or identify, whether all Project assets, expenses and Interest have been accounted or not accounted for in the Books

(XXVII) **Irregular grants were made to Sri. Girish C.Giri** of MACP. Part recovery of the excess amount paid was made from his Salary.The High Court has ordered stay to the recovery and recover the refund as per the judgement.
The transaction has not been accounted for

(XXVIII) **Of the Advances made,Rs 2.83 lacs advance paid to Vidhaywati Constructions remains to be recovered** and the case is under arbitration
The transaction **has not been accounted for.**

(XXIX) **Sponsored Project Grants include provision for Overheads**, payable to the Institute where the sponsored project is being researched, for the administrative support and infrastructure made available for the Research and Project. However, till 31.03.18 "NIL" Funds were contributed by the Sponsored Projects, leading to "loss of revenue"
In the absence **of records and information, this INCOME cannot be identified or quantified.**

(XXX) **ST radar assets of Rs 684.62 lacs (Building) & Rs 597.81lacs(Instruments) have not been recorded** in the Books of the Institute. Running expenses of ST Radar including Salary are being met by the Institute. The **Project has been indefinitely delayed and is yet to be handed over**. ECIL has been given the last extension of the Contract till Oct 2018.
The **Bank account is being operated under the single signature of the PI, in contravention of GC guidelines. The PI himself is awaiting approval of "advance /sliding increments"** from DST since 2008.

(XXXI) A **Canadian grant of Euro 50,000/ was to be adjusted** against AMOS. However, the same could not be accounted. The amount is to be accounted against ILMT Project expenses.

(XXXII) Employees were paid 7th Pay Commission arrears in March 2018.In March 2018, 70% has been paid but **no provision has been made for the 30% of the Pay arrears.**

(XXXIII) **The status of "Works not completed" has not been made available.** To our knowledge Works Order 2266 and 2173 has not been completed and as per the File noting, the Site has been abandoned since July 2017.

(XXXIV) The Institute has been exempted from the whole of Excise Duty and 95% of Custom Duty under Notification no 51/96 dated 23.07.96 and General Exemption no 36.**The Custom duty exemption has been availed off, but Excise duty exemption was not claimed.**
In the absence of recorded information, we cannot identify or quantify the additional cost paid for Assets, Consumables, and fabrication etc in earlier years.

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(XXXV) The Institute procures by way of Imports Project Equipment..**By hedging the Currency ,Projects could have saved a very considerable value(Rs 2500.00 lacs)**,due to Euro appreciation between 2007(IND Rs 56.42=1 E),when the Purchase Order for the 3.6 DOT was raised for Euros 155,68,115,and when the Telescope was cleared at Custom in 2012(IND RS 72.31=1E)

(XXXVI) As per Financial reporting guidelines ,the **total value of Foreign Exchange transactions has to be reported** in the annual Report .In the absence of Records maintained, we are unable to quantify ,identify and report the total value of such currency transactions

(XXXVII) **Projects have been mismanaged and have lacked planning and execution,** due to non involvement of Project consultants. This has **lead to time and cost over runs. The 3.6 DOT was stored for as long as 18 months at the Devasthal site** due to non availability of the Site, where the principal contractors fell far behind schedule. This led **to moisture exposure to the very delicate instruments and delay in installation** of the telescope by, since the damaged parts had to be reordered. There was inordinate delay in the preparation of the Site, causing irreparable harm in terms of time, cost and information generation.

Currently the 3.6 telescope is operating within **a limited torque due to the damaged Azimuth** motor, due to mild condensation (moisture) and lack of sufficient technical expertise.,

The **ST Radar project should** have been handed over by ECIL in Marc 2013 and the hand over is still awaited as on September 2018,a **delay of 5 years**

(XXXVIII) **Fund management** and authority for utilization is delegated by the Governing Council up to a Limit as decided from time to time. However, this has not been adhered to, which is **a violation in Fund management and GC guidelines.**

Funds have been transferred from Core Grant to Endowment Account .Fixed Deposit s were made of Core Grant funds (funds were transferred to Non Grant Bank account)Rs 990.00 lacs and thereafter on maturity the funds were transferred back to the Core Grant bank account

Endowment Funds were deployed at low rates of Interest, when higher rates of Interest were available on the same period. Endowment funds were left idle earning only Saving Bank interest. Endowment funds must be deployed to earn the maximum income by way of Interest, so as to bolster the Fund balance for the employees .Fixed deposits were en-cashed prematurely, leading to loss of interest income in 2016.17 and 2017.18.

Erroneously, Interest earned on Endowment Funds Rs 299.35 lacs during 2016.17 were transferred to DST, Delhi(without approval of the GC), instead of Rs 137.39 lacs .(being Interest earned on Core Grant, as per GC guidelines).**DST has in principal agreed to look into the refund** of Rs 161.95 lacs, being the excess amount transferred.

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Without prior approval of the GC, Rs 366.00 lac Grant received for Capital expenses was re-appropriated for General expenses.

The Directors responsibility is to administer the Budget approved by the GC,to the extent restricted by the GC, currently upto Rs 100.00 lacs .Prior consent of the Council is required for re appropriation of Funds under Salaries ,he cannot appropriate Capital Funds for Revenue and to ensure that Funds are deployed for the purpose for which they were granted.

Only the GC can(1) consider, approve, authorize and operate the Funds and Grants(2)create ,abolish, upgrade Posts(3)approve Annual accounts ,Development programmes and Budgets(4)frame rules and regulations and (5)delegate ,approve the Directors delegation and authority.

(XXXIX) **The Employee Endowment Funds are in a precarious condition**. The Corpus has not been kept intact and the Committee has not exercized its responsibility.
The Liability has not been actuarially evaluated and since the Total Liability has not been provided for, there is great risk of the Future liability of Employees not being met on Retirement, unless urgent steps are taken to Fund the shortfall and have the Fund managed externally by a professional organization.

There is approximately Rs 1250.0 lacs available as on 31.03.18.The current outflow is(a)for Pension is Rs 144.00 lacs ,(b) Rs 50.00 lacs for Commutation(c)Rs 50.00 lacs for Providend Fund(d) Rs 30.00 lacs for Gratuity and Rs 7.00 lacs for Leave encashment pa ie Rs 280.00 lacs pa

The current Funds will run out in 4 years since they are not invested, there is no contribution to the Corpus and the Employees have withdrawn upto 90% of their Corpus balances.

* **GPF withdrawal of up to 90 per cent of balance will be allowed for government servants who are due for retirement (or) superannuation within 2 years**. Saving in GPF is for long term goal like 'retirement'. Hence, withdrawal from GPF should be considered very pragmatically by the Trustees.

The Trust is not created, registered and hence "not a legal investment vehicle". The Funds are not being managed according to the guidelines of the PF Act.

OPINION:

In our opinion and to be best of our information and according to the explanations given to us, except for the effects of the matters described in the Basis for Qualified Opinion Paragraph above, the aforesaid financial statements give the information required by the applicable Acts and regulations, in the manner so required and give a true and fair view in conformity with the accounting principles generally accepted in India, of the state of affairs of "the institute" as at 31st March 2018, and its excess of expenditure over income for the year ended on that date.

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Further we report that:

(a) Except for the matters described in the Basis for Matter of Emphasis paragraph, we have sought and obtained all the information and explanations which to the best of our knowledge and belief were necessary for the purpose of our audit.

(b) Except for the matters described in the Basis for Qualified Matter of Emphasis ,transactions have been accounted by the Society so far as it appears from our examination of those books.

(c) The Balance sheet and income and' expenditure account dealt with by this report are in agreement with the books of account.

(d) In our opinion, the Balance Sheet and Income & expenditure account comply with the Accounting standards except as stated in the basis of Matter of Emphasis

(e) The matters described in the Matter of Emphasis paragraph above, in our opinion may have an adverse effect on the functioning of "the institute"

(f) In our opinion and to the best of our information and according to the explanations given to us, the aforesaid financial statements together with schedules attached, give the information required by the Act, in the manner so required and give a true and fair view, except as stated in basis of qualified opinion para, in conformity with the accounting principles generally accepted in India. (i) In the case of the Balance Sheet, of the State of affairs of "the institute" as at 31st March 2018, (ii) In the case of the statement of Income and Expenditure, of the deficit for the year ended on that date

CA Manoj Joshi,MN 025757
Managing Partner,
Manoj Vatsal & Co.
Chartered Accountants,010155C

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SIGNIFICANT ACCOUNTING POLICIES

- **ACCOUNTING CONVENTION**: The financial statements are prepared on the basis of historical cost convention, unless otherwise stated and on the accrual method of accounting
- 2. **INVENTORY VALUATION**: Inventories are valued at lower of market price or cost basis
- 3. **FIXED ASSETS**: Fixed assets are stated at cost of acquisition inclusive of inward freight, duties and taxes and incidental and direct expenses relating to acquisition. Assets created out of grants are shown as a deduction from the gross value of the asset concerned in arriving at its book value
- 4. **DEPRECIATION** : Depreciation in respect of the Assets: Buildings, Books and Periodicals has been charged on written down value at the rates as prescribed by CPWD Rules and the rest of the assets are depreciated at the rates prescribed by Income Tax Act, 1961. Roads, compound walls are treated as part of land and no depreciation is provided. Assets valuing Rs.5,000/- or less each are provided full depreciation
- 5. **GOVERNMENT GRANTS**: Revenue grants received from Government towards recurring activities are accounted as Income on accrual basis. Grants related to specific fixed assets are shown as a deduction from **the Gross value of the asset concerned in arriving at its book value.**

NOTES TO ACCOUNTS

- **GRANTS**

1.1. An amount of Rs1472.89 lacs was received for various activities executed during the year. The funds were received for (1) Salary Rs 940.00 lacs(2) General Rs 295.00 lacs(3) Capital Rs 238.00 lacs
1.2. Opening balance of Grants as on 1.04.17 was (1) Salaries Rs 351.80 lacs(2)General Rs 202.84 lacs (3) SC/ST Rs 50.78 lacs(4) Capital Rs 602.31 lacs)
1.3. Budgeted expenditure was (1) Salaries Rs 1045.00 lacs(2) General Rs 1019.00 lacs(3)Capital Rs 1520.00 lacs
1.4. Actual expenditure was (1) Salaries Rs 1024.00(2)General Rs 821.00 lacs(3) Capital Rs 475.00 lacs & (4) SC/ST Rs 88.00 lacs
1.5 Rs 322.00 lacs spent under General was re appropriated from Capital grant

- 2. **RETIREMENT BENEFITS**

2.1. Liability towards gratuity payable on death / retirement of employees is provided on payment basis, as per workings of the Institute
2.2. Provision for accumulated leave encashment benefit to the employees is made on payment basis and computed on the assumption that employees are entitled to receive the benefit as at each year end, as per workings of the Institute
2.3. Pursuant to the decision taken by the Governing Council accumulations under the fund relating to the Employees retirement benefits were to be transferred to the separate fund account and a Trust created .The trust is still to be created, though a Separate Balance Sheet has been prepared from the FY 2016.17

- 3. **SIGNIFICANT ACCOUNTING POLICIES & NOTES TO ACCOUNTS**

1. ACCOUNTING CONVENTIONS
The financial statements are prepared on the basis of historical cost convention, going concern concept, confirming to generally accepted accounting principles and standards, unless otherwise stated and on the accrual method of accounting

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2. INVENTORY VALUATION
(2.1)Stores & Spares (including machinery spares) are valued at cost
(2.2)Valuation of Raw materials, semi finished goods, finished goods is not applicable, since production activity does not take place
(2.3)Inventory is as independently confirmed by Stores and the Institute

3. INVESTMENTS
The Institute does not have any market based Investments
(3.1)Long term investments, Current investments are not invested in by the Institute
(3.2)There is no acquisition cost to consider
(3.3)All surplus funds of the Institute and Employee Welfare Funds are invested in Fixed Deposits
(3.4)At the end of the financial year, a decision was taken to en cash the Fixed Deposits, so that all accrued Interest earlier not accounted would be encashed. The Institute was earlier accounting for Interest on Cash basis.

4. EXCISE DUTY
Liability for Excise Duty does not exist, since Production activity does not take place in the Institute,however ED on Purchases is Exempt

5. FIXED ASSETS
(5.1)Fixed Assets are stated at cost of acquisition, including inward freight, duties and taxes and incidental and direct expenses related to acquisition
(5.2)Fixed Assets received by way of non monetary Grants are capitalized at values stated, by corresponding credit to Capital Reserve
(5.3)Fixed Assets acquired from independently funded Projects, are stated at acquisition cost and by the corresponding credit to Capital Funds
(5.4)Fixed assets are as verified by the different Project Officers, Sections and Departments of the Institute

6. DEPRECIATION
(6.1)Depreciation is provided on WDV method as per rates prescribed in the Income Tax Act
(6.2)Capital work in progress is stated at the value of Cost incurred
(6.3)Assets acquired for independently funded Projects are stated at Cost and Depreciation is not computed
(6.4)In respect of additions to/deductions from Fixed Assets, Depreciation is provided for the full year, if the Asset has been acquired before 30th September and for half the year, if the Asset is acquired after 1st October
(6.5)Assets costing Rs 5,000 or less each are fully provided

7. MISCELLANEOUS EXPENDITURE
Deferred revenue expenditure if any is written over a period of 5 years from the year in which it is incurred

8. ACCOUNTING FOR SALES
Sales transactions do not occur in the Institute

9. GOVERNMENT GRANT & SUBSIDIES
(9.1)Government grants in the nature of contribution for setting up Projects are treated as Capital Reserve
(9.2)Grants for specific assets, are shown as deductions from the cost of the related asset
(9.3)Government grants/ subsidies are accounted on realization basis

10. FOREIGN CURRENCY TRANSACTIONS
Transactions denominated in foreign currency are accounted at the exchange rate prevailing on the date of transaction

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

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11. LEASE
Lease rentals are expensed with reference to lease terms

12. RETIREMENT BENEFITS
(12.1)Liability towards Gratuity payable on death/retirement has not been accrued based on actuarial valuation, but has been paid on annual basis, calculated as per Dept. guidelines
(12.2)Provision for accumulated leave encashment benefit to the employees has been accrued on the assumption that the employee is entitled to receive the benefit at the end of each year

The Institute maintains a separate Bank account for Provident Fund, Pension, Superannuation and Leave encashment. This includes the amount transferred by the U.P Govt. towards terminal benefits of State Govt. employees absorbed by the Autonomous body.

However, over the years actuarial valuation of retirement benefits was not computed and contributions were Transferred, without creating individual liabilities for Gratuity, Superannuation, Leave encashment.

-CONTINGENT LIABILITIES AND NOTES ON ACCOUNTS
1. CONTINGENT LIABILITIES
1. There are Claims against the Entity not acknowledged as Debts and the Court has directed that the matter be put up for Arbitration. The amount as reported in the Notes on Accounts in the previous year was Rs 1251.00 lacks (M/S Vidhyawati Construction, Allahabad) and Rs 600.00 lacks (AMOS, Belgium).The Claims are before arbitration and no hearing was held during the FY 2016.17
2. Disputed demands in respect of Income Tax of Rs328.00 lacs(AY year 2016.17 has not been appealed against the Income Tax authorities
3. Service related issues are also before various Courts and the matter is sub judice
4. There is also a legal case related to payment to a MSME vendor and the matter is sub judice

2. CAPITAL COMMITMENTS
Estimated value of contracts remaining to be executed on Capital Account and not provided for (net of Advances)Rs........................(previous year Rs...........................)

3. LEASE OBLIGATIONS
Future obligations for rentals under finance lease arrangements are NIL

4. CURRENT ASSETS, LOANS & ADVANCES
In the opinion of the Management, the Current Assets, Loans & Advances have a value on realization in the ordinary course of business, equal at least to the aggregate amount shown in the Balance Sheet

5. TAXATION
In view of there being no taxable income under Income Tax Act 1961, no provision for Income Tax has been considered necessary. The Institute is exempt under Sec 12 AA of the Income Tax Act and the income of the Institute is exempt

6. FOREIGN CURRENCY TRANSACTIONS	CURRENT YEAR	PREVIOUS YEAR
Value of Imports calculated on CIF Basis		
-Purchase of Finished Goods		
-Raw material & Components (including in Transit)		Rs
-Capital Goods		
-Stores, Spares & Consumables		

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Expenditure in Foreign Currency
-Travel Rs
-Remittance and Interest payable to financial institutions
-Other expenditure

Earnings
-Value of Exports on FOB Basis NA

Remuneration to Auditors
-as Auditors
-Others

7. Corresponding figures for the previous year have been regrouped /rearranged wherever necessary

8. Schedules 1 to 25 are annexed to, and form an integral part of the Balance Sheet as at 31.03.17 & the Income & Expenditure Account for the year ended on that date,

For: Manoj Vatsal & Co.
Chartered Accountants,
Firm Registration No. 010155C

Date: 24.09.2018
Place: Haldwani

Manoj Joshi
FCA,DISA,DIRM(ICAI),
Certified Valuer,
Certified Concurrent Auditor (ICAI),
Sr. Partner
M.N.025757

MANOJ VATSAL & CO. HALDWANI

ARYABHATTA RESEARCH INSTITUTE OF OBSERVATIONAL SCIENCES, NAINITAL

BALANCE SHEET AS AT 31st MARCH 2018

(Amount- Rs)

CAPITAL FUND AND LIABLITIES	Schedule	2017-18	2016-17
CAPITAL FUND	1	1,863,454,376.79	1,833,037,636.79
RESERVES AND SURPLUS	2	(297,101,359.24)	(22,745,776.91)
EARMARKED/ENDOWMENT FUNDS	3	143,236,942.74	120,867,930.82
SECURED LOANS AND BORROWINGS	4	-	-
UNSECURED LOANS AND BORROWINGS	5	-	-
DEFERRED CREDIT LIABLITIES	6	-	-
CURRENT LIABLITIES AND PROVISIONS	7	47,199,015.00	44,833,929.96
TOTAL		1,756,788,975.29	1,975,993,720.66
ASSETS			
FIXED ASSETS*	8	1,462,986,310.01	1,612,907,126.99
INVESTMENTS- FROM EARMARKED/ENDOWMENT FUNDS	9	36,490,984.00	-
INVESTMENTS- OTHERS	10	9,176,482.00	5,000,000.00
CURRENT ASSETS, LOANS, ADVANCES ETC.*	11	248,135,199.27	358,086,593.67
MISCELLANEOUS EXPENDITURE (to the extent not written off or adjusted)			
TOTAL		1,756,788,975.29	1,975,993,720.66
SIGNIFICANT ACCOUNTING POLICIES	24		
CONTINGENT LIABILITIES AND NOTES ON ACCOUNTS	25		

*FIXED ASSETS INCLUDE ASSETS ACQUIRED FOR INDEPENDENTLY FUNDED PROJECTS

*CURRENT ASSETS INCLUDE BANK BALANCES OF FUNDS FROM INDEPENDENT PROJECTS

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

Manoj Joshi
FCA,DISA,DIRM(ICAI)
SR. Partner
Membership No. 025757

For Registrar Aires
Registrar
ARIES, NAINITAL

For Director Aires
निदेशक,
Director
एरीज, नैनीताल
ARIES, NAINITAL

Date: 24.09.2018
Place: Nainital

MANOJ VATSAL & CO. HALDWANI

ARYABHATTA RESEARCH INSTITUTE OF OBSERVATIONAL SCIENCES, NAINITAL
INCOME AND EXPENDITURE ACCOUNT FOR THE PERIOD/YEAR ENDED 31ST MARCH 2018

(Amount- Rs)

INCOME	Schedule	2017-18	2016-17
Income from Sales/Services	12	-	-
Grants/Subsidies*	13	123,520,000.00	198,591,000.00
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	14,001,653.50	13,739,368.44
Other Income	18	1,308,318.00	1,309,662.75
Increase/(decrease) in stock of Finished goods and works-in-progress	19	256,107.26	2,987,893.81
TOTAL(A)		139,086,078.76	216,627,925.00
EXPENDITURE			
Establishment Expenses	20	113,961,367.00	106,307,720.00
Other Administrative Expenses etc.	21	57,158,620.95	42,993,794.13
Expenditure on Grants, Subsidies etc.	22	-	-
Interest	23	-	-
Depreciation (Net Total at the year-end- corresponding to Schedule 8)***		209,246,634.98	237,806,443.18
TOTAL(B)		380,366,622.93	387,107,957.31
Balance being excess of Income over Expenditure (A-B)**		(241,280,544.17)	(170,480,032.31)
Prior Period Expenses/Income (TDS from Bank Interest 2014-15)		-	-
Transfer to Special Reserve (Specify each)			
Transfer to/ from General Reserve			
BALANCE BEING SURPLUS/(DEFICIT) CARRIED TO CORPUS/CAPITAL FUND		(241,280,544.17)	(170,480,032.31)
SIGNIFICANT ACCOUNTING POLICIES	24		
CONTINGENT LIABLITIES AND NOTES ON ACCOUNTS	25		

*GRANTS RECEIVED DURING FY 2015.16 HAVE NOT BEEN REGROUPED TO ACCOUNT FOR CAPITAL GRANTS SEPARATELY

**THE EXCESS OF EXPENDITURE OVER INCOME IS IN ON ACCOUNT OF NON RECOGNITION OF CAPITAL GRANT AS INCOME & ON ACCOUNT OF THE INCREASE IN THE CHARGE FOR DEPRECIATION AFTER THE COMMISSIONING OF THE 3.6 TELESCOPE AT DEVASTHAL DURING THE FINANCIAL YEAR 2016.17

***THE DEVASTHAL PROJECT WAS COMMISSIONED DURING THE FINANCIAL YEAR 2015.16 AND THAT HAS LEAD TO THE INCREASE IN DEPRECIATION

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

Manoj Joshi
FCA,DISA,DIRM(ICAI)
SR. Partner
Membership No. 025757

For Registrar Aires
Registrar
ARIES, NAINITAL

For Director Aires
Director
एरीज, नैनीताल
ARIES, NAINITAL

Date: 24.09.2018
Place: Nainital

MANOJ VATSAL & CO. M.No. 025757 U.C.C. HALDWANI

ARYABHATTA RESEARCH INSTITUTE OF OBSERVATIONAL SCIENCES NAINITAL
RECEIPT & PAYMENT ACCOUNT FOR YEAR ENDED 31ST MARCH 2018

RECEIPTS	2017-18 AMOUNT		PAYMENTS	2017-18 AMOUNT	
I. Opening balance		229,940,540.99	I.Expenses		
Cash in Hand	20,000.00		a) Establishment Expenses		110,773,024.0
Cash at Bank -SB Account	302,911,692.99		Salary and Allowance	87,814,307.00	
Amount in LC Account with SBI	18,099,980.00		Interest to Provident Fund	2,719,351.00	
Project Accounts	8,908,917.00		Contribution to NPS	4,271,814.00	
			Medical Reimbursement	2,682,393.00	
II. Grant Received		164,239,439.00	Tuition Fee Reimbursement	1,165,494.00	
Central Government	147,289,000.00		Dispensary Expenses	253,806.00	
Project Grant Central Govt.	10,302,699.00		Leveries Expenses	20,160.00	
Projects Funds (Unspent)	6,647,740.00		Honorarium	351,800.00	
			Leave Travel Concession	1,160,250.00	
III. Income on Investment		17,259,268.00	Scholarship	157,208.00	
a) Earmarked/Endow. Fund	5,101,708.00		Fellowship	10,156,675.00	
b) Own Funds	2,391,264.00				
c) Contribution to Provident fund	7,096,945.00				
d) Interest Provision for Provident fund	2,719,351.00				
			b) Administrative Expenses	-	55,877,468.7
IV. Interest Received		11,652,194.50	Advertisement and Publicity	295,615.00	
a) Earmarked/Endow. Fund	764,676.00		ASI -2017	47,008.00	
b) Own Funds	5,418,301.00		Auditor's Remuneration	115,168.00	
c) Projects Bank Accounts	5,222,107.50		Bank Charges	38,587.37	
d) Loan Advances etc			Computer Accessories & Consumable	1,028,029.00	
HBA UT- I	57,170.00		Consumable Expenses	1,906,896.00	
HBA UT- II(Int)	152,109.00		Registration	188,424.00	
CA Int	8,470.00		Gardening Expenses	90,079.00	
Car Advance Int.	13,656.00		Electricity	5,858,541.00	
Computer Adv Int. (ARIES)	15,754.00		Fuel (POL)	1,467,025.00	
			Water Charges	514,400.00	
			Insurance Charges	37,656.00	
V. Other Income		1,325,694.00	Repairs and maintenance Instrument/AMC	2,749,387.00	
Miscellaneous Income	2,400.00		Repairs and maintenance others	409,717.00	
Dispensary Receipts	300.00		Repairs and maintenance Building	4,228,856.00	
Electricity Receipts	354,481.00		Vechicles Running and Maintenance	131,963.00	
Staff House Rent A/c	348,136.00		UEST	57,667.00	
Hostel/Shop Rent	86,233.00		Observational Facilities	734,429.00	
House Licence Fee	440,563.00		Telephone and Communication Charges	415,935.00	
RTI Receipt	1,464.00		Postage	27,795.00	
Telephone Receipts	5,659.00		Printing and Stationary	594,101.00	
Tender Fee A/c	7,000.00		Conveyance Expenses	4,034,163.00	
Water Receipts	61,963.00		Travelling Expenses	2,037,422.00	
Interest on Income Tax Refund	17,346.00		TA EXP(M/S Balmer Lawrie & co. ltd)	892,457.00	
			Expenses on Seminar/BINA/CNC Workshops	173,609.00	
			Canteen Expenses	1,917,447.00	
V.FDR Matured		176,982,180.00	Cleaning Work	1,895,976.13	
FDR Old Pension	77,982,180.00		Hospitality Expenses	22,518.00	
FDR Grant	99,000,000.00		Legal Charges	129,758.00	
			Public Outreach Program -Exhibition	259,394.00	
			Security*	14,919,026.00	
VI.Any Other Receipt		9,070,212.00	Sundry Expenditure	44,339.00	
Annual Workshop	160,000.00		Consumable & Maintenence 3.60 Mt. Telescope	1,157,003.00	
Earnest Money Received	1,687,615.00		Meeting of governing council/FC	661,453.00	
Performance Security	1,076,382.00		Meeting of Other Scientific Bodies	2,443,488.00	
Running Security	180,808.00		Office Exp	332,942.00	
Advances Recovered Employee/Other	2,811,657.00		Financial Support to IAU Symposium	200,000.00	

Cont....

[illegible] tax Refund	887,374.00		ISF Expo - 2017	350,000.00	
Advance Custom Duty	1,272,169.00		Training Expenses	73,700.00	
Vehicle Sold	184,227.00		Projects Expenses	3,375,600.25	
			III. Investments and deposits made		229,345,383.0
Any Other		429,562.00	a) Out of Earmarked/Endowment funds	112,962,180.00	
Sundry Creditors	292,323.00		b) Out of Own Funds(Investment others)	99,000,000.00	
[illegible]	137,239.00		c) Old Pension Provident Fund	13,863,203.00	
			d) FDR ISRO Projects	3,500,000.00	
			IV. Expenditure on Fixed Assets & Capital Work in Progress		59,539,818.0
			a) Purchase of Fixed Assets	46,474,553.00	
			b) Capital WIP	13,065,265.00	
			V. Refund of surplus money/Loans		29,934,889.0
			Interest Paid Recoverable From DST	29,934,889.00	
			VI. Finance Charges(Interest)	-	-
			VII. Other Payments		20,970,350.0
			GPF Advance/Withdrawal	8,392,048.00	
			Advance for Scientific Meeting	429,664.00	
			Advance SRF/JRF	189,362.00	
			Prepaid Expenses	1,823,625.00	
			Advance Custom Duty	19,362.00	
			GST	2,596,284.00	
			Performance Security	824,918.00	
			Advances to Employees/Car/HBA/LTC/Etc	3,807,426.00	
			Sundry Advances	737,364.00	
			SLSI	125,203.00	
			Astrosat Workshop	171,714.00	
			ST Radar Project (Loan)	721,000.00	
			EMD Paid	1,132,500.00	
			VIII.Closing balance		204,458,136.74
			a) Cash in Hand	21,213.00	
			b) Bank Balances		
			Savings accounts	172,963,968.49	
			LC with Bank	3,876,641.00	
			Project Accounts	27,596,314.25	
TOTAL		710,899,069.49	TOTAL		710,899,069.49

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

Manoj Joshi
FCA,DISA,DIRM(ICAI)
SR. Partner
Membership No. 025757

For Registrar Aries
Registrar
ARIES, NAINITAL

For Director Aries
निदेशक
Director
एरीज, नैनीताल
ARIES, NAINITAL

Date: 24.09.2018
Place: Nainital

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

ARYABHATTA RESEARCH INSTITUTE OF OBSERVATIONAL SCIENCES, NAINITAL

SCHEDULES FORMING PART OF BALANCE SHEET AS AT 31ST MARCH 2017

(Amount- Rs.)

SCHEDULE 1-CAPITAL FUND:	2017-18		2016-17	
Capital Fund Opening Balance*		1,717,892,906.71		1,686,185,439.79
Grant-Other Opening Projects		16,377,879.24		
Unspent Grant:Opening balance		98,766,850.84		40,538,364.00
Unspent Grant Salary	50,494,850.84		4,089,000.00	
Unspent Grant General	-		1,615,000.00	
Unspent Grant Capital	48,272,000.00		34,834,364.00	
Total		1,833,037,636.79		1,726,723,803.79
Add: Capital Fund 2016-17		-	-	92,208,000.00
Add: Revenue Grant		23,769,000.00		198,591,000.00
Add: Projects Grant (Unspent)***		6,647,740.00		-
Less:Capital Grant spent		-		(78,770,264.00)
Less:Revenue Grant spent		-		(136,198,515.24)
Less: Misc Project Grant spent		(10,302,699.00)		-
Total		1,853,151,677.79		1,802,553,924.55
Grant-Other Projects-Annexure		10,302,699.00		14,106,833.00
Grant Other				2,272,846.24
Unspent Grant:Closing Balance		23,769,000.00		98,766,850.84
Unspent Grant Salary	7,991,038.00		50,494,850.84	
Unspent Grant General	(35,724,607.44)		-	
Unspent Plan SC/ST	5,058,000.00		-	
Unspent Grant Capital	38,926,516.00		48,272,000.00	
Unspent Grant Other	7,518,053.44		-	
Add/(Deduct): Balance of net income/(expenditure) transferred from the Income and Expenditure Account				
Closing Balance CAPITAL ACCOUNT		1,839,685,376.79		1,717,892,906.71
BALANCE AS AT THE YEAR- END		1,863,454,376.79		1,833,037,636.79

SCHEDULE 2- RESERVES AND SURPLUS	2017-18		2016-17	
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		(22,745,776.91)		147,734,255.40
Addition during the year		(241,280,544.17)		(170,480,032.31)
Interest Income on Revenue Returned to DST FY 2016-17		(13,739,368.44)		
Endowment Surplus Transfer to Endowment Fund		(19,335,569.72)		
Less: Deductions during the year				
TOTAL		(297,101,259.24)		(22,745,776.91)

*CAPITAL FUND NOW DOES NOT INCLUDE THE UNSPENT FUNDS RECEIVED ON GRANTS, THEY ARE LIABILITIES TILL UTILIZED AND NOT PART OF CORPUS

**THE EXCESS OF EXPENDITURE OVER INCOME HAS BEEN SET OFF AGAINST THE OPENING BALANCE IN CAPITAL ACCOUNT

*** THE PROJECTS FUND (UNSPENT) HAS BEEN ACCOUNTED FOR F.Y 2017-18

@THE CLOSING BALANCE INCLUDES UNSPENT PORTION OF REVENUE & CAPITAL GRANT [illegible] AS THE BALANCE UNSPENT OF INDEPENDENTALLY FUNDED PROJECTS

$GENERAL RESERVE CONSISTS OF LOSS ON ACCOUNT OF EXPENDITURE IN EXCESS [illegible] CARRIED FORWARD

ARYABHATTA RESEARCH INSTITUTE OF OBSERVATIONAL SCIENCES, NAINITAL

SCHEDULES FORMING PART OF BALANCE SHEET AS AT 31ST MARCH 2018

(Amount- Rs.)

SCHEDULE 3- EARMARKED/ENDOWNMENT FUNDS	FUND- WISE BREAK UP		TOTALS	
	Old Pension Fund	GPF Fund	2017-18	2016-17
a) Opening balance of the funds a)*	82,798,366.26	38,069,564.56	120,867,930.82	108,998,390.62
b) Additions to the Funds:				
i. Donations/grants-Contribution(NPS)	-	-	4,271,614.00	3,995,658.00
ii. Income from Investments made in account of funds	5,101,708.00	1,640,086.00	6,741,794.00	29,934,889.00
iii. Other additions -SB Interest	575,233.00	189,443.00	764,676.00	806,581.00
iv. Interest Contribution	-	5,429,835.00	5,429,835.00	
v. Employee Contribution/Received	24,742,968.20	7,046,945.00	31,789,913.20	10,350,525.00
v. Endowment Surplus	-	-	19,335,669.72	-
	30,419,909.20	14,306,309.00	68,333,501.92	45,087,653.00
Less: Retirement Benefits Paid	-	2,058,966.00	2,058,966.00	20,104,845.80
Less: GPF Withdrawal	-	5,987,482.00	5,987,482.00	9,117,609.00
Less: Pension	33,646,428.00	-	33,646,428.00	-
Less: Remitted to NPS	-	-	4,271,614.00	3,995,658.00
b)	(3,226,518.80)	6,259,861.00	22,369,011.92	11,869,540.20
TOTAL (a+b)	79,571,847.46	44,329,425.56	143,236,942.74	120,867,930.82
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)				

(1)**INTEREST RECEIVED AND ACCOUNTED, WILL BE RECONCILED DURING FY 2018.19

(2)*THE OPENING BALANCE HAS TO BE RECONCILED FOR FUND BALANCES RELATING TO GRATUITY,PF,LEAVE ENCASHMENT & PENSION

(3)GRATUITY, PF,PENSION,LEAVE ENCASHMENT HAVE NOT BEEN ACTUARIALLY ASSESSED AND HAVE NOT BEEN PROVIDED FOR

(4)THERE IS NO EPF COVERAGE OF EMPLOYEES,THEY ARE COVERED UNDER NPS

(5) REGISTERED RECOGNIZED ENDOWMWNT TRUST HAS NOT BEEN SET UP

MANOJ VATSAL & CO. M.No. 92157 D.C.C. HALDWANI

ARYABHATTA RESEARCH INSTITUTE OF OBSERVATIONAL SCIENCES, NAINITAL

SCHEDULES FORMING PART OF BALANCE SHEET AS AT 31ST MARCH 2018

(Amount- Rs.

SCHEDULE 4- SECURED LOANS AND BORROWINGS	2017-18		2016-17	
Central Government	-	-	-	-
State Government(Specify)	-	-	-	-
Financial Institutions	-	-	-	-
a) Term Loans	-	-	-	-
b) Interest accrued and due	-	-	-	-
Banks:	-	-	-	-
a) Term Loans	-	-	-	-
- Interest accrued and due	-	-	-	-
b) Other Loans	-	-	-	-
- Interest accrued and due	-	-	-	-
Other Institutions and Agencies	-	-	-	-
Debentures and Bonds	-	-	-	-
Others	-	-	-	-
TOTAL		-		-
Note: Amounts due within one year				

MANOJ VATSAL & CO. D.C.C. HALDWANI M.No. 025787

ARYABHATTA RESEARCH INSTITUTE OF OBSERVATIONAL SCIENCES, NAINITAL

SCHEDULES FORMING PART OF BALANCE SHEET AS AT 31ST MARCH 2018

(Amount- Rs.)

SCHEDULE 5- UNSECURED LOANS AND BORROWINGS	Current Year	Previous Year
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:	Current Year	Previous Year
a) Acceptances secured by hypothecation of capital equipment and other assets	-	-
b) Others		
TOTAL	-	-
Note: Amounts due within one year.		

ARYABHATTA RESEARCH INSTITUTE OF OBSERVATIONAL SCIENCES, NAINITAL

SCHEDULES FORMING PART OF BALANCE SHEET AS AT 31ST MARCH 2018

(Amount- Rs.)

	2017-18		2016-17	
SCHEDULE 7- CURRENT LIABILITIES AND PROVISIONS				
A. OTHER CURRENT LIABILITIES				
Security and earnest deposits**	5,337,954.00		5,337,954.00	
Performance Security**	4,477,627.00		3,726,163.00	
Retention and performance security deposits**	2,057,617.00		1,876,809.00	
DDO DST	76,163.00		76,163.00	
Earnest Money A/c**	2,727,993.00		1,872,878.00	
Canteen Security	2,000.00	14,679,354.00	2,000.00	12,891,987.00
IIC PAR Research Project		52,650.00		52,650.00
Money received on account of other projects		20,840,342.00		10,537,643.00
Faulad Construction		20,000.00		20,000.00
Sundry Creditors		1,682,616.00		1,390,293.00
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		-
GIS Payable		36,606.00		-
TDS Payable		275,659.00		5,365.00
Service- Tax (F.Y. 2015-16)		3,410.00		3,410.00
Mission Butter Fly Payable		-		(4,100.00)
OUTSTANDING EXPENSES & CONTRIBUTIONS*				
NPS Payable		572,703.00		64,951.00
Outstanding Expenses		100,628.00		836,671.00
Salary & Allowance Payable		8,109,169.00		5,634,907.00
Medical Expenses payble		-		60,573.00
Fellowship & Scholarship Payable		830,846.00		1,804,422.00
**Statutory Dues from Contractors are to be recovered				
TOTAL (A)		**47,199,015.00**		**32,507,708.00**
B. PROVISIONS#				
1.For Taxation		NIL		NIL
2.Gratuity***				
3.Superannuation GPF Intt Contribution		-		2,710,484.00
4.Accumulated Leave Encashment		-		3,105,379.00
5.Trade Warranties/Claims		NIL		NIL
6. GPF Payable		-		3,835,122.96
7.Pension Contibution		-		2,876,236.00
TOTAL (B)		-		**12,326,221.96**
TOTAL (A+B)		**47,199,015.00**		**44,833,929.96**

(1)**THEIR DUES FOR TAX FROM CONTRACTORS WILL BE ACCOUNTED FOR DURING FY 2018-19

(2)#THE PROVISION FOR GRATUITY,PENSION AND LEAVE ENCASHMENT HAS NOT BEEN ACTURALLY VALUED

(3)***THE PROVISION FOR GRATUITY IS CURRENTLY MERGED WITH OTHER PROVISIONS AND WILL BE SEGREAGTED DURING THE FINANCIAL YEAR AFTER INDEPENDENT

(4)IRRECOVABLE TRUSTS ARE TO BE CREATED FOR GRATUITY,PENSION & SUPERANNUATION

(5)PF,PENSION,GRATUITY & LEAVE ENCASHMENT NOT PROVIDED FOR

(6)EXPENSES FOR SECURITY,CLEANING,TRANSPORT,CONVEYANCE,AMC EXPENSE,SUPPLIES INCURRED HAVE NOT BEEN PROVIDED FOR

(7)ACCRUAL SYTEM OF ACCOUNTING IS NOT BEING FOLLOWED

(8)THE LIABILITY FOR EMD,PSD,SD IS NOT RECONCILED

(9)SEVERAL OLD LIABILITY BALANCES APPEAR AND THESE HAVE NOT BEEN RECONCILED

(10)LIABILITY FOR EXPENSES AND SUPPLIES IS NOT ACCOUNTED AT SOURCE AND THE SUNDRY CREDITORS OUTSTANDINGS ARE UNRECONCILED

(11) SEVERAL OF THE PROVISIONS NEED TO BE WRITTEN BACK

FORM OF FINANCIAL STATEMENTS (NON- PROFIT ORGANISATIONS)
ARYABHATTA RESEARCH INSTITUTE OF OBSERVATIONAL SCIENCES, NAINITAL
SCHEDULES FORMING PART OF BALANCE SHEET AS AT 31ST MARCH 2018

(Amount Rs)

SCHEDULE 8- FIXED ASSETS DESCRIPTION	GROSS BLOCK					DEPRECIATION					NET BLOCK		% age
	Cost/valuation As on 01.04.2017	Additions upto 30.09.2017	Additions after 30.09.2017	Deductions during the year	Cost/valuation As on 31.03.2018	As on 01.04.2017	Additions upto 30.09.2017	Additions after 30.09.2017	Other than addition during 2017-18	Total Dep. up to 31.03.2018	As on 31.03.2018	As on 31.03.2017	
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	29,361,839.80	1,357,365.00	-	-	30,719,204.80	8,413,582.22	67,868.25	-	1,147,414.27	7,628,834.84	23,090,369.76	22,948,257.35	5
(ii) Non Residential- Manora Peak	107,627,691.00	-	-	-	107,627,691.00	60,242,250.43	-	-	4,738,943.16	64,980,802.59	42,646,888.41	47,385,431.57	10
(iii) Residential- Devsthal (Guest House)	1,224,022.00	-	-	-	1,224,022.00	461,438.46	-	-	38,129.18	499,567.63	724,454.37	762,583.54	5
(iv) Non Residential- Devsthal	8,801,426.00	-	-	-	8,801,426.00	4,664,240.36	-	-	413,718.56	5,077,958.92	3,723,467.08	4,137,185.65	10
3. Infrastructure Dev. (Manora Peak)	14,420,299.70	-	1,425,783.00	-	15,846,082.70	5,863,293.06	-	71,200.15	875,703.46	6,810,257.66	9,035,825.01	8,757,004.62	10
4. Infrastructure Dev. (Devsthal)	50,072,786.90	-	-	-	50,072,786.90	12,222,829.35	-	-	3,785,815.75	16,007,645.11	34,065,141.79	37,850,157.55	10
5. Road at Devsthal	22,849,164.00	-	-	-	22,849,164.00	10,789,578.92	-	-	1,205,958.51	11,995,537.43	10,853,626.57	12,059,585.08	10
6. Furniture & Fixture	9,325,059.70	388,282.00	2,500.00	-	9,715,841.70	4,345,481.04	38,826.28	125.00	957,905.81	5,242,320.64	4,473,521.06	4,979,558.66	10
7. Office Equipment	1,749,883.25	-	-	20,000.00	1,729,883.25	1,068,305.73	-	-	68,167.75	1,136,473.48	593,909.77	681,577.52	10
8. Instruments & Equipments:-													
(i) Telescope	7,454,895.55	-	-	-	7,454,895.55	1,810,716.70	-	-	846,596.63	2,657,313.03	4,797,282.02	5,643,978.85	15
(ii) Telescope (Solar)	1,367,166.00	-	-	-	1,367,166.08	1,003,525.79	-	-	60,046.03	1,063,571.82	283,594.18	333,640.22	15
(iii) 1.3 Mt Telescope	77,016,439.09	812,463.00	14,377,378.00	-	92,206,878.08	47,966,315.09	121,889.45	1,078,348.29	4,357,688.68	53,523,291.32	38,683,876.68	29,051,123.91	15
(iv) 3.60 Mtr Telescope	1,263,868,868.00	682,163.00	10,385,874.00	-	1,274,946,525.08	189,480,300.70	107,327.45	779,675.55	161,841,295.17	351,383,858.37	922,782,966.63	1,073,608,367.89	15
(v) Aluminizing Plant (Devsthal)	38,523,736.06	-	-	-	38,523,736.06	5,928,580.40	-	-	5,036,276.34	10,967,836.74	28,555,890.29	33,595,176.08	15
(vi) Public Outreach Telescope	607,295.00	-	-	-	607,295.06	378,253.87	-	-	34,356.17	412,610.04	194,684.98	228,041.13	15
(vii) Schmidt Telescope	10,738,623.06	-	-	-	10,738,623.08	7,764,408.51	-	-	446,132.16	8,210,540.77	2,528,082.23	2,974,214.38	15
(viii) Electronic Section	9,055,749.55	-	-	-	9,055,749.55	7,358,108.38	-	-	254,646.16	7,612,754.55	1,442,995.00	1,697,641.17	15
(ix) Work Shop	273,027.45	-	-	-	273,027.46	221,844.87	-	-	7,677.51	229,521.58	43,505.87	51,183.38	15
(x) Aluminizing Anealing	103,357.45	-	-	-	103,357.45	83,951.87	-	-	2,906.32	86,858.29	16,499.15	19,375.48	15
(xi) Optics	27,240.00	-	-	-	27,240.00	22,103.84	-	-	786.04	22,889.88	4,340.92	5,136.96	15
(xii) Instruments	107,834,547.67	835,626.00	155,270.08	-	108,825,443.67	96,686,738.65	95,343.90	11,640.29	7,685,071.35	64,282,793.15	44,232,644.52	51,233,809.02	15
(xiii) Modernization of Instruments	63,485,321.00	316,397.00	4,279,313.00	-	68,083,031.06	28,173,603.65	47,789.55	320,048.46	5,296,647.56	33,838,559.54	34,244,471.46	35,312,317.06	15
(xiv) LIDAR	8,760,485.00	-	-	-	8,760,485.00	6,073,500.99	-	-	403,044.60	6,476,545.59	2,283,919.41	2,686,984.01	15
(xv) ADFOSC (Backend Instrument)	3,313,267.00	-	244,308.00	-	3,557,575.00	1,882,523.54	-	18,323.10	217,611.52	2,098,458.16	1,459,116.84	1,430,743.46	15
(xvi) Solar Section	8,227.00	-	-	-	8,227.00	5,871.79	-	-	383.30	6,054.99	2,172.01	2,555.30	15
(xvii) Projector (Public Outreach)	105,000.00	-	-	-	105,000.00	61,606.12	-	-	6,494.23	68,399.35	36,630.65	43,094.08	15
(xviii) Planetarium (Public Outreach)	3,918,714.00	-	-	-	3,918,714.00	1,873,120.80	-	-	306,838.98	2,179,959.78	1,738,754.22	2,045,593.20	15
(xix) Library Instruments	9,500.00	-	-	-	9,500.00	1,425.00	-	-	1,211.25	2,636.25	6,863.75	8,075.00	15
(xx) CCTV Cameras	77,500.00	-	-	-	77,500.00	5,812.50	-	-	10,753.13	16,565.63	60,934.38	71,687.50	15
(xxi) Spectrometer	1,062,951.00	-	-	-	1,062,951.00	79,721.33	-	-	147,484.45	227,205.78	835,745.22	983,229.67	15
9. Vehicles	2,663,477.10	-	-	184,237.00	2,469,263.10	1,848,451.61	-	-	122,263.82	1,970,765.43	498,544.67	815,025.49	15
10. Electric Installation (Manora Peak)	5,905,720.00	-	3,813,518.00	-	9,719,238.00	2,201,424.84	-	386,013.86	542,144.27	3,119,582.97	6,599,655.03	3,814,295.16	15
11. Electric Installation (Devsthal)	2,922,165.00	-	-	-	2,922,165.00	2,054,713.79	-	-	130,117.69	2,184,831.40	737,333.60	867,451.30	15
12. Computer	36,155,589.40	548,305.00	3,132,598.00	-	39,836,992.40	33,941,758.12	324,201.00	939,899.40	1,328,286.77	36,534,145.29	3,294,757.11	2,213,811.28	60
13. Computer Software	1,405,432.00	-	-	-	1,405,432.00	1,392,109.69	-	-	7,993.39	1,400,103.07	5,328.93	13,322.33	60
14. Library Books	47,790,090.50	190,936.00	3,722,793.08	-	51,681,799.50	45,696,698.00	190,036.00	1,861,241.50	1,872,311.58	49,620,417.06	1,861,381.54	1,872,311.58	100
TOTAL OF CURRENT YEAR	2,945,815,584.02	4,904,817.00	41,556,183.08	214,237.00	2,860,176,117.62	590,468,399.63	989,223.00	5,367,649.48	202,890,761.78	759,707,034.61	1,332,469,083.01	1,456,456,164.89	
PREVIOUS YEAR	708,244,548.02		1,299,671,487.08	471.00	2,845,815,584.02	312,653,996.45		202,917,967.89	36,798,486.29	558,468,399.63	1,455,455,164.95	353,566,592.18	

II. CAPITAL WORK-IN-PROGRESS		133,320,211.00	117,258,045.80
C. PROJECT ASSETS*		106,816.00	190,916.80
TOTAL		1,462,988,310.01	1,612,907,136.80
(Note to be given as to cost of assets on hire purchase basis included above)			

[illegible]
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[illegible]
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ARYABHATTA RESEARCH INSTITUTE OF OBSERVATIONAL SCIENCES, NAINITAL
SCHEDULES FORMING PART OF BALANCE SHEET AS AT 31ST MARCH 2018

(Amount-Rs)

SCHEDULE 9- INVESTMENTS FROM EARMARKED/ENDOWMENT FUNDS	2017-18	2016-17
Investment in FDR's in Scheduled Banks (GPF A/c)*	35,000,000.00	-
Interest accrued on SBI FDR's (GPF A/c)*	1,490,984.00	-
Investment in UBI FDR's (Old Pension)*	-	-
Interest accrued on UBI FDR's (GPF A/c)*	-	-
TOTAL	36,490,984.00	-

SCHEDULES 10- INVSTMENTS- OTHERS	2017-18	2016-17
FDR-ISRO Project	8,500,000.00	5,000,000.00
Interest accrued on FDR's	676,482.00	-
	-	-
	-	-
	-	-
TOTAL	9,176,482.00	5,000,000.00

MANOJ VATSAL & CO. HALDWANI

ARYABHATTA RESEARCH INSTITUTE OF OBSERVATIONAL SCIENCES, NAINITAL
SCHEDULES FORMING PART OF BALANCE SHEET AS AT 31ST MARCH 2018

(Amount-Rs)

SCHEDULE 11- CURRENT ASSETS, LOANS, ADVANCES ETC	2017-18		2016-17	
A. CURRENT ASSETS:				
1. Inventories:				
a) Stores and Spares	3,016,419.30		2,648,383.22	
b) Stationery Stock	551,422.39		287,374.99	
c) Computer Accessories Stock	2,704,875.01		3,023,220.51	
d) Fuel (POL)	10,402.60	6,283,119.30	68,033.32	6,027,012.04
		6,283,119.30		**6,027,012.04**
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		20,030.00
4. Bank Balances:				
a) With Scheduled Banks:				
-On Deposit Accounts -LC (includes margin money)	3,876,641.00		18,099,980.00	
-On Savings Accounts(As per Annexure I)*	172,963,968.49	176,840,609.49	302,911,622.19	321,011,602.19
		176,861,822.49		**321,031,632.19**
b) With Scheduled Banks Project Wise				
-On Current Accounts		-		-
-On Deposit Accounts		-		-
-On Savings Accounts		27,596,314.25		8,908,917.00
5. Post Office- Savings Accounts		-		-
TOTAL (A)		**210,741,256.04**		**335,967,561.23**

*MATURITY PROCEEDS OF INVESTMENT FDs

ARYABHATTA RESEARCH INSTITUTE OF OBSERVATIONAL SCIENCES, NAINITAL

SCHEDULES FORMING PART OF BALANCE SHEET AS AT 31ST MARCH 2018

(Amount-Rs

SCHEDULE 11- CURRENT ASSETS, LOANS, ADVANCES ETC.	2017-18	2016-17
B. LOANS, ADVANCES AND OTHER ASSETS		
1. Loans: (As per Annexure- 3)		
a) Staff	5,252,725.00	7,839,415.76
b) Other Entities engaged in activities/objectives similar to that of the Entity	-	-
c) Others	20,726,996.06	1,368,534.50
2. Advances and other amounts recoverable in cash or kind or for value to be received: (As per Annexure- 3)		
a) On Capital Account	1,115,294.00	2,068,101.00
b) Prepayments		-
c) Others	10,298,928.17	10,842,981.17
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)	37,393,943.23	22,119,032.43
TOTAL (A + B)	248,135,199.27	358,086,593.67

(i) LOAN OUTSTANDINGS ARE NOT RECONCILED NOR CONFIRMED INDEPENDENTLY

(ii) SUPPLIER ADVANCES ARE NOT RECONCILED NOR CONFIRMED INDEPENDENTLY

MANOJ VATSAL & CO. HALDWANI

ARYABHATTA RESEARCH INSTITUTE OF OBSERVATIONAL SCIENCES, NAINITAL

SCHEDULES FORMING PART OF BALANCE SHEET AS AT 31ST MARCH 2018

(Amount- Rs.)

	2017-18	2016-17
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	-	-

	2017-18	2016-17
SCHEDULE 13- GRANTS/SUBSIDIES		
(Irrevocable Grants & Subsidies Received)		
1) Central Government*	147,289,000.00	198,591,000.00
2) State Government(S)		
3) Government Agencies		
4) Institutions/Welfare Bodies		
5) International Organisations		
6) Others		
TOTAL	147,289,000.00	198,591,000.00

*ONLY GRANTS RECEIVED FOR SALARY & GENERAL EXPENSES HAVE BEEN TAKEN TO INCOME & EXPENDITURE

ARYABHATTA RESEARCH INSTITUTE OF OBSERVATIONAL SCIENCES, NAINITAL

SCHEDULES FORMING PART OF BALANCE SHEET AS AT 31ST MARCH 2018

(Amount- Rs.)

SCHEDULE 14- FEES/SUBSCRIPTIONS	2017-18	2016-17
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 INVESTEMENTS (Income on Invest. From Earmarked/Endowment Funds Transferred to Funds)	2017-18	2016-17	2017-18	2016-17
1) Interest:				
a) On Govt. Securities				
b) Other Bonds/ Debentures				
c) FDR				
2) Dividends:				
a) On Shares				
b) On Mutual Ffund Securities				
3) Rents				
4) Others				
TOTAL				
TRANSFERRED TO EARMARKED/ENDOWMENT FUNDS				

ARYABHATTA RESEARCH INSTITUTE OF OBSERVATIONAL SCIENCES, NAINITAL
SCHEDULES FORMING PART OF BALANCE SHEET AS AT 31ST MARCH 2018

(Amount- Rs.)

	2017-18	2016-17
SCHEDULE 16- INCOME FROM ROYALTY, PUBLICATION ETC.		
1) Income from Royalty	-	-
2) Income from Publications	-	-
3) Others	-	-
TOTAL	-	-

	2017-18	2016-17
SCHEDULE 17- INTEREST EARNED		
1) On Term Deposits:		
a) With Scheduled Banks	2,394,486.00	10,190,111.65
b) With Non- Scheduled Banks	-	-
c) With Institutions	-	-
d) Others	-	-
2) On Savings Accounts:		
a) With Scheduled Banks	5,418,301.00	3,434,880.79
b) With Non- Scheduled Banks	-	-
c) Post Office Savings Accounts	-	-
d) Others	-	-
3) Loans:	-	-
a) Employees/Staff		
HBA UT- I	57,170.00	8,000.00
HBA UT- II (Intt)	-	1,000.00
HBA UT- I (Intt)	152,100.00	44,320.00
OMCA , Intt	8,420.00	38,973.00
Car Advance Intt.	13,856.00	-
Computer Adv Intt. (ARIES)	15,764.00	22,083.00
b) Others Interest	-	-
Interest on Projects Accounts	5,222,107.50	-
Interest on Projects FDR	702,303.00	
Interest on Income Tax Refund	17,346.00	
4) Interest on Debtors and Other Receivables:	-	-
TOTAL	14,001,653.50	13,739,368.44
Note- Tax deducted at source to be indicated*	149,102.00	491,902.00

MANOJ VATSAL & CO. M.NO. 505767 C.C. HALDWANI

ARYABHATTA RESEARCH INSTITUTE OF OBSERVATIONAL SCIENCES, NAINITAL

SCHEDULES FORMING PART OF BALANCE SHEET AS AT 31ST MARCH 2018

(Amount- Rs.)

	2017-18	2016-17
SCHEDULE 18- OTHER INCOME		
Miscelleneous Income	2,400.00	391.00
Dispencary Receipts	330.00	450.00
Electricity Receipts	354,481.00	332,448.00
EMD/Security Forfieted	-	125,000.00
Guest House Rent A/c	348,135.00	339,337.00
Hostel/Shop Rent	86,233.00	20,670.00
House Licence Fee	440,663.00	391,797.00
RTI Receipt	1,464.00	4,678.00
Telephone Receipts	5,659.00	4,960.00
Tender Fee A/c	7,000.00	11,142.75
Water Receipts	61,953.00	78,789.00
TOTAL	**1,308,318.00**	**1,309,662.75**

	2017-18	2016-17
SCHEDULE 19- INCREASE/(DECREASE) IN STOCK OF FINISHED GOODS & WORK IN PROGRESS		
a) Closing Stock		
Finished Goods	6,283,119.30	6,027,012.04
b) Less: Opening Stock		
Finished Goods	6,027,012.04	3,039,118.23
NET INCREASE/(DECREASE) [a-b]	**256,107.26**	**2,987,893.81**

Cont...

	2017-18	2016-17
SCHEDULE 20- ESTABLISHMENT EXPENSES		
Salaries and Allowances	90,796,401.00	75,005,859.00
Bonus	-	641,868.00
Overtime	-	10,685.00
Contribution to Provident Fund	2,719,351.00	2,710,484.00
Contribution to NPS	4,271,614.00	3,995,658.00
Medical Reimbursement	3,062,498.00	2,620,614.00
Tuition Fee Reimbursement	1,165,494.00	1,157,174.00
Dispensary Expenses	253,696.00	313,575.00
Leveries Expenses	20,160.00	36,083.00
Expenses on Employees' Retirement and Terminal Benefits	-	236,918.00
Contribution to Old Pension Fund	-	5,980,615.00
Honorarium	351,800.00	214,500.00
Leave Travel Concession	1,180,250.00	1,822,082.00
Stipend/Training		46,250.00
Scholorship	157,200.00	-
Fellowship	9,982,903.00	11,515,355.00
TOTAL	**113,961,367.00**	**106,307,720.00**

(1)BONUS IS PAYABLE TO EMPLOYEES DRAWING UPTO RS 21,000 PM

(2)NIL CONTRIBUTION TO EPF,EMPLOYEES ONLY CONTRIBUTE TO NPS

(3)PF,ESI COVERAGE IS NOT PROVIDED TO OUTSOURCED EMPLOYEES

ARYABHATTA RESEARCH INSTITUTE OF OBSERVATIONAL SCIENCES, NAINITAL

SCHEDULES FORMING PART OF BALANCE SHEET AS AT 31ST MARCH 2018

(Amount- Rs.)

	2017-18	2016-17
SCHEDULE 21- OTHER ADMINISTRATIVE EXPENSES ETC.		
Advertisement and Publicity	264,949.00	563,515.00
ATSOA-2016	-	70,977.00
ATSOA-2017	-	290,966.00
ASI -2017	47,000.00	200,000.00
Auditor's Remuneration	115,168.00	42,000.00
Bank Charges	39,586.57	27,399.30
Computer Accessories & Consumable	942,826.00	1,444,162.00
Consumable Expeses	1,916,993.00	1,283,456.00
Registration/Licence Fee	166,424.00	272,538.00
Gardening Expenses	90,079.00	626,875.00
Electricity Expenses	5,912,534.00	4,721,490.00
Fuel (POL)	1,467,025.00	1,474,210.00
Water Expenses	514,400.00	594,092.00
Insurance Expenses	37,656.00	38,463.00
Repairs and maintenance/ Instrument/AMC	2,774,247.00	1,428,790.83
Repairs and maintenance others	2,080,337.00	76,966.00
Repairs and maintenance Building	4,228,886.00	3,532,362.00
Vechicles Running and Maintenance	131,063.00	219,146.00
JEST	57,667.00	100,000.00
Observational Facilities	710,160.00	1,085,123.00
Telephone and Communication Expenses	426,015.00	1,697,134.00
Postage & Courier Expenses	27,796.00	109,079.00
Printing and Stationary Expenses	584,101.00	480,237.00
Conveyance Expenses	4,034,163.00	3,431,619.00
Travelling Expenses	2,020,848.00	1,626,169.00
TA EXP(M/S Balmer Lawrie & co. ltd)	891,283.00	766,587.00
Expenses on Seminar/SINA/CNC Workshops	173,609.00	556,310.00
Canteen Expenses	1,742,469.00	2,090,299.00
Cleaning Work Expenses	1,796,754.13	1,958,110.00
Hospitality Expenses	22,510.00	52,120.00
Legal Expenses	129,750.00	179,601.00
Professional Expenses	-	53,808.00
Public Outreach Program -Exhibition	259,394.00	144,000.00
Security Expenses*	14,868,581.00	6,222,715.00
Sundry Expenditure	44,336.00	21,420.00
Consumable & Maintaince 3.60 Mt. Telescope	1,186,003.00	51,000.00
Meeting of governing council	681,453.00	334,305.00
Meeting of Other Scientific Bodies	2,443,480.00	3,728,964.00
Office Exp	328,776.00	1,197,793.00
Financial Support to IAU Symposium	200,000.00	-
IISF Expo - 2017	350,000.00	-
Training Expenses	73,700.00	
Projects Expenses	3,375,600.25	-
TOTAL	**57,158,620.95**	**42,993,794.13**

*SECURITY AT DEVASTHAL IS FROM AN AGENCY THAT RECRUITS FROM EX SERVICE MEN PAYABLE AND THE WAGES ARE AS PAYABLE UNDER THE MINIMUM WAGES ACT,UTTRAKHAND AND HENCE THE INCREASE IN EXPENSES.THE SAME SECURITY NOW PROVIDES SERVICES AT MANORMA PEAK ALSO

MANOJ VATSAL & CO. M.N. 025797 HALDWANI

ARYABHATTA RESEARCH INSTITUTE OF OBSERVATIONAL SCIENCES, NAINITAL
SCHEDULES FORMING PART OF BALANCE SHEET AS AT 31ST MARCH 2018

(Amount- Rs.)

	2017-18	2016-17
SCHEDULE 22- EXPENDITURE ON GRANTS, SUBSIDIES ETC.		
a) Grants given to Institution/Organisations	-	-
b) Subsidies given to Institution/Organisations	-	-
TOTAL	-	-

Note- Name of the Entities, their Activities along with the amount of Grants/Subsidies are to be disclosed.

	2017-18	2016-17
SCHEDULE 23- INTEREST		
a) On Fixed Loans	-	-
b) On Other Loans (including Bank Charges)	-	-
c) Others	-	-
TOTAL	-	-

MANOJ NAITHANI & CO. HALDWANI

BANK BALANCES

ANNEXURE- I

PARTICULARS	2017-18	2016-17
LC No: 2016-02*	2,464,502.00	16,716,836.00
LC No:2016-04	1,412,139.00	1,383,144.00
	3,876,641.00	**18,099,980.00**
Bank Balances with scheduled Banks		
On Savings Accounts		
(i) Director Account- SBI, Nainital- 10860840253	66,762,711.75	171,038,216.93
(ii) GPF Account - SBI, Nainital- 10860840300	2,219,529.00	38,425,189.00
(iii) Pension Account (Old)- SBI, Nainital- 10860840311	19,382,694.74	14,286,317.26
(iv) Union Bank of India, Nainital- 535	84,599,033.00	79,161,899.00
	172,963,968.49	**302,911,622.19**
Project Bank A/c		
INT/RUS/RFBR/p-167	4,787.00	4,787.00
Vikram Sarabhai Center	2,952,072.00	2,952,072.00
SB A/c 34024763826 SBI	226,943.00	299,798.00
Department of Space	20,560.00	20,560.00
PDF/2015/000691	1,394,768.00	1,394,768.00
SERB	2,522,780.00	2,522,780.00
SB A/c 30310168038	3,323,361.50	1,712,778.00
SB A/c 36065850402 -BINA	1,373.00	1,373.00
S.B.I. SB - 30192927780	630,370.00	-
S.B.I. S/B 30318931302	2,679,947.50	-
S.B.I. SB - 31286509555	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	2,575,525.50	-
S.B.I. S/B - 37054985887	338,057.75	-
S.B.I SB - 37265312732	499,714.00	-
S B I SB - 312845	406,584.50	
S B I SB - 37598108567	1,447,200.00	-
ST Radar S.B.I A/C 30357703902	6,880,677.00	-
	27,596,314.25	**8,908,917.00**
TOTAL	**200,560,282.74**	**311,820,539.19**

*LC FOR CAMERAS RECEIVED IN 2017.18

LOAN/ADVANCE TO STAFF

ANNEXURE- 2

PARTICULARS	2017-18	2016-17
(i) Motor Car	977,426.00	1,098,466.00
(ii) Motor Cycle	124,340.00	152,340.00
(iii) Computer	103,800.00	201,800.00
(iv) House Building/Others	3,642,859.00	2,652,416.00
(v) Festival	45,200.00	172,600.00
(vi) LTC	13,500.00	19,000.00
(vii) Medical Advance	-	50,000.00
(vii) GPF Advance	345,600.00	3,592,793.76
TOTAL	5,252,725.00	7,839,415.76

Long term loans and advances	2017-18		2016-17
(a) Advance for Capital items- fixed assets			
National Institute of Design	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	1,115,294.00	1,304,278.00
(b) Advances to staff recoverable from salary (as per Annexure- 2)	-	-	-
TOTAL		1,115,294.00	2,068,101.00

ADVANCES- OTHERS

ANNEXURE- 3

	PARTICULARS	2016-17	2015-16
1	Intt. Earned Return DST (Recoverable)	16,195,520.56	-
2	Adv. To Mr A K Sharma (3.6Mt.)	50,001.00	-
3	Advance for Scientific Meeting	1,538,911.00	979,895.00
4	Travelling Advance	9,000.00	9,000.00
5	GST Receivable	2,596,284.00	-
6	Sundry Advance	337,279.50	379,639.50
	Advances to Staff (A)	20,726,996.06	1,368,534.50

Cont....

1	Interest Accured Electricity Board	49,015.00	49,015.00
2	Advances for Consumable Purchase	157,197.00	126,772.00
3	Security Deposits	501,573.00	501,573.00
5	Advance for IL TP Project	27,003.00	27,003.00
6	Advance to Forties Hospital (J.C. Pandey)	-	410,678.00
7	Indo Austria Project (Dr A.K. Srivastava)	36,422.00	36,422.00
8	Advance to Uttarakhand Power Corporation	1,500,004.00	1,500,004.00
9	TDS Advance (Receivable)	3,657,562.00	4,346,791.00
12	Advance legal fees	50,000.00	50,000.00
13	ST Radar Project Loan A/c	1,864,642.00	1,143,642.00
14	INDO- US Project (Dr Wahab Uddin)	36,306.00	36,306.00
16	Prepaid Expenses	2,419,205.17	2,614,776.17
17	Other advances/ST Radar/Custom duty	-	-
	Advances and security deposits (B)	**10,298,928.17**	**10,842,981.17**
	Total (A+B)	**31,025,924.23**	**12,211,515.67**

**INTEREST RECEIVED AND TO BE ADJUSTED DURING FY 2017.18

BALANCES ARE UNRECONCILED AND NOT INDEPENDENTLY VERIFIED

Schedule 8A : Fixed Assets work in progress as on 31.03.2018

.l.	Description of Assets	Opening balance on April 1, 2017	Addition during year	Assets completed	Balance as on March 31, 2018
1	4.00 Mt International Liquid Mirror Telescope	21,970,650.00	3,163,450.00	-	25,134,100.00
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 -Devasthal (CPWD)	7,895,000.00	7,350,000.00	-	15,245,000.00
5	WG-02 (ASTRAD)	2,869,417.00	2,551,815.00	-	5,421,232.00
	TOTAL	117,255,046.00	13,065,265.00	-	130,320,311.00

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

ARYABHATTA RESEARCH INSTITUTE OF OBSERVATIONAL SCIENCES, NAINITAL
BALANCE SHEET OF ARIES EMPLOYEES ENDOWMENT TRUST AS AT 31.03.2018

LIABILITIES		AMOUNT(Rs)	ASSETS		AMOUNT(Rs)
CORPUS			INVESTMENTS		36,490,984.00
GPF Fund A/c	36,240,035.56	108,998,390.62	FDR SBI	35,000,000.00	
Old Pension Fund A/c	72,758,355.06		Accrued interest	1,490,984.00	
RESERVES & SURPLUS		21,690,135.12			
Opening Reserve & Surplus	17,776,709.40		LOANS & ADVANCES		395,600.00
Excess of Income over Expenditure	7,506,219.48		GPF Advance to Employee	345,600.00	
Less Previous Year Provisions	(3,592,793.76)		ISRO project	50,000.00	
CONTRIBUTION		3,857,318.00	BANK ACCOUNT		106,201,256.74
Add: Employees contribution	7,046,945.00		GPF SBI -300	2,219,529.00	
Add: Pension Fund Receive	18,720,024.00		SBI-Pension -311	19,382,694.74	
Less :PF Withdrawal	(5,987,482.00)		UBI-535	84,599,033.00	
Less :Pension	(13,863,203.00)				
Less :Retirement benefits paid	(2,058,966.00)				
			TDS	149,102.00	149,102.00
PROVISION		8,691,099.00			
Superannuation	2,710,484.00				
Leave encashment	3,105,379.00				
Pension	2,875,236.00				
TOTAL		143,236,942.74	TOTAL		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

For Registrar Aries
Registrar
ARIES, NAINITAL

For Director Aries
Director
एरीज, नैनीताल
ARIES, NAINITAL

Date: 24.09.2018
Place: Nainital

ARYABHATTA RESEARCH INSTITUTE OF OBSERVATIONAL SCIENCES, NAINITAL

INCOME & EXPENDITURE ACCOUNT OF ARIES EMPLOYEES EMPLOYEES ENDOWMENT TRUST FOR THE YEAR ENDED ON 31.03.2018

ARTICULARS	AMOUNT(Rs)	AMOUNT(Rs)	PARTICULARS	AMOUNT (Rs)	AMOUNT(Rs)
EXPENSES		2,362,519.52	INCOMES		9,868,739.00
To Bank Charges	250.52		By Interest earned from SBI GPF	189,443.00	
To Director Aries 253 (interest)	2,362,269.00		By Interest earned from SBI Pension	575,233.00	
			By Interest earned from GPF FDR	1,840,086.00	
			By Interest earned from Old Pension FDR	7,463,977.00	
To Surplus of Income over Expenditure		7,506,219.48			
TOTAL		9,868,739.00	TOTAL		9,868,739.00

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

Manoj Joshi
FCA,DISA,DIRM(ICAI)
(Partner
Membership No. 025757

For Registrar Aries
Registrar
ARIES, NAINITAL

For Director Aries
निदेशक
Director
एरीज, नैनीताल
ARIES, NAINITAL

Date: 24.09.2018
Place: Nainital

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

ARYABHATTA RESEARCH INSTITUTE OF OBSERVATIONAL SCIENCES, NAINITAL
RECEIPT & PAYMENTS ACCOUNT OF ARIES EMPLOYEES ENDOWMENT TRUST FOR THE YEAR ENDED ON 31.03.2018

RECEIPTS	AMOUNT(Rs)	AMOUNT(Rs)	PAYMENTS	AMOUNT(Rs)	AMOUNT(Rs)
Opening Balance:		131,673,405.26	**PAYMENTS**		21,909,901.52
GPF 300	38,425,189.00		Bank charges	250.52	
Pension	14,286,317.26		Retirement Benefits paid	2,058,966.00	
UB-SB	79,161,899.00		PF Withdrawal	5,987,482.00	
			Pension (Retd. Employee)	13,863,203.00	
INTEREST RECEIVED		764,676.00	**Investments**		211,982,180.00
Interest earned from SBI GPF	189,443.00		FDR SBI	35,000,000.00	
Interest earned from SBI Pension	575,233.00		FDR UBI	176,982,180.00	
OTHER RECEIPT			**Loans & Advances**		395,600.00
Receive From Director Aries 253	99,000,000.00	99,000,000.00	GPF Advance	345,600.00	
			ISRO PROJECT	50,000.00	
FDR MATURED		184,446,157.00	**Repayments**		101,362,269.00
FDR MATURED	184,446,157.00		Director Aries 253	99,000,000.00	
			Director Aries 253 (Interest)	2,362,269.00	
CONTRIBUTION		25,766,969.00	**Closing balance**		106,201,256.74
Employees contribution	7,046,945.00		GPF-300-SBI	2,219,529.00	
Pension Fund Receive	18,720,024.00		SBI-Pension 311	19,382,694.74	
			UBI 535	84,599,033.00	
TOTAL		**441,851,207.26**	TOTAL		**441,851,207.26**

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

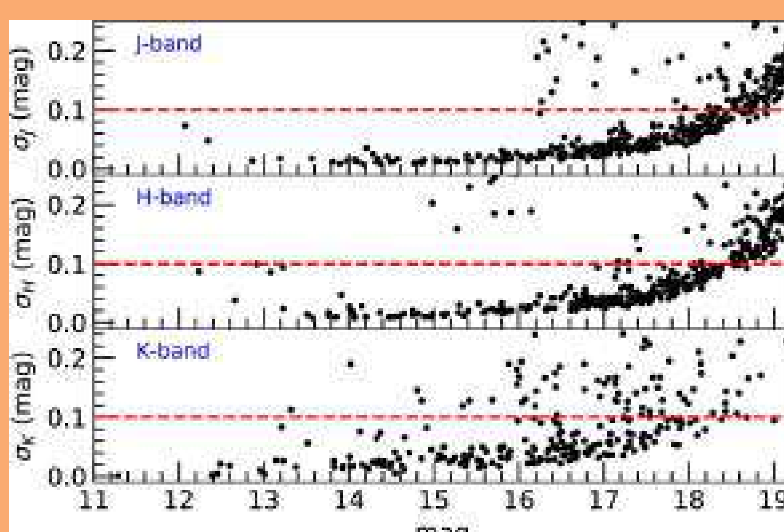
Manoj Joshi
FCA,DISA,DIRM(ICAI)
SR. Partner
Membership No. 025757

For Registrar Aries
Registrar
ARIES, NAINITAL

For Director Aries
निदेशक, Director
एरीज, नैनीताल
ARIES, NAINITAL

Date: 24.09.2018
Place: Nainital

MANOJ VATSAL & CO.
M.N. 065757
D.C.G. HALDWANI



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