ARIES

Aryabhatta Research Institute of Observational Sciences

Annual Report 2016-17

ARYABHATTA RESEARCH INSTITUTE
OF
OBSERVATIONAL SCIENCES

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

Manora Peak, Nainital - 263 001, India

ANNUAL REPORT
2016 - 2017

(1st April, 2016 to 31st March, 2017)

ARIES, Annual Report: 2016 - 2017
No. 13, 119 pages

Editor: Dr. Alok C. Gupta
Associate Editor: Dr. Kuntal Misra

Editorial Assistance: Mr. Arjun Singh
Mr. Prashant Kumar

Phone : +91 (5942) 270700
EPABX : +91 (5942) 233727, 233734, 233735, 232655
Fax : +91 (5942) 233439
E-mail : krc@aries.res.in
URL : http://www.aries.res.in/

Front Cover:
JHK Color composite picture of Trapezium Star Forming Region (left) observed with TIRCAM2 and the BR color composite image of a supernova remnant (Crab nebula) (right) observed with 4K Imager instrument mounted at 3.6m DOT.

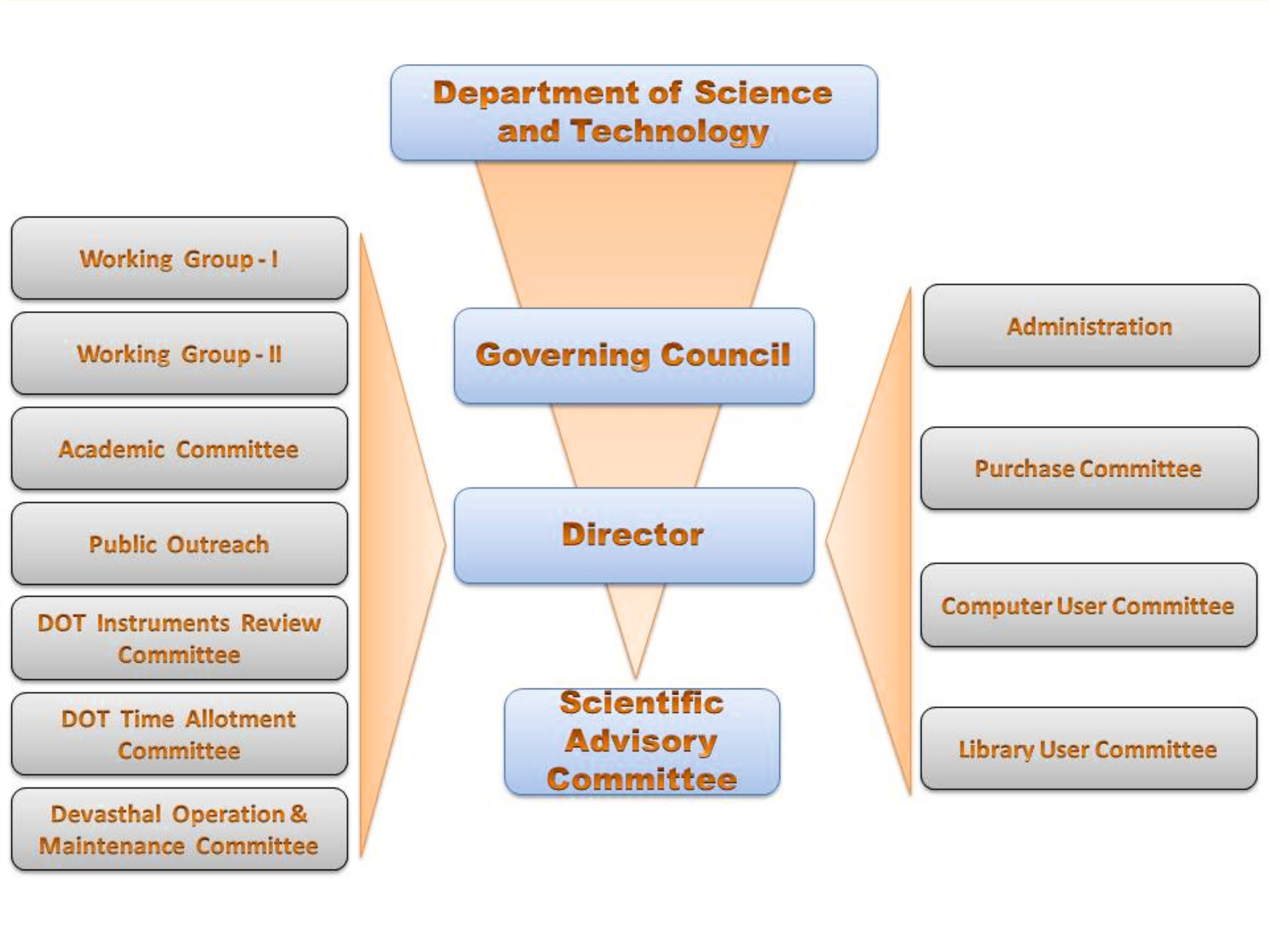
Back Cover:
View of ILMT, 3.6m DOT and 1.3m DFOT at Devasthal, ARIES, Nainital.

September, 2017

Contents

1. Organizational Structure of ARIES i
2. General Body and Governing Council ii
3. Finance Committee iii
4. Statutory Committee iv
    (i) SAC
    (ii) PMB
    (iii) PMC
5. From Director's Desk 1
6. Research Highlights
    (i) Research Working Group – I (Astronomy & Astrophysics) 4
    (ii) Research Working Group – II (Solar Physics & Atmospheric Science) 21
    (iii) List of Publications 33
7. International and National Research Projects 40
8. Updates on the major facilities
    (i) ILMT 42
    (ii) ARIES ST Radar (ASTRAD) 45
9. Status report on the upcoming instruments
    (i) 4Kx4K CCD Imager 49
    (ii) FOSC 51
    (iii) TANSPEC 53
10. Thirty Meter Telescope - a status report 55
11. Report from existing observing facilities
    (i) The 1.04m Sampurnanand Telescope (ST) 56
    (ii) The 1.3m Devasthal Fast Optical Telescope (D-FOT) 56
    (iii) The 3.6m Devasthal Optical Telescope 57
    (iv) 15cm Solar Telescope 61
12. Report from the Labs
    (i) Electronics Lab 62
    (ii) Optics Lab 64
    (iii) Mechanical Engineering Section 68
    (iv) Computer Lab 71
13. Knowledge Resources Centre (KRC)/Library 73
14. Academic Programmes of ARIES 74
15. Public Outreach Activities 76
16. Report on International Meeting held at ARIES (BINA Workshop) 78
17. Staff Welfare Measure 80
18. Members of ARIES 81
19. Visits by ARIES members 83
20. Visitors at ARIES 86
21. Abbreviations 91
22. Audit Statements of Account 94

Organizational Structure



General Body and Governing Council

CHAIRPERSON

Dr. Govind Swarup FRS
Honorary Fellow TIFR, Former Centre Director, NCRA of TIFR
and Former Project Director, GMRT
Pune - 411007

MEMBERS

Prof. Ashutosh Sharma
Secretary
Ministry of Science and Technology
Department of Science and Technology
Govt. of India,
New Delhi - 110 016

Chief Secretary
Govt. of Uttarakhand
Dehradun - 248 001
Uttarakhand

Mr. J. B. Mohapatra
Joint Secretary and Financial Advisor
Ministry of Science and Technology
DST, Govt. of India
New Delhi - 110 016

Prof. Avinash C. Pandey
Senior Professor
University of Allahabad, Allahabad
Uttar Pradesh

Prof. P. C. Agrawal
Centre for Excellence in Basic Sciences
University of Mumbai
Vidhyanagari Campus
Mumbai - 400 098

Prof. Sibaji Raha
Senior Professor
Bose Institute, Kolkata

Prof. V. P. N. Nampoori
International School of Photonics
Cochin University of Science And Technology
Cochin 682022, Kerala

Prof. Raja Ram Yadav
Vice Chancellor
VBS Purvanchal University, Jaunpur

Dr. Wahab Uddin *(Acting Director)* ***(till 05-03-2017)***
Dr. Anil Kumar Pandey ***(from 06-03-2017)***
(Member Secretary)
Director, ARIES
Manora Peak, Nainital – 263 001

Mr. Ravinder Kumar
(Non – Member Secretary)
Registrar, ARIES
Manora Peak, Nainital - 263 001

Finance Committee

CHAIRPERSON

Dr. Wahab Uddin *(Acting Director) (till 05-03-2017)*
Dr. Anil Kumar Pandey *(from 06-03-2017)*
Director, ARIES
Manora Peak, Nainital - 263 002

MEMBERS

Mr. J. B. Mohapatra
Joint Secretary and Financial Advisor
Ministry of Science and Technology
DST, Govt. of India
New Delhi - 110 016

Prof. P. C. Agrawal
Centre for Excellence in Basic Sciences
University of Mumbai
Vidhyanagari Campus
Mumbai - 400 098

Dr. Brijesh Kumar
Scientist-E, ARIES
Manora Peak
Nainital - 263 001

Mr. Ravinder Kumar
(Member Secretary)
Registrar, ARIES
Manora Peak, Nainital - 263 001

Statutory Committee

The Scientific Advisory Committee (SAC)

Prof. Dipankar Bhattacharya
(Chairman)
IUCAA, Pune

Prof. D. K. Ojha
(Member)
TIFR, Mumbai

Prof. P. Venkatakrishnan
(Member)
IIA, Bangalore

Prof. Gajendra Pandey
(Member)
IIA, Bangalore

Prof. J. N. Chengalur
(Memebr)
(NCRA, Pune)

Prof. S. K. Satheesh
(Member)
IISc,Bengaluru

Prof. Vinayak Sinha
(Member)
IISER, Mohali

Director
(convener)
ARIES, Nainital

3.6m Telescope Project Management Board (PMB)

Prof. P. C. Agrawal
(Chairman)
Mumbai

Prof. G. Srinivasan
(Vice Chairman)
Bangalore

Prof. T. G. K. Murthy
(Member)
ISRO, Bangalore

Prof. S. N. Tandon
(Member)
IUCAA, Pune

Prof. S. Anathakrishnan
(Member)
Pune University, Pune

Prof. T. P. Prabhu
(Member)
IIA, Bangalore

Mr. S. C. Tapde
(Member)
ECIL, Hyderabad

Prof. A. S. Kirankumar
(Member)
S. A. C., Ahmedabad

Prof. R. Srinivasan
(Member)
VIT, Bangalore

Prof. Pramesh Rao
(Member)
NCRA, Pune

Director
(Convener)
ARIES, Nainital

Stratosphere Troposphere (ST) Radar Project Management Committee (PMC)

Prof. B. M. Reddy,
(Chairman)
NGRI, Hyderabad

Director
(Member)
ARIES, Nainital

Dr. P. Sanjeeva Rao
(Member - Secretary)
DST, New Delhi

Dr. B. Hari Gopal
(Member)
SERB, New Delhi

Mr. G. Viswanathan
(Member)
ISRAO Lay Out, Bangalore

Dr. M. Satyanarayana
(Member)
Hyderabad

Dr. V. K. Anandan
(Member)
ISTRAC-ISRO, Bangalore

Dr. Manish Naja
(Convener)
ARIES, Nainital

Prof. A. Jayaraman
(Member)
NARL, Gadanki, AP

Prof. R. N. Keshavamurthy
(Member)
Bangalore

Dr. P. Srinivasulu
(Member)
NARL, Gadanki

From Director's Desk

I am glad to say that during the period of the report, ARIES continued to excel in academic fronts as well as in developing world class research facilities in Astronomy & Astrophysics and Atmospheric Science. One of the most exciting challenge of the period was to stream line the operation of 3.6m Devasthal Optical Telescope (DOT) which was technically activated jointly by Honourable Prime Minister of India, Shri Narendra Modi and Honourable Prime Minister of Belgium, Mr. Charles Michel remotely from Brussels on 30 March 2016 in the gracious presence of the Honourable Minister of Science and Technology and Earth Sciences, Dr. Harshvardhan at Devasthal.

A few technical issues related to DOT e.g., replacement of UMAC and GPS card were successfully tackled by ARIES team with the help of AMOS, Belgium. The characterisation of 4K imager and TIRCAM 2 (TIFR infrared camera II) was successfully done by ARIES with the help of TIFR team in the case of TIRCAM2. The realuminisation of primary mirror M1 of DOT was successfully done by ARIES team in March 2017. The sensor arm focus (SAF) ball-screw replacement was also performed in March 2017. The Devasthal time allocation committee (DTAC) announced the cycle 2017A (during April – May 2017) call for observing proposals for 3.6m DOT for early science.

The 3.6m DOT is a technologically advanced telescope. The primary mirror of telescope has diameter to thickness ratio of 1:22 and is supported by active pneumatic actuators. The active optics system of the telescope is used for in-situ control and alignment of the primary and secondary mirrors at all elevations and hence delivering the best resolution seeing limited images of the celestial sources. Several measurements of celestial sources using CCD camera mounted with the telescope were also taken to record the image quality of telescope. It is found that the stars with about 1 arcsec are clearly resolved. In the best condition we have also been able to resolve a binary star with a known separation of ~0.4 arcsec. These results are consistent with the seeing recorded at Devasthal in the year 2000. At Devasthal, the ground level median seeing was found to be 1.1 arcsec. Microthermal measurements taken in 1998 indicated that a seeing of ~ 0.6 arcsec can be achieved, if the telescope is located at the height of 13 m above the ground.

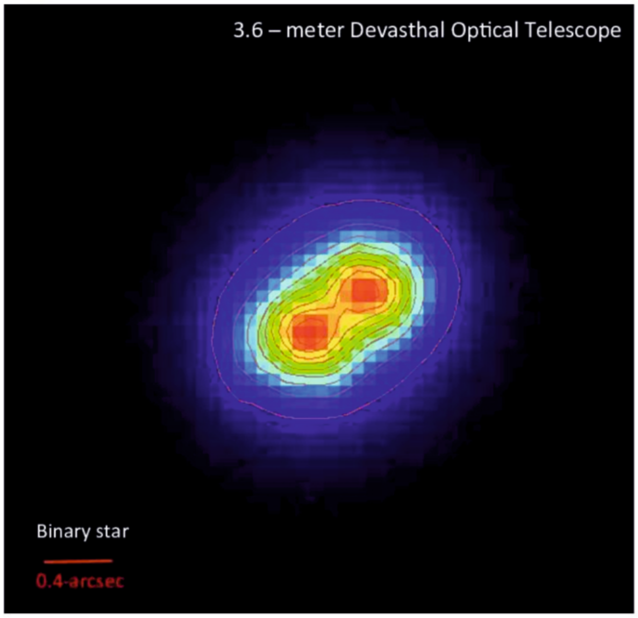


Figure 1. Picture of a binary star HIP 25060 with a known separation of 0.4 arcsec taken with the 3.6m DOT using a test camera. The exposure time is one second.

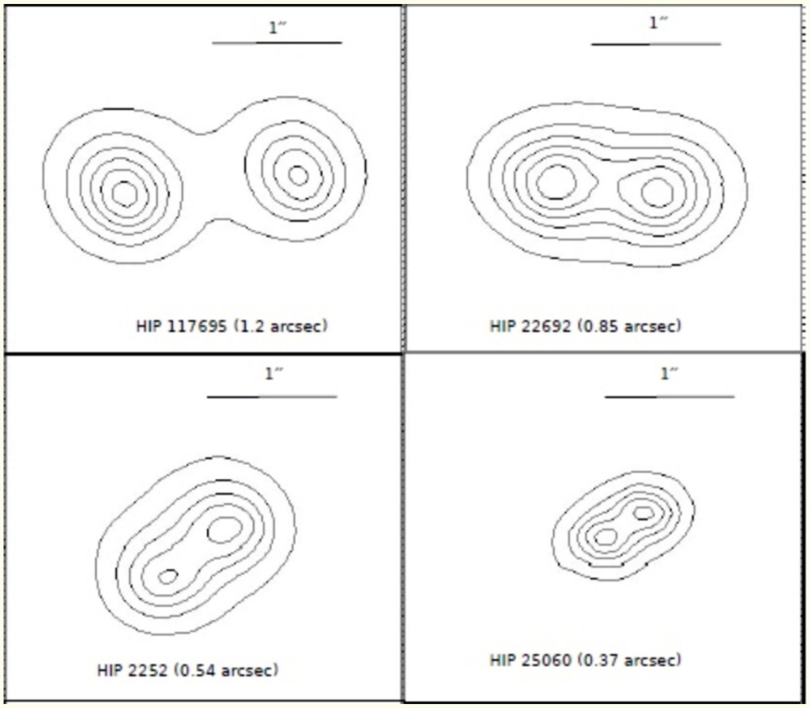


Figure 2. The iso-intensity contour images of closely separated binary stars observed with the 3.6m DOT. Stars up to 0.4 arcsec angular separation were resolved in the best seeing condition. This seeing is at par with those at major ground-based international large telescope sites.

The time allocation was finalised by the end of March 2017. Out of 60 nights, 38 and 3 nights of telescope time were allotted to the proposals from India and Belgium respectively. Remaining nights were scheduled as observatory time for calibration etc. I am sure that the coming years are expected to produce interesting new results using the 3.6m DOT and the telescope will open a new window for the Indian scientific community to develop new international collaborations.

On 06 March 2017 I assumed the charge of the Director ARIES, where I was a faculty since 1980. ARIES, the reincarnation of U. P. State Observatory/ State Observatory (Uttarakhand) is a leading institute for Astronomy & Astrophysics since 1954. We further expanded our academic activities in Atmospheric Sciences in 2004. It is both a privilege and a challenge for me to lead such an institution which has India's largest optical telescope and a unique upcoming ST-Radar system for atmospheric science studies.

The Institute's academic activities are centered around research in the areas of Astronomy, Astrophysics and Atmospheric Sciences. We operate a suite of optical telescopes with advanced instruments to study Earth's atmosphere, Sun, Planets, Stars and Galaxies. The astrophysical topics related to the Galactic and Extragalactic astronomy which include the fields of exoplanetary systems, star formation, star clusters, roAp stars, micro-lensing, active galactic nuclei (AGNs), quasars, supernovae, X-ray sources, Wolf-Rayet galaxies, giant radio galaxies and gamma ray bursts (GRBs). The research in solar physics concentrates on the observations and modelling of the transients (e.g., flares and associated plasma processes, jets, spicules, etc.), space weather phenomena and magneto-hydrodynamic waves in the solar atmosphere. In Atmospheric Sciences, research is focused on the lower atmospheric processes those are contributing to air pollution and climate changes. Extensive observations of trace gases (including greenhouse gases), aerosols, and meteorological parameters are being made and modelling activities are carried out to understand the chemical, physical and dynamical processes. Galactic and Extra-galactic studies include multi-wavelength studies of various classes of sources listed above.

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

The engineers/engineering staff at ARIES are actively involved not only in development of back-end instruments/softwares but also efficiently maintaining the available facilities. The efficient operation of 45 year old 1.04m Sampurnanand telescope is the best example of dedication of ARIES team. The imaging polarimeter (AIMPOL) which was built in the Institute during 2004 using the limited facilities available at the Institute and subsequent successful use of the AIMPOL with the 1.04m telescope by the ARIES faculty and students is an accomplishment of team work.

During the year of report the Institute had 35 Scientists and Engineers, 14 administrative and support staff, 36 scientific and technical staff, 13 laboratory assistants, 08 post doctoral fellows and 32 research scholars. In the year 2016, four new research scholars joined the Institute, while 5 research scholars submitted their thesis and 4 research scholars were awarded the Ph. D. degree. ARIES faculty have published 67 and 11 papers in the refereed journals of high impact factors and conferences/ seminars etc., respectively. About 50 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.

A significant progress has been made during the year in the case of upcoming facilities. The progress of TANSPEC, a near-infrared spectrograph which is being built in collaboration with TIFR, Mumbai is as per schedule. The ARIES Devasthal faint object spectrograph and camera is expected to be operational in next observing run. The 1.04m Sampurnanad telescope and 1.3m telescope are functioning well and providing excellent scientific results. ST-Radar was operational with 7 clusters and the wind data are found to be in reasonable agreement with the balloon borne wind observations.

The first Indo – Belgian workshop under the Belgo – Indian Network for Astronomy and Astrophysics (BINA) was held in Nainital during 15 – 18 November 2016. The theme of the conference was Instrumentation and Science with the 3.6m DOT and 4.0m ILMT. More than 100 astronomers from 8 countries (India, Belgium, Russia, Japan, China, South Africa, Thailand and Taiwan) participated in the workshop.

Continuous efforts are being made to implement the official language in the day to day administrative work. 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.

I sincerely believe that with several new upcoming facilities the Institute will continue to enhance its academic excellence and carve a niche in the academic world.

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

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

The working group members are responsible for the annual planning and monitoring of the activities on the academic and technical matters. In this section, a brief highlight of the scientific and instrumentation achievements of the institute, during the period 2016-17, are presented.

Research Working Group – I

All the scientists working on topics related to Galactic and Extragalactic astronomy are the members of WG – I. The group consists of 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.

Astronomy & Astrophysics

Galactic Astronomy:

1. Study of Individual Stars

The Nainital-Cape Survey : A search for pulsational variability in chemically peculiar stars

The Nainital-Cape Survey is a dedicated survey programme initiated in 1999 in coordination of the astronomers from ARIES Nainital and ISRO Bangalore with aims to search for new roAp stars and pulsating Am

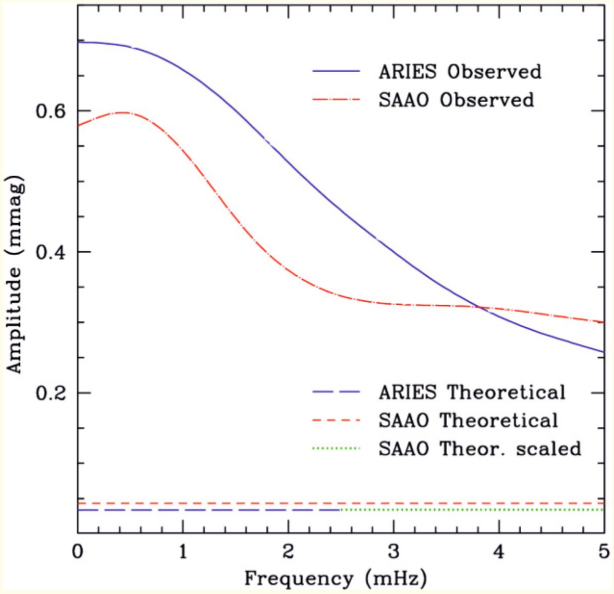


Figure 3. Noise characteristics at the ARIES site at Nainital and SAAO Sutherland site. The acspline-fitted curve of ARIES and SAAO amplitude spectra are shown in solid blue and dot-dashed red curves, respectively. The theoretical scintillation noise levels of ARIES and SAAO are shown with blue long-dashed and red small-dashed horizontal lines, respectively, and the scintillation noise level of SAAO (scaled to 104 cm diameter) is also shown with a green dotted horizontal line.

stars in the northern and southern hemisphere, and perform asteroseismic studies to understand their internal structure and evolution. The candidate stars were selected on the basis of having Strömgren photometric indices similar to those of known pulsating chemically peculiar (CP) stars, and the survey was conducted using high-speed photometry. Over the last 17 years a total of 337 candidate pulsating CP stars were observed in the Nainital-Cape survey, making it one of the longest ground-based surveys for pulsation in CP stars in terms of time span and sample size. Under this survey, the rapid pulsation in an Ap star HD12098 was discovered while Delta Scuti pulsations were detected in seven Am stars. As a part of establishing the detection limits in the Nainital-Cape survey, the scintillation noise level at the two observing sites, Sutherland and Nainital, were investigated by comparing the combined frequency spectra of stars observed from each location. The analysis shows that both the sites permit the detection of variations of the order of 0.6 milli-magnitude (mmag) in the frequency range 1- 4 mHz. Sutherland is on an average marginally better. **[Joshi, S.,** et al. (including **Joshi, Y. C.**) (2016). *Astron. & Astrophy., 590*, A116 (36pp).**]**

Broad-band linear polarization in late-type active dwarfs

Polarimetric observations of a sample 43 active late-type dwarfs were carried out using the AIMPOL with the aim to investigate the origin of polarization and its dependence on the various activity parameters. The polarization in these stars

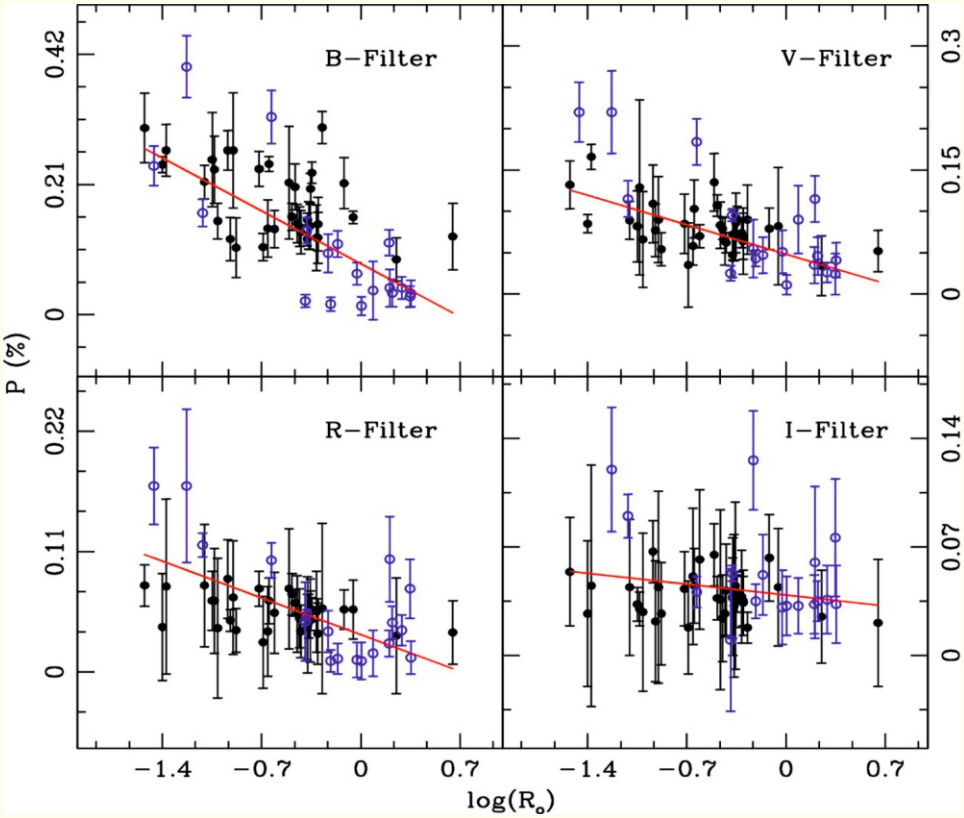


Figure 4. Degree of polarization (P) versus Rossby number (R$_O$) in B, V, R and I bands, where solid and open circles represent present data and literature data, respectively, and continuous straight line are the linear regression fit.

is found to be wavelength dependent, decreasing towards the longer wavelength with the average values of degree of polarization of 0.16 ± 0.01, 0.080 ± 0.006, 0.056 ± 0.004 and 0.042 ± 0.003 per cent in *B*, *V*, *R*, and *I* bands, respectively. In three stars, namely V526 Aur, V1658 Aql and V1659 Aql, the polarization is due to the ISM. However, polarization in 40 stars was found to be intrinsic rather than ISM induced. In order to determine wavelength-dependence polarization, the power law $P \propto \lambda^b$ to be observed and theoretical values of polarization were fitted. The derived values of power-law indices 'b' for the observed polarization and the theoretical polarization were then compared. It is noticed that polarization in the majority of active dwarfs was primarily due to sum of polarization by magnetic intensification and scattering. However, supplementary sources of polarization were also found to be present in some active stars. The correlations between linear polarizations and magnetic activity indicators Rossby Number (R_O), chromospheric activity indicators (R'_{HK}) and coronal activity indicator (R_X) were also studied. The degree of polarization increases with increasing magnetic activity. These correlations were found to be strongest in the *B* band and also show the largest slope of linear regression fit in the *B* band. The correlation becomes weaker towards longer wavelengths. This could be due to the increase in the number of saturated Zeeman-sensitive absorption lines towards the blue end of the optical spectrum, which in turn produce net linear polarization via the magnetic intensification mechanism and scattering in the optically thin part of stellar atmosphere. **[**Patel, M. K., **Pandey, J. C., Karmakar, S.,** Srivastava, D. C. & Savanov, I. S. (2016). *Mon. Not. Roy. Astron. Soc., 457,* 3178-3190.**]**

Paloma: a magnetic CV between polars and intermediate polars

The analysis of a magnetic cataclysmic variable (MCV) Paloma using archival X-ray data from the *XMM-Newton* satellite, optical photometric data from 1 m class telescopes of ARIES, Nainital were presented. Two persistent periods at 156 ± 1 minutes and 130 ± 1 minutes were present in the X-ray data, which were interpreted as the orbital and spin periods, respectively. These periods were similar to those obtained from the previous as well as new optical photometric observations. The soft-X-ray excess seen in the X-ray spectrum of Paloma and the averaged X-ray spectra were well fitted by two-temperature plasma models with temperatures of 0.10 ± 0.02 and 13.0 ± 0.5 keV with the Fe Kα line and an absorbing column density of 4.6×10^{22} cm^{-2}. This material partially covers 60 ± 2% of the X-ray source. The orbital and spin-phase-resolved spectroscopy of Paloma in the 0.3-10.0 keV energy band was also presented, and it was

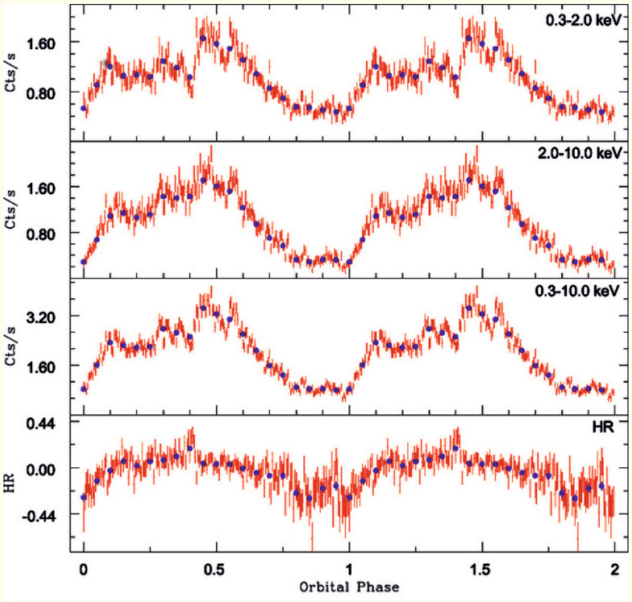


Figure 5. Orbital phase folded light curve of an Intermediate Polar Paloma.

found that the X-ray spectral parameters show orbital and spin-phase dependencies. New results obtained from optical and X-ray studies of Paloma indicate that it belongs to a class of a few magnetic CVs that seem to have the characteristics of both the polars and the intermediate polars. **[Joshi, A., Pandey, J. C.,** Singh, K. P. & Agrawal, P. C. (2016). *Astrophy. Jr., 830,* 56 (11pp).**]**

LO Peg: surface differential rotation, flares, and spot-topographic evolution

Using the wealth of ~24 year multiband data, an in-depth study of the star-spot cycles, surface differential rotations (SDR), optical flares, evolution of star-spot distributions, and coronal activities on the surface of young, single, main-sequence, ultrafast rotator LO Peg was presented. From the long-term *V*-band photometry, the rotational period of LO Peg was found to be 0.4231 ± 0.0001 days. Using the seasonal variations on the rotational period, the SDR pattern was investigated, which shows a solar-like pattern of SDR. A cyclic pattern with period of ~2.7 years appears to be present in rotational period variation. During the observations, 20 optical flares were detected with a flare frequency of ~1 flare per two days and with flare energy of ~10^{31-34} ergs. The surface coverage of cool spots is found to be in the range of ~ 9-26 per cent. It appears that the high- and low-latitude spots were interchanging their positions. Quasi-simultaneous observations in X-ray, UV, and optical photometric bands show a signature of an excess of X-ray and UV activities in spotted regions. **[Karmakar, S.,** et al. (including **Pandey, J. C., Pandey, S. B., Misra, K. & Joshi, S.)** (2016). *Mon. Not. Roy. Astron. Soc., 459,* 3112-3129.**]**

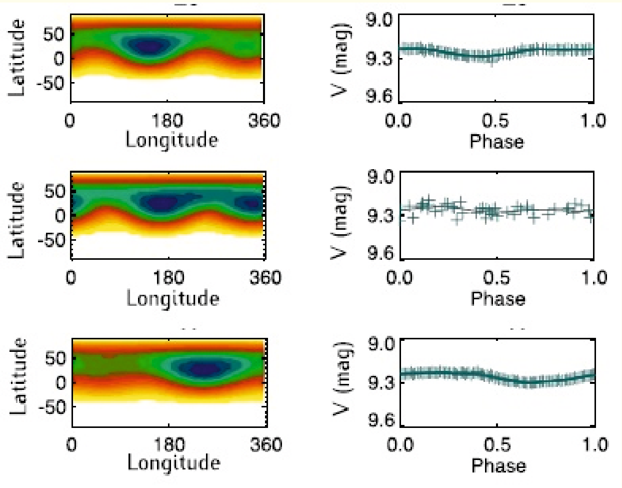


Figure 6. The surface temperature inhomogeneity maps of an ultra-fast rotator LO Peg.

The hot γ Doradus and Maia stars

The hot γ Doradus stars have multiple low frequencies characteristic of γ Dor or SPB variables, but are located between the red edge of the SPB and the blue edge of the γ Dor instability strips where all low-frequency modes are stable in current models of these stars. Though δ Sct stars also have low frequencies, there is no sign of high frequencies in hot γ Dor stars. Spectra were obtained to refine the locations of some of these stars in the H-R diagram and concluded that these were, indeed, anomalous pulsating stars. The Maia variables have multiple high frequencies characteristic of β Cep and δ Sct stars, but lie between the red edge of the β Cep and the blue edge of the δ Sct instability strips. A list of all Maia candidates was compiled and spectra of two of these stars were obtained. It is likely that these were anomalous pulsating stars which are currently not understood. [Balona, L. A., et al. (including **Joshi, Y. C. & Joshi, S.)** (2016). *Mon. Not. Roy. Astron. Soc., 460,* 1318-1327]**.**

Evidence of asymmetries in the Aldebaran photosphere from multi-wavelength lunar occultations

Three lunar occultations of the star Aldebaran (α Tau) have been studied using the data taken in various band passes, from the ultraviolet to the far red from different telescopes. The data have been analysed using both model-dependent and model-independent methods. The derived uniform-disc angular diameter values have been converted to limb-darkened values using model atmosphere relations and were found in broad agreement among themselves and with previous values reported in the literature. The limb-darkened diameter was about 20.3 milli-arcsec (mas) on an average. It was found that the photospheric brightness profile of Aldebaran may not have been symmetric, which is also reported by other authors for this and for similar late-type stars. At the sampling scale of the brightness profile, between 1 and 2 mas, the uniform and limb-darkened disc models may not be a good description for Aldebaran. The asymmetries appear to differ with wavelength and over the 137 days time span of the measurements. Surface spots appear as a likely explanation for the differences between observations and the models. **[** Richichi, A., et al. (including **Pandey, A. K.** & **Sharma, S**.) (2017). *Mon. Not. Roy. Astron. Soc., 464,* 231-236.**]**

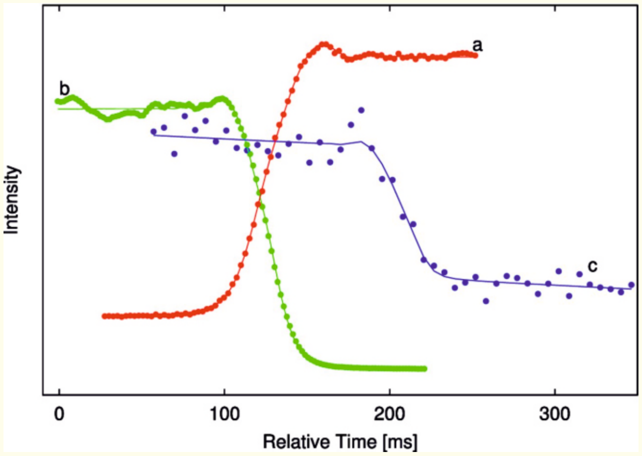


Figure 7. Light curves (points) marked as a, b, c, from the SAO 6m, Devasthal 1.3m and TNT 2.4m telescopes, respectively. The data have been shifted in time, scaled and shifted in intensity, to fit in a single figure. The solid lines are the best fit by a uniform-disc (UD) model in each case.

2. Study of Star Clusters

Study of open clusters within 1.8 kpc and understanding the Galactic structure

Based on an almost complete sample of Galactic open star clusters within 1.8 kpc, a comprehensive statistical analysis of various cluster parameters like spatial position, age, size, mass and extinction in order to understand the general properties of the open cluster system in the Galaxy and the Galactic structure were performed. Based on the distribution of 1241 open clusters about the Galactic plane and in different age bins, it was found that the average Galactic scale height is $Z_h = 60 \pm 2$ pc for the youngest cluster population having age < 700 Myr, however, it increases up to 64 ± 2 pc when older population of clusters was also included. The solar offset is found to be 6.2 ± 1.1 pc above the formal Galactic plane. A local mass density of $\rho_0 = 0.090 \pm 0.005\ M_\odot/pc^3$ was derived and found a negligibly small amount of dark matter in the solar neighbourhood. The reddening in the direction of clusters suggests a strong correlation with their vertical distance from the Galactic plane having a respective slope of $dE(B-V)/dz = 0.40 \pm 0.04$ and 0.42 ± 0.05 mag/kpc below and above the galactic plane. A linear mass-radius and mass-age relations in the open clusters was observed with a slope of $dR/d(\log M) = 2.08 \pm 0.10$ and $d(\log M)/d(\log T) = -0.36 \pm 0.05$, respectively. **[Joshi, Y. C.,** Dambis, A. K., **Pandey, A. K.** & **Joshi, S.** (2016). *Astro. & Astrophy., 593,* A116 (1-13 pp).**]**

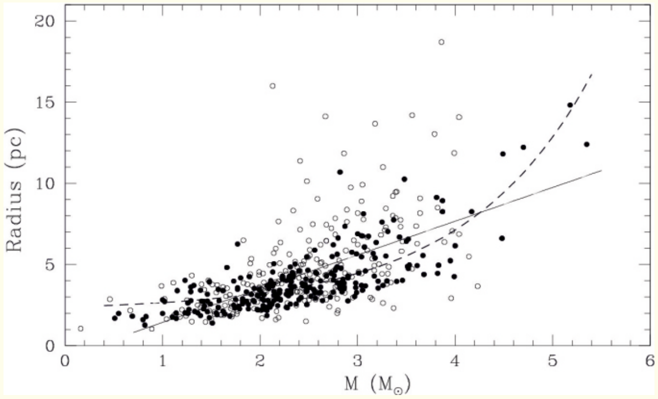


Figure 8. Mass-radius distribution for the clusters. The filled and open circles represent clusters within and outside the solar orbit. The continuous line represents the best-fit linear regression line. The dashed curve shows the $R \propto M^{1/3}$ relation for the clusters within the solar orbit assuming a constant cluster density.

Investigation of open clusters based on IPHAS and APASS survey data

The classical Q-method based on a reddening-free parameter constructed from three passband magnitudes to the filter set of Isaac Newton Telescope Photometric Hα Survey in combination with the maximum-likelihood-based cluster parameter estimator by Naylor & Jeffries (2006) was adapted to determine the extinction, heliocentric distances, and ages of young open clusters using *Hαri* data. The method was also adapted for the case of significant variations of extinction across the cluster field. The present technique was validated by comparing the colour excesses, distances, and ages determined in this study with the most bona fide values reported for the 18 well-studied young open clusters in the past, and a fairly good agreement was found between the estimated extinction and distance and earlier published results. Although present age estimates were not very consistent with those published by other authors. The individual extinction values can be determined rather accurately for stars with $(r - i) > 0.1$. The present results open up a prospect for determining a uniform set of parameters for northern clusters based on homogeneous photometric data, and searching for new, hitherto undiscovered open clusters. [Dambis, A. K., Glushkova, E. V., Berdnikov, L. N., **Joshi, Y. C.** & **Pandey, A. K.** (2017). *Mon. Not. Roy. Astron. Soc., 465,* 1505-1517.]

UBVI photometric study of open star clusters Ruprecht 25 and Czernik 6

The *UBVI* CCD photometric study of two open star clusters Ruprecht 25 and Czernik 6 using the data taken with 1.04m Sampurnanand telescope, ARIES, Nainital, India was presented. The optical CCD data for these clusters were obtained for the first time. The clusters radius were found to be 2'.4 and 1'.5. Using two colour $(U - B)$ versus $(B - V)$ diagram, the reddening was estimated as $E(B - V) = 0.55 \pm 0.05$ mag for Ruprecht 25 and 0.48 ± 0.05 mag for Czernik 6, while the corresponding distances were 5.8 ± 0.5 and 5.0 ± 0.3 kpc, respectively. Ages of 800 ± 80 Myr for Ruprecht 25 and 40 ± 10 Myr for Czernik 6 were determined using the stellar isochrones of metallicity Z = 0.019 . The relaxation time for the clusters Ruprecht 25 and Czernik 6 was also determined. The analysis indicates that both clusters are dynamically relaxed. This may be due to the dynamical evolution or imprint of star formation itself or both. [Bisht, D., **Yadav, R. K. S.** and Durgapal, A. K. (2016). *New Astron., 49,* 1-7.]

A Proper Motions Study of the Globular Cluster NGC 3201

With a high value of heliocentric radial velocity, a retrograde orbit, and suspected to have an extragalactic origin, NGC 3201 is an interesting globular cluster for kinematical studies. The purpose was to calculate the relative proper motions (PMs) and membership probability for the stars in the wide region of globular cluster NGC 3201. PM based membership probabilities were used to isolate the cluster sample from the field stars. The membership catalog will help to address the question of chemical inhomogeneity in the cluster. Archive CCD data taken with a wide-field imager (WFI) mounted on the ESO 2.2 m telescope were reduced using the high-precision astrometric software developed by Anderson et al. (2006) for the WFI images. The epoch gap between the two observational runs is ~14.3 years. The CCD data with an epoch gap of ~14.3 years enable to decontaminate the cluster stars from field stars efficiently. The median precision of PMs was better than ~0.8 mas yr^{-1} for stars having $V < 18$ mag that increases up to ~1.5 mas yr^{-1} for stars with $18 < V < 20$ mag. Kinematic membership probabilities were calculated using PMs for stars brighter than $V \sim 20$ mag. An electronic catalog of positions, relative PMs, *BVI* magnitudes, and membership probabilities in the ~19.7 × 17 $arcmin^2$ region of NGC 3201 was generated and used to identify probable cluster members among the known variables and X-ray sources in the direction of NGC 3201. [Sariya, D. P., Jiang, Ing-Guey and **Yadav, R. K. S.** (2017). *Astron. Jr., 153*, 134 (10 pp).]

3. Study of Star Formation

Structural studies of eight bright rimmed clouds in the southern hemisphere

A deep- and wide-field near- and mid-infrared observations for a sample of eight bright-rimmed clouds (BRCs) have been carried out. Supplemented with the Spitzer archival data, 44 to 43 young stellar objects (YSOs) associated with these BRCs were identified and classified. The Class I sources are generally located towards the places with higher extinction and are relatively closer to each other than the Class II sources, confirming that the young proto-stars are usually found in regions with denser molecular material. On the other hand the comparatively older population, Class II objects, were more randomly found throughout the regions, which can be due to their dynamical evolution. Using the minimal sampling tree analyses, 13 stellar cores of eight or more members were extracted, which contain 60% of the total YSOs. The typical core is ~0.6 pc in radii and somewhat elongated (aspect ratio of 1.45), of relatively low stellar density (surface density 60 pc^{-2}), consisting of a small (35) number of YSOs of relatively young sources (66% Class I), and partially embedded (median A_K=1.1 mag). But the cores show a wide range in their mass distribution (~20 to 2400 $M_{\odot}$), with a median value of around 130 $M_{\odot}$. The star- formation efficiencies

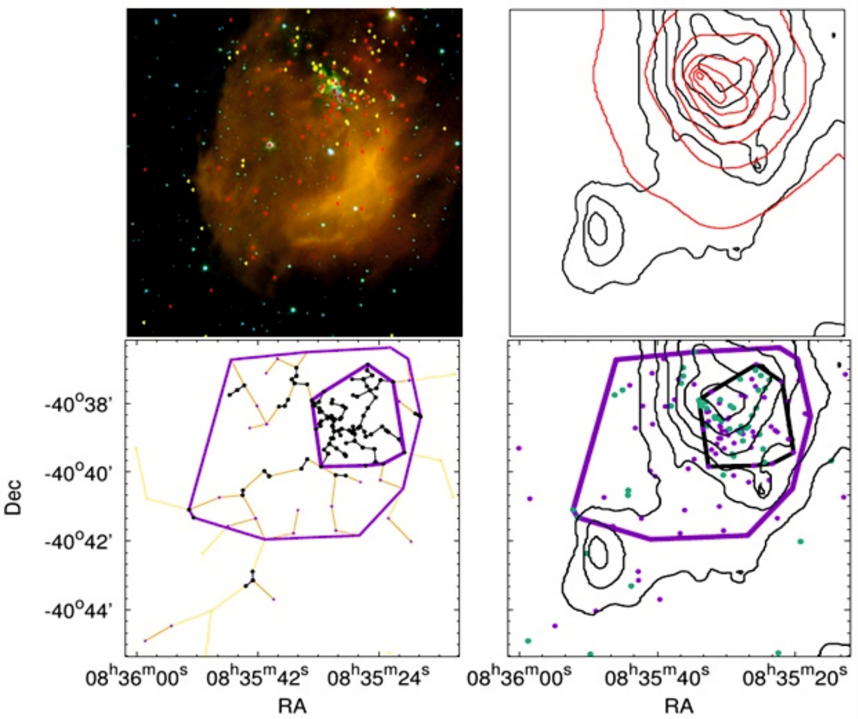


Figure 9. (Top Left) Color-composite image of the SFO 54 region obtained by combining the K (blue), 3.6 μm (green), and 8.0 μm (red) images for an area ~ 10×10 arcmin^2. The identified YSOs (Class I: yellow dots, Class II: red dots) are also plotted. (Top Right): isodensity contours for the YSO distribution (red dotted contours) and the reddening map (black solid contours) for the same region. (Bottom Left): minimal spanning tree (MST) for the identified YSOs in the same region along with the convex hull. The black dots connected with solid lines and gray dots connected with dark yellow lines are the branches smaller than the critical length for the cores and the active region, respectively. The identified core and the active region are encircled with purple solid polygons. (Bottom Right): spatial correlation between the molecular material inferred from the extinction map (thin black contours) and the distribution of YSOs along with the identified cores and active regions (thick black and purple lines, respectively).

in the cores was found to be between 3% and 30% with an average of ~14%, which agrees with the efficiencies needed to link the core mass function to the initial mass function. A linear relation between the density of the clouds and the number of YSOs was found. The peaked nearest neighbor spacing distributions of the YSOs and the ratio of Jeans lengths to the YSO separations indicates a significant degree of non-thermally driven fragmentation in these BRCs. **[Sharma, S.,** et al. (including **Pandey, A. K., Gopinathan, M.** & **Yadav, R. K.**) (2016). *Astron. Jr., 151*:126 (26pp).**]**

A multi-wavelength investigation of the HII region S311: young stellar population and star formation

A multi-wavelength investigation of the young stellar population and star formation activities in the HII region Sharpless 311 was done. Using the deep near- infrared observations and archival Spitzer-IRAC observations, A total of 125 Young Stellar Objects (YSOs) in an area of ~86 arcmin^2 were detected. The YSO sample includes 8 Class I and 117 Class II candidate YSOs. The mass completeness of the identified YSO sample was estimated to be 1.0 $M_{\odot}$. The ages and masses of the majority of the candidate YSOs were estimated to be in the range of ~ 0.1−5 Myr and ~ 0.3−6 $M_{\odot}$, respectively. The 8 µm image of S311 displays an approximately spherical cavity around the ionizing source which was possibly created due to the expansion of the HII region. The spatial distribution of YSO candidates reveals that a significant number of candidate YSOs were distributed systematically along the 8 µm emissions with a majority clustered around the eastern border of the HII region. Four clumps/compact HII regions were detected in the radio continuum observations at 1280 MHz, which might have been formed during the expansion of the HII region.

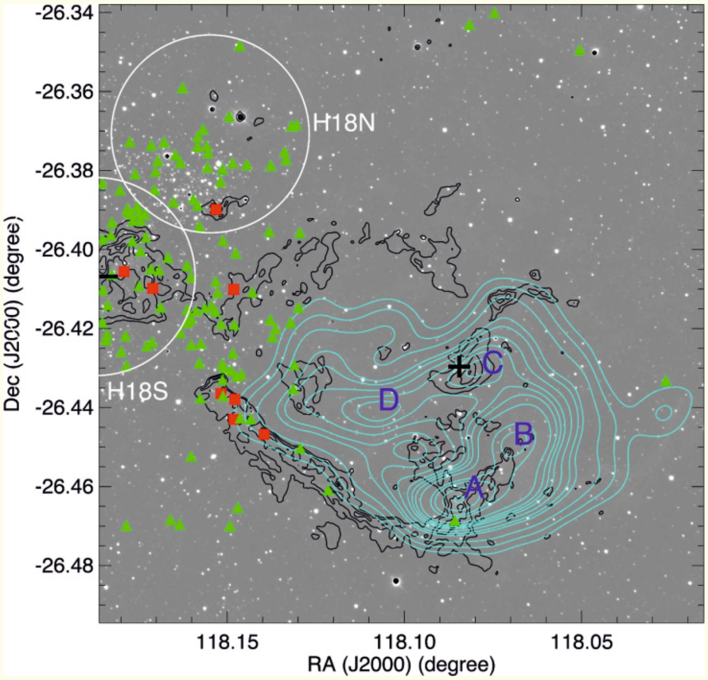


Figure 10. Spatial distribution of candidate YSOs overlaid on the *Ks*-band image. The candidate YSOs, classified as Class I and Class II on the basis of criteria mentioned in Gutermuth et al. (2009), are shown by the red squares and green triangles, respectively. The 8-µm contours (black) and GMRT radio contours (cyan) at 1280 MHz are also over-plotted. The ionizing source (HD 64315) is shown by a plus (+) sign. The selected sub-regions, namely H18N and H18S, are also shown. The letters A, B, C and D denote four compact HII regions identified from the 1280-MHz radio analysis.

The estimated dynamical age of the region, main-sequence lifetime of the ionizing source, the spatial distribution and ages of the YSO candidates indicate triggered star formation in the complex. [**Yadav, R. K.,** et al. (including **Pandey, A. K.** & **Sharma, S.**) (2016). *Mon. Not. Roy. Astron. Soc., 461,* 2502-2518.]

Extra-Galactic Astronomy

1. Studies of External Galaxies

Study of nearby star-forming galaxies

The 1.4 GHz radio continuum emission at a level of ~80 μJy was detected from weak-emission line blue early-type galaxies using image stacking technique. The corresponding radio power was ~2x10^{20} W/Hz. It was also shown that the star formation rate in blue early-type galaxies is dependent on the central stellar velocity dispersion. This dependence is most likely linked to the growth of a black hole and the suppression of star formation via active galactic nucleus feedback. [**Paswan, A.** & **Omar, A.** (2016). *Mon. Not. Roy. Astron. Soc., 459,* 233-238.]

Hα imaging work was carried out on 25 nearby Wolf-Rayet galaxies using the 1.3m Devasthal Fast Optical Telescope. The Hα based star formation rates (SFR) were estimated for the galaxies. Based on the comparisons of SFR estimated by different methods, viz., far-infrared, Hα, 1.4 GHz radio, far-ultraviolet, it was found that the SFR estimates from Hα and far-ultraviolet are most

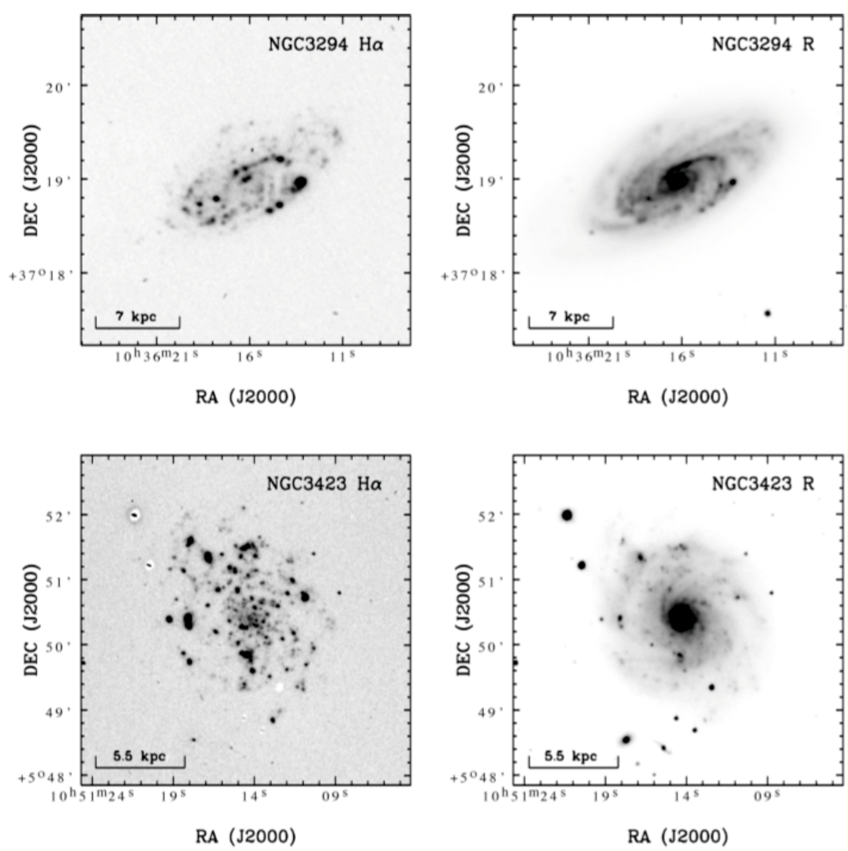


Figure 11. The representative *Hα* and *r*-band images of two galaxies from a large sample of star-forming Wolf-Rayet galaxies studied using the 1.3m DFOT.

tightly correlated. It was also found that the majority of Wolf-Rayet dwarf galaxies have significant non-thermal radio deficiency possibly due to lack of supernovae from the present phase of starburst. **[Jaiswal, S.** & **Omar, A.** (2016). *Mon. Not. Roy. Astron. Soc., 462,* 92-114.**]**

Four giant low surface brightness (GLSB) galaxies were studied using the HI 21 cm-line observations from the GMRT. The rotation curves of the galaxies indicated that the maximum rotation velocities of GLSB were between 225 and 432 km/s. The galaxy UGC 1922 with rotation velocity >400 km/s is among the fastest rotating spiral galaxies known so far. **[Mishra, A.,** et. al. (including **Omar, A.**) (2017). *Mon. Not. Roy. Astron. Soc., 464,* 2741-2751.**]**

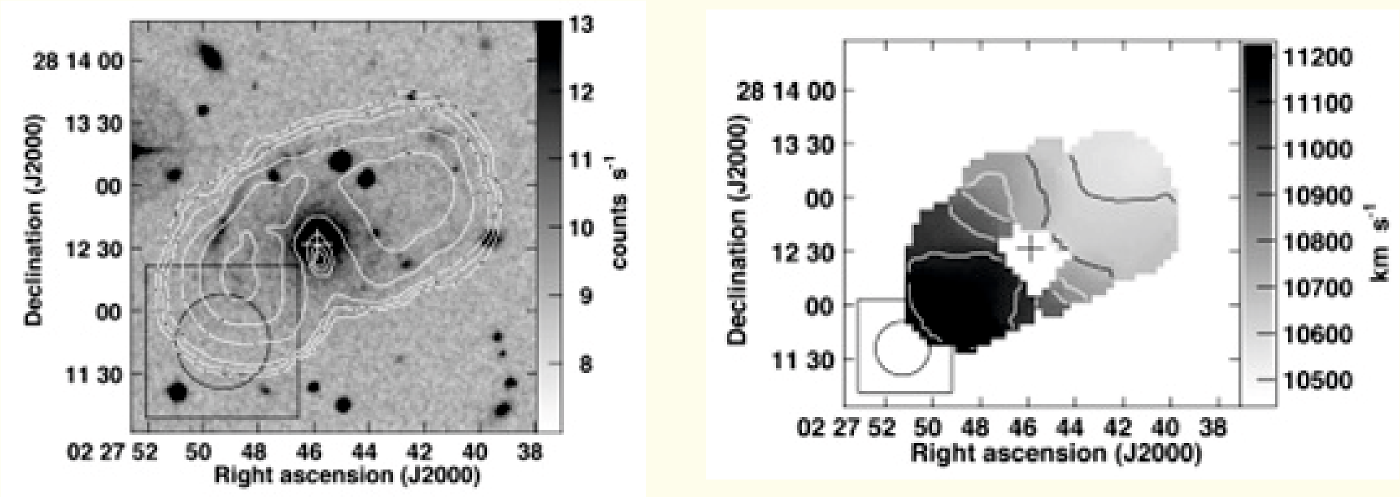


Figure 12. The GMRT HI image (left) and velocity field contours of UGC 1922, one of the fastest rotating spiral galaxies with rotation velocity exceeding 400 km/s.

2. Study of GRB and Supernovae

Explosive and Radio-Selected Transients: Transient Astronomy with Square Kilometre Array and its Precursors

Exploration of the transient Universe is an exciting and fast-emerging area within the radio astronomy. With the wide field-of-view and higher sensitivity of the square kilometer array (SKA), large samples of explosive transients are expected to be discovered. The importance of radio wavelengths in unraveling the complex transient phenomena was discussed because the observations at radio wavelengths may suffer less obscuration than in other bands (e.g. optical/IR or X-rays) due to dust absorption. At the same time, multi waveband information often provides critical source classification rapidly than possible with only radio band data. Therefore, multi waveband observational efforts with wide fields of view will offer unprecedented progress in transient astronomy. The importance of sensitive radio observations of GRB afterglows and supernovae in SKA era were discussed. SKA will uncover not only much fainter bursts and verify claims of sensitivity-limited population versus intrinsically dim GRBs, they will also unravel the enigmatic population of orphan afterglows. The understanding of single degenerate scenario versus double degenerate scenario for thermonuclear supernovae will be greatly enhanced due to the sensitive measurements with SKA because of the accurate mass loss estimates that will be available. In addition, various new kinds of transients are likely to be discovered with SKA. **[**Chandra, P. et. al. (including **Misra, K.**) (2016). *Jr. Astroph. & Astron., 37*: 30.**]**

3. Study of AGN and Quasars

Intranight optical variability of radio-quiet weak emission line quasars

Using 1.3m DFOT a programme to search for radio-quiet BL Lac candidates using intranight optical variability (INOV) was started. The INOV observations of this programme in last year cover a well defined representative set of 10 radio-quiet weak-emission-line quasars (RQWLQs), selected from a newly published sample of 46 such sources, derived from the Sloan Digital Sky Survey (Data release 7). Intranight CCD monitoring of 10 RQWLQs was carried out in 18 sessions lasting at least 3.5 hours. For each session, differential light curves of the target RQWLQ were derived relative to two steady comparison stars monitored simultaneously. Combining these new data with those already published, for 15 RQWLQs monitored in 30 sessions, an INOV duty cycle of 3 per cent for the RQWLQs is estimated, which appears inconsistent with BL Lacs. However, the observed INOV events (which occurred in just two of the sessions) were strong (with a fractional variability amplitude more than 10 per cent), hence blazar-like. The prospects of an

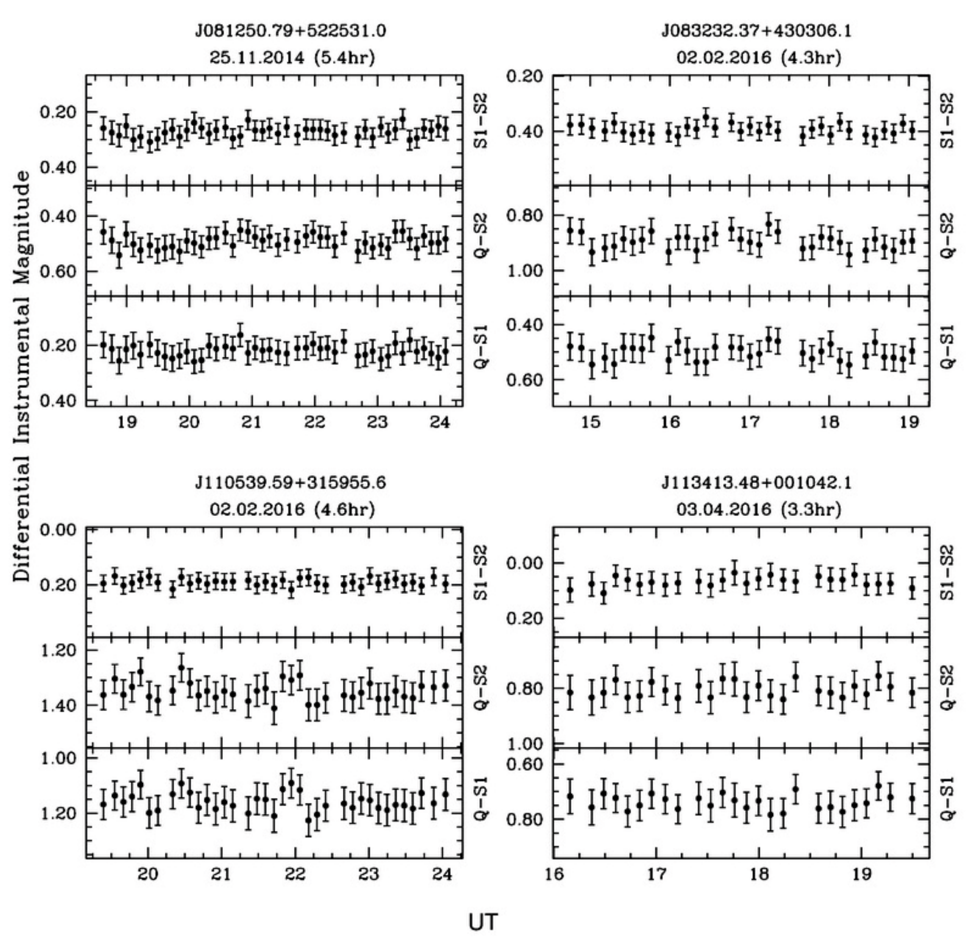


Figure 13. Differential light curves (DLCs) in R-band, for 4 members of a total sample of 10 RQWLQs based on 1.3m DFOT. The name of the RQWLQ along with the date and duration of its monitoring session are given at the top of each panel. In each panel, the upper DLC is derived using the two 'non-varying' comparison stars, while the lower two DLCs are the 'quasar-star' DLCs, as defined in the labels on the right side.

appreciable rise in the estimated INOV duty cycle for RQWLQs with a relatively modest increase in sensitivity for monitoring these rather faint objects was also discussed. [**Kumar, Parveen, Chand, H.** & Gopal-Krishna (2016). *Mon. Not. Roy. Astron. Soc., 461,* 666 - 673.**]**

The origin of UV-optical variability in AGN and test of disc models: *XMM-Newton* and ground-based observations of NGC 4395

The origin of short timescale (weeks/months) variability of AGN, whether due to intrinsic disc variations or reprocessing of X-ray emission by a surrounding accretion disc, has been a puzzle for many years. However, recently a number of observational programmes, particularly of NGC 5548 with *Swift*, have shown that the UV/optical variations lag behind the X-ray variations in a manner strongly supportive of X-ray reprocessing. Somewhat surprisingly, the implied size of the accretion disc is ~3 times greater than expected from a standard, smooth, Shakura-Sunyaev thin disc model. Although the difference may be explained by a clumpy accretion disc, it is not clear whether the difference will occur in all AGN or whether it may change as, e.g., a function of black hole mass, accretion rate, or disc temperature. Measurements of inter-band lags for most AGN require long timescale monitoring, which is hard to arrange. However for low mass (less than 10^6 $M_\odot$) AGN, the combination of *XMM-Newton* EPIC with the optical monitor in fast readout mode allows an X-ray/UV-optical lag to be measured within a single long observation. Using the previous and new observations of NGC 4395 (100 times less massive and accretion rate ~ 20 times lower than NGC 5548) with *XMM-Newton,* it was found that UVW1 lags the X-rays by ~ 470 sec. Simultaneous observations at 6 different ground based observatories (including ARIES DFOT) also allowed the *g*-band lag (~ 800s) to be measured. These observations were in agreement with X-ray reprocessing but initial analysis suggests that, for NGC 4395, they do not differ markedly from the predictions of the standard thin disc model. [McHardy, I. M. et al. (including **Chand, H.**) (2016). *Astron. Nachr., 337,* 500-506.**]**

4. Study of Blazars

Flux and spectral variability of the blazar PKS 2155 -304 with *XMM-Newton*: Evidence of particle acceleration and synchrotron cooling

XMM-Newton observations of the blazar, PKS 2155-304, made on 24 May 2002 in 0.3 - 10 keV X-ray band which display a mini-flare, a nearly constant flux period and a

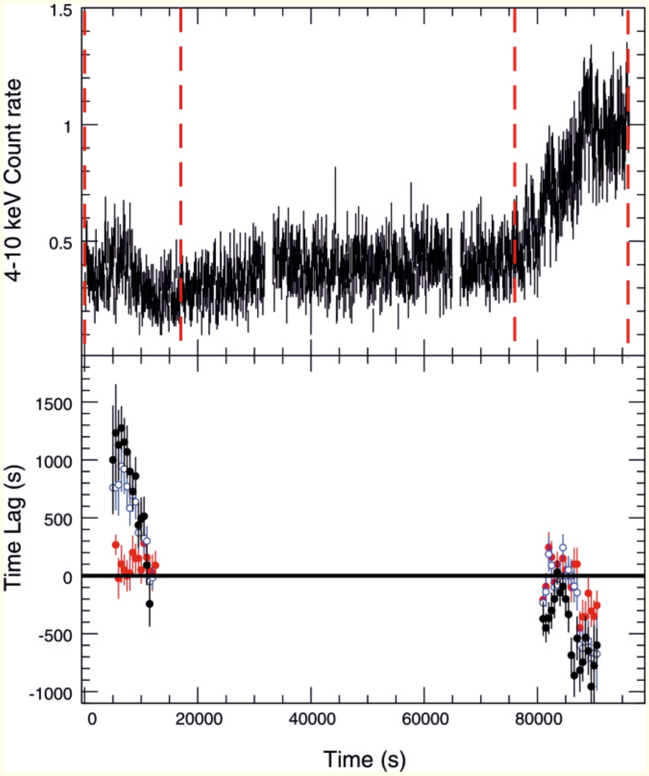


Figure 14. The 4–10 keV band light curve (top panel) together with the temporal variation of the delays between the 0.3–0.5 keV band light curve and the 0.5–2, 2–4 and 4–10 keV band light curves, in the bottom panel (red filled circles, blue open circles and black field circles, respectively).

strong flux increase. A time-resolved spectral study of the data, by dividing the data into eight segments was made. The spectrum was fitted with a power-law and a broken power-law model, and in some of the segments, noticeable spectral flattening below 10 keV was seen. Time-resolved cross-correlation analyses gave significant hard and soft lags (for the first time in a single observation of this source) during the first and last parts of the observation, respectively. Analysis of the spectra, the variations of photon-index with flux as well as the correlation and lags between the harder and softer X-ray bands indicate that both the particle acceleration and synchrotron cooling processes make an important contribution to the emission from this blazar. The hard lags indicate a variable acceleration process. Using soft lags, the magnetic field value was estimated. The value of the magnetic field was consistent with the values derived from the broad-band spectral energy distribution (SED) modeling of this source. **[Bhagwan, J., Gupta, A. C.,** Papadakis, I. E. & Wiita, P. J. (2016). *New Astronomy, 44*, 21-28.**]**

Multiband optical variability of three TeV blazars on diverse time-scales

During 2012–2014, optical photometric observations of three TeV blazars, PKS 1510−089, PG 1553+113, and Mrk 501 were taken using two telescopes in India, one in Bulgaria, one in Greece, and one in Serbia. These observations covered a total of 95 nights with a total of ~ 1500 image frames in *BVRI* filters. Multi-band flux and colour variability studies of these blazars on diverse time-scales were done. Which helps in understanding the emission mechanisms of these blazars. Variability characteristics show all blazars to be active over the period of entire observational campaign. During the times of variability, no significant evidence for the sources to display spectral changes correlated with magnitude was found on time-scales of a few months. Briefly the possible physical mechanisms most likely responsible for the observed flux variability are discussed. **[Gupta, A. C.,** et al. (including **Agarwal, A.** & **Bhagwan, J.**) (2016). *Mon. Not. Roy. Astron. Soc., 458,* 1127-1137.**]**

Peak of spectral energy distribution plays an important role in intra-day variability of blazars?

Blazars can be divided into two sub-classes namely high energy and low energy peaked blazars. In spectral energy distribution, the first synchrotron hump of the former class peaks in UV/ X-rays and in IR/optical bands for the latter class. The peak of the spectral energy distribution seems to be responsible for variability properties of these classes of blazars in X-ray and optical bands. Since, in low energy peaked blazars, the X-ray bands lie well below the synchrotron hump, one expects that the highest energy electrons available for the synchrotron emission would have slower effect of variability on X-ray intra-day time-scale. By taking a sample of 12 low energy peaked blazars with total 50 observations from *XMM–Newton* since its launch, it was confirmed that this class is less variable in X-ray bands. It was found that out of 50 observational light curves, genuine intra-day variability was present in only two of light curves i.e 4%. Similar results have been obtained from earlier optical intra-day variability studies of high energy peaked blazars where out of 144 light curves, only genuine intra-day variability was detected in 6 light curves i.e ~4%. Since, X-ray bands lie below the peak of the spectral energy distribution of LSPs where inverse Compton mechanism is dominating rather than synchrotron radiation at the peak of the optical band, leads to slower variability in the X-ray bands. Hence, it reduces their intra-day variability in X-ray bands as compared to the variability in optical bands. **[Gupta, A. C., Kalita, N.,** Gaur, H. & Duorah, K. (2016). *Mon. Not. Roy. Astron. Soc., 462,* 1508-1516.**]**

Multiwavelength temporal variability of the blazar 3C 454.3 during 2014 activity phase

A multi-wavelength temporal analysis of the blazar 3C 454.3 during the high γ-ray active period from May to December, 2014 was done. Except for X-rays, the period is well sampled at near-infrared (NIR)–optical by the Small and Moderate Aperture Research Telescope System (SMARTS) facility, and the source is detected continuously on a daily time-scale in the *Fermi* Large Area Telescope (LAT) γ-ray band. The source exhibits diverse levels of variability with many flaring/active states in the continuously sampled γ-ray light curve which were also reflected in the NIR–optical light curves and the sparsely sampled X-ray light curve by the *Swift*-XRT. Multiband correlation analysis of this continuous segment during different activity periods shows a change of state from no lags between IR and γ-ray, optical and γ-ray, and IR and optical to a state where γ-ray lags the IR/optical by ~3 days. The results are consistent with the previous studies of the same during various γ-ray flaring and active episodes of the source. This consistency, in turn, suggests an extended localized emission region with almost similar conditions during various γ-ray activity states. On the other hand, the delay of γ-ray with respect to IR/optical and a trend similar to IR/optical in X-rays along with strong broadband correlations favour magnetic field related origin with X-ray and γ -ray being inverse Comptonization of IR/optical photons and external radiation field, respectively. [Kushwaha, P., **Gupta, A. C.,** Misra, R. & Singh, K. P. (2017). *Mon. Not. Roy. Astron. Soc., 464,* 2046-2052.]

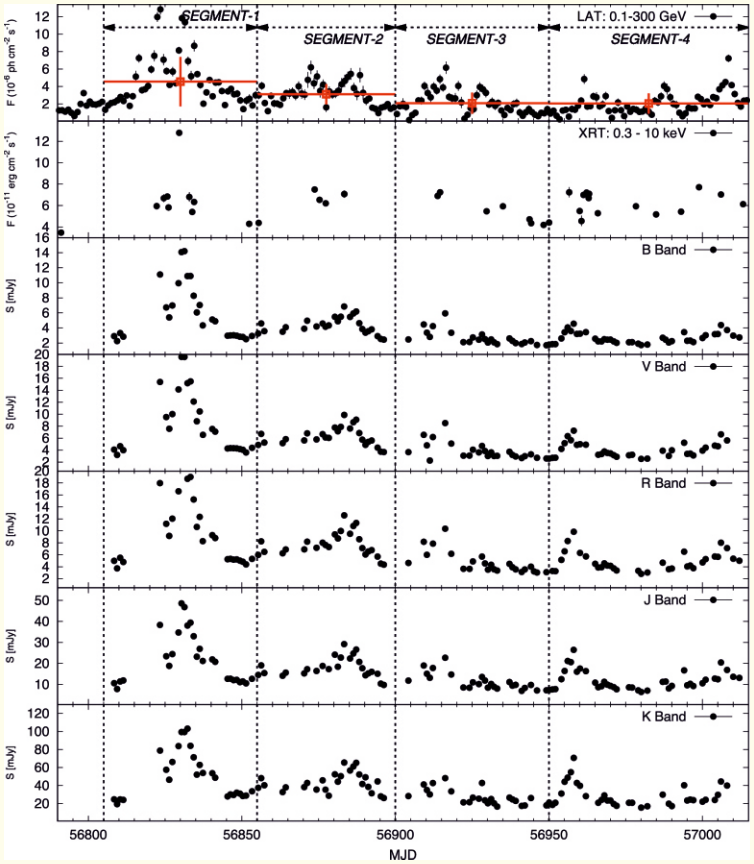


Figure 15. Multiwavelength light curves of 3C 454.3 from γ-rays to IR–Optical during a high γ-ray activity period from 2014 May 13–December 24. The LAT light curve is extracted on daily time-scale with X-ray from the publicly available data and NIR–optical from SMARTS follow up. The vertical lines demarcate the segments considered for temporal analyses in this work, whereas the red point represent the respective mean with intrinsic variance as its error.

Multiband optical variability of the blazar OJ 287 during its outbursts in 2015-2016

OJ 287 is a blazar which is believed to have binary black hole system and show double peak optical outburst on ~12 years. To detect the outburst, intense optical photometric observations of the blazar OJ 287 were taken during 2015 September–2016 May. The blazar started large optical outburst in mid November 2015 which reached to the brightest level on 5 December 2015. For the observing campaign, a total of nine ground-based optical telescopes located in different parts of the world were used. These observations were carried out in 102 nights with a total of ~1000 image frames in *BVRI* bands, though the majority were in the *R* band. A second comparably strong flare was detected in 2016 March. In addition, multiband flux variations, colour variations, and spectral changes in the blazar on diverse time-scales which are useful in understanding the emission mechanisms were also investigated. The possible physical mechanisms most likely responsible for the observed flux, colour, and spectral variability were discussed. **[Gupta, A. C.** et. al. (including **Agarwal, A., Mishra, Alka,** and **Pandey, Ashwani**) (2017). *Mon. Not. Roy. Astron. Soc., 465,* 4423-4433.**]**

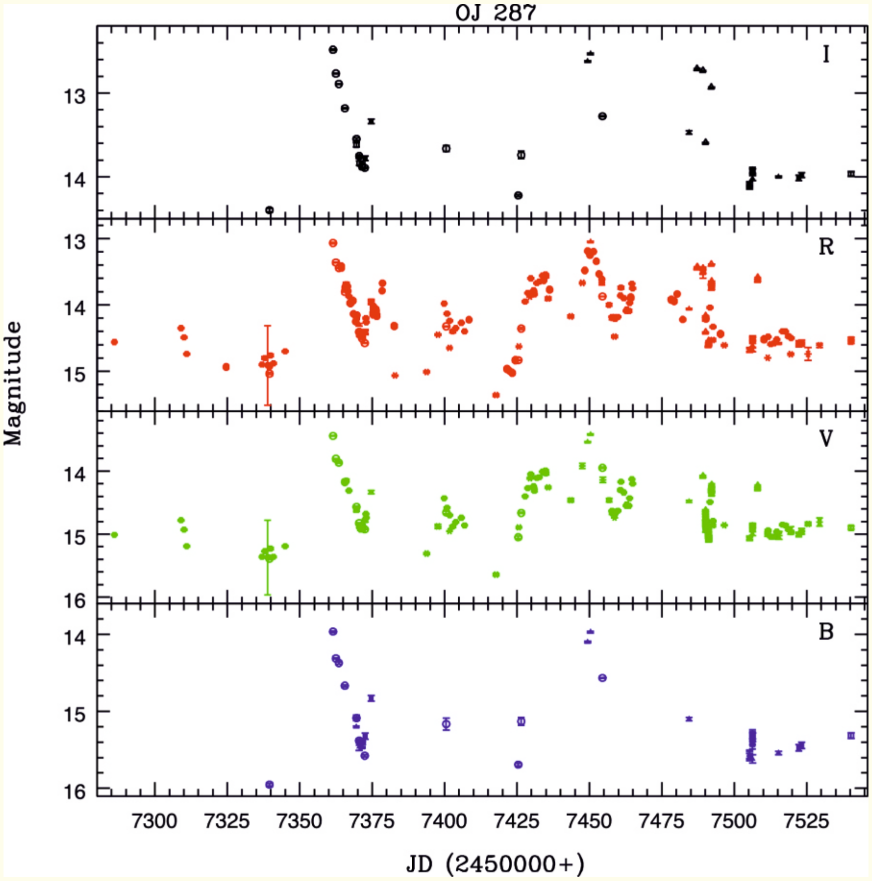


Figure 16. Optical-variability of OJ 287. Filled hexagon represents data from Arizona telescopes (A); open triangle for the data from 1.04m India telescope (B); open and filled square for the data from 2m (C) and 50/70cm (D) telescopes, Rozen, Bulgaria, respectively; filled triangle for the data from 60cm (E) telescope, Belogradchik, Bulgaria; open circle for the data from 60cm (F) telescope, Serbia; filled circle for the data from 70cm (G) telescope, Georgia; and asterisk for the data from 1.5m (H) telescope, Kanata, Japan.

5. Theoretical and Numerical Studies

Theoretical and numerical investigations of accretion-ejection flows around black holes

Two-dimensional numerical simulation of matter flow around black holes in pseudo-Newtonian limit, has been conducted with a novel Lagrangian-TVD code (LTVD). The computational domain was 400rg in radial direction and 200 rg in the axial direction. The input, or injection parameters were chosen from an earlier steady state analytical paper (Kumar & Chattopadhyay). One set of parameters predicted accretion shock and the other predicted smooth solution. As the simulation code

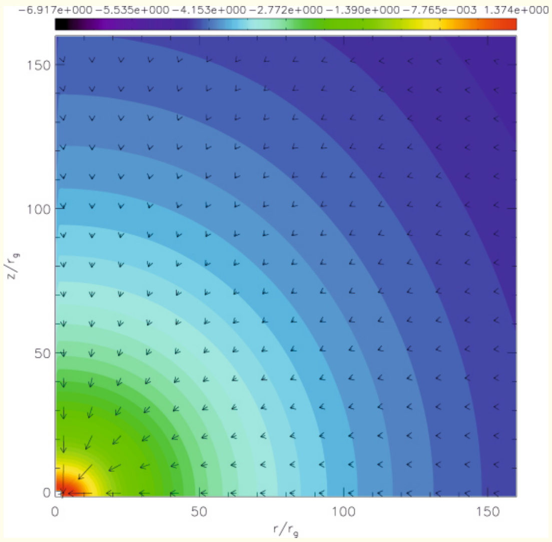


Figure 17. Density contours and velocity fields of a shock-free viscous disk for α = 0.05.

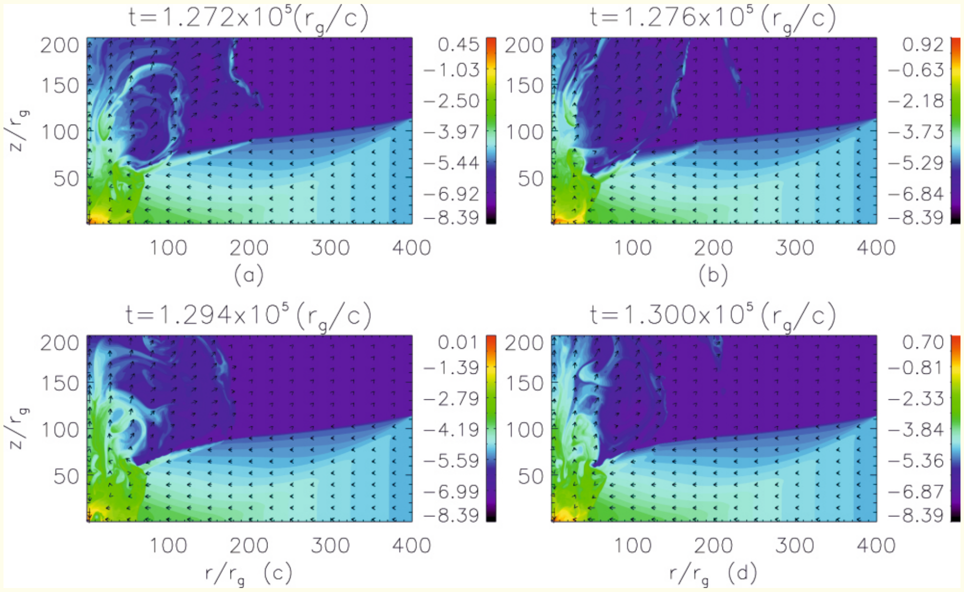


Figure 18. Contours of density and velocity vectors of an accretion disk and its jet. The various time snaps are at t = 1.272 × 10^5, 1.276 × 10^5, 1.294 x 10^5, and 1.3 × 10^5. The viscosity parameter α is 0.3.

reached steady state, the simulation results, for given injection parameters and viscosity parameter (α), were excellent match of the analytical results. Having regenerated the analytical steady state solution, the viscosity parameter was increased, but the flow injection paramters were kept the same. Beyond some critical limit of viscosity paramter, the solutions became time dependent. It was shown that shock-free accretion flows do not produce either jet like features, nor quasi periodic oscillations (QPO). Shocked accretion flows showed bipolar jets and the oscillating post-shock disc (PSD) powered the quasi-steady jets to achieve moderately relativistic terminal speed (>20 % of the speed of light). The quasi-periodic oscillation of the PSD also produced QPO in hard photons, that were generated by the PSD. When the PSD underwent regular oscillation, the power density spectrum of radiation produced sharp peaks with high Q factor, while irregular oscillations produced peaks with low Q factor. This is exactly seen in observations as C-type, B-type or A-type low frequency QPOs in blackhole microquasars. **[**Lee, S. J., **Chattopadhyay, I., Kumar, R.,** Hyung, S. and Ryu, D. (2016). *Astrophy. Jr., 831*:33 (22pp).**]**

Viscous solutions in general relativity is highly non-trivial. Moreover, studying jet-generation from general relativistic accretion disc around black holes are even harder. This ardous was taken up, albeit around the simplest black hole, i. e.,

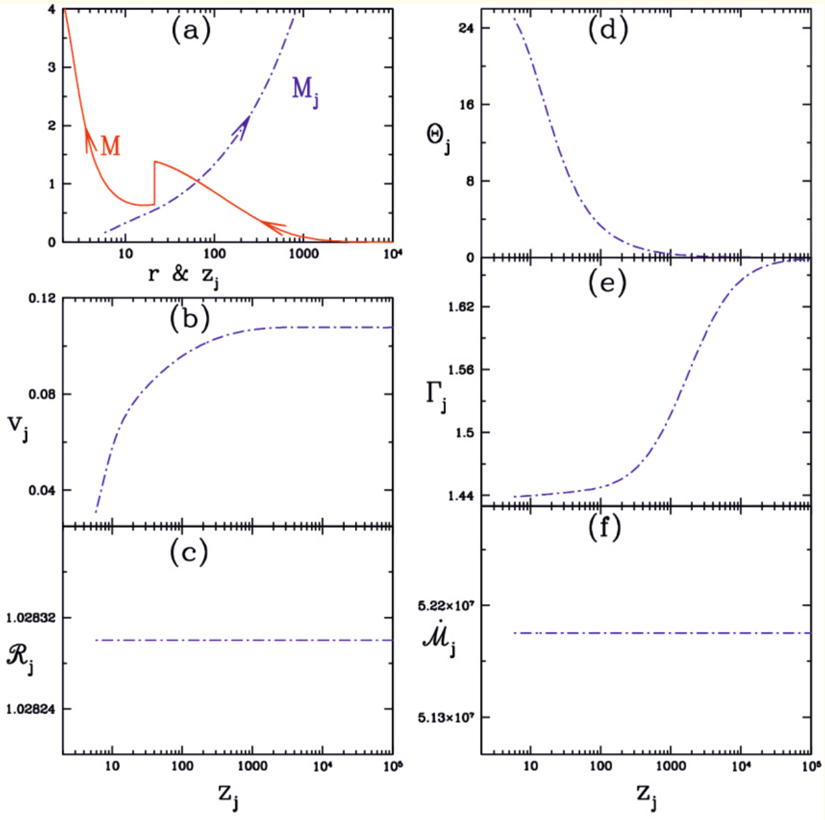


Figure 19. (a) Accretion Mach number M (solid) is plotted w.r.t. *r* and jet Mach number Mj (dash–dotted) is plotted w.r.t. zj; (b) variation of jet three-velocity v_j; (c) jet Bernoulli parameter $\Re_j$; (d) jet dimensionless temperature Θ_j; (e) jet adiabatic index Γ_j and (f) jet entropy $\dot{M}_j$ all are plotted w.r.t. z_j. Accretion disc parameters are $E = 1.001$, $L_0 = 2.906$, $\alpha = 0.01$. The disc and jet flow composition is described by $\xi = 1.0$ and relative mass outflow rate is $R_{\dot{m}}$=0.053.

a Schwarzschild black hole. A relativistic equation of state was used to describe the fluid which constitutes the accretion disc and jet. The jet streamline was computed by obtaining the von-Zeipel surfaces (VZS). The foot point of the jet streamline i.e. VZS was computed from the disc parameters. Solving the accretion and jet equation of motions simultaneously, a self-consistent accretion-ejection solution in general relativity was obtained. It was shown that the accretion shock moves closer to the horizon, for discs starting with same outer boundary but for increasing viscosity parameter. It was found that the jet is stronger in general relativistic description than in pseudo-Newtonian description. **[Chattopadhyay, I.** and **Kumar, Rajiv** (2016). *Mon. Not. Roy. Astron. Soc., 459,* 3792-3811.**]**

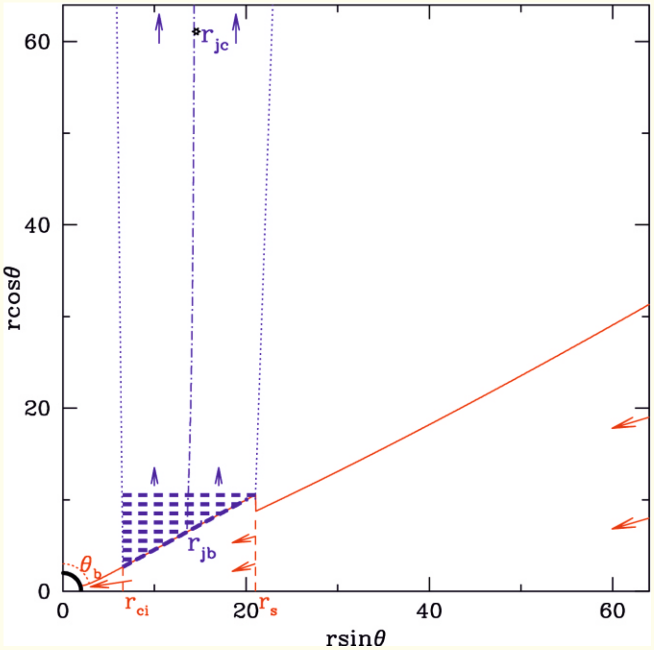


Figure 20. Typical accretion-jet flow geometry for accretion disc parameters $E = 1.0001$, $L_0 = 2.92$, $\alpha = 0.01$ and $\xi = 1$. Here solid (red) curve represents disc-half height. Dot–dashed (blue) line is jet streamline for von Zeipel parameter $Z\phi = 13.28$, and dotted line is the inner and outer boundary of jet flow cross-section. The jet sonic point is located at r_{jc}. Arrows represent direction of bulk motion and the solid thick quarter of a circle represents the event horizon.

Research Working Group – II

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

Solar Physics

Peculiar stationary EUV wave fronts in the eruption on 2011 May 11

As the two largest eruptive phenomena in a solar atmosphere, both solar flares and coronal mass ejections (CMEs) are frequently associated with erupting filaments, which later become the core of the CMEs. A detailed study of the extreme ultraviolet (EUV) waves associated with a filament eruption on 2011 May 11 has been done. The filament eruption also produces a small B-class two ribbon flare and a CME. The event was observed by the Solar Dynamic Observatory (SDO) with high spatio-temporal resolution data recorded by the Atmospheric Imaging Assembly (AIA). As the filament erupts, the two types of EUV waves (slow and fast) propagating outwards were observed. The faster EUV wave has a propagation velocity of ~500 km s^{-1} and the slower EUV wave has an initial velocity of ~120 km s^{-1} . It was reported, for the first time, that not only does the slower EUV wave stop at a magnetic separatrix to form bright stationary fronts, but also the faster EUV wave transits a magnetic separatrix, leaving another stationary EUV front behind. **[**Chandra, R., Chen, P. F., Fulara, A., Srivastava, A. K., & **Uddin, W.** (2016). *Astrophy. Jr., 822,* 106 (8pp).**]**

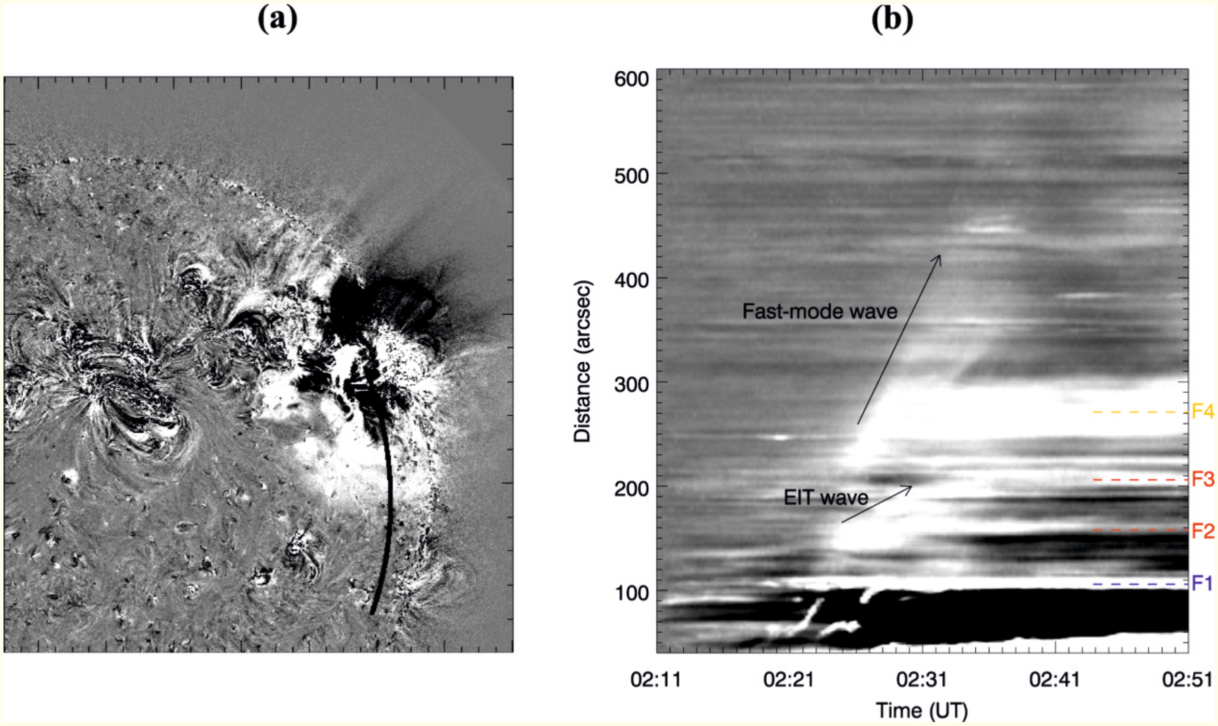


Figure 21. (a) The SDO/193 Å (02:11:07 UT) difference image showing a slice (black line) to be used in the time–distance diagram. (b) Time–distance diagram showing two types of EUV waves and several stationary fronts, F1, F2, F3, and F4. The fast-mode MHD wave and the slowly moving EIT wave are marked by the arrows.

Interaction of two filament channels of different chiralities

Another data has been taken from SDO/AIA observations which show the interactions between the two filament channels of different chiralities and associated dynamics that occurred during 18-20 April 2014. While two flux ropes of different helicity with parallel axial magnetic fields can only undergo a bounce interaction when they are brought together, the observations at first glance show that the heated plasma was moving from one filament channel to the other. The SDO/AIA 171 Å observations and the potential-field source-surface magnetic field extrapolation reveal the presence of a fan-spine magnetic configuration over the filament channels with a null point located above them. Three different events of filament activations, partial eruptions, and associated filament channel interactions have been observed. The activation initiated in one filament channel seems to propagate along the neighboring filament channel. It is believed that the activation and partial eruption of the filaments brings the field lines of flux ropes containing them closer to the null point and triggers the magnetic reconnection between them and the fan-spine magnetic configuration. As a result, the hot plasma moves along the outer spine line toward the remote point.

The most interesting aspect of these events is the geometry of the spine line of the coronal fan-spine structure. In projection on the solar disk, the spine line runs nearly parallel to the SF axis, or close to it. The remote point, where the outer spine line is anchored in the photosphere, is located near the western end of the SF. It leads to the wrong impression that plasma from one filament channel easily penetrates to the other filament

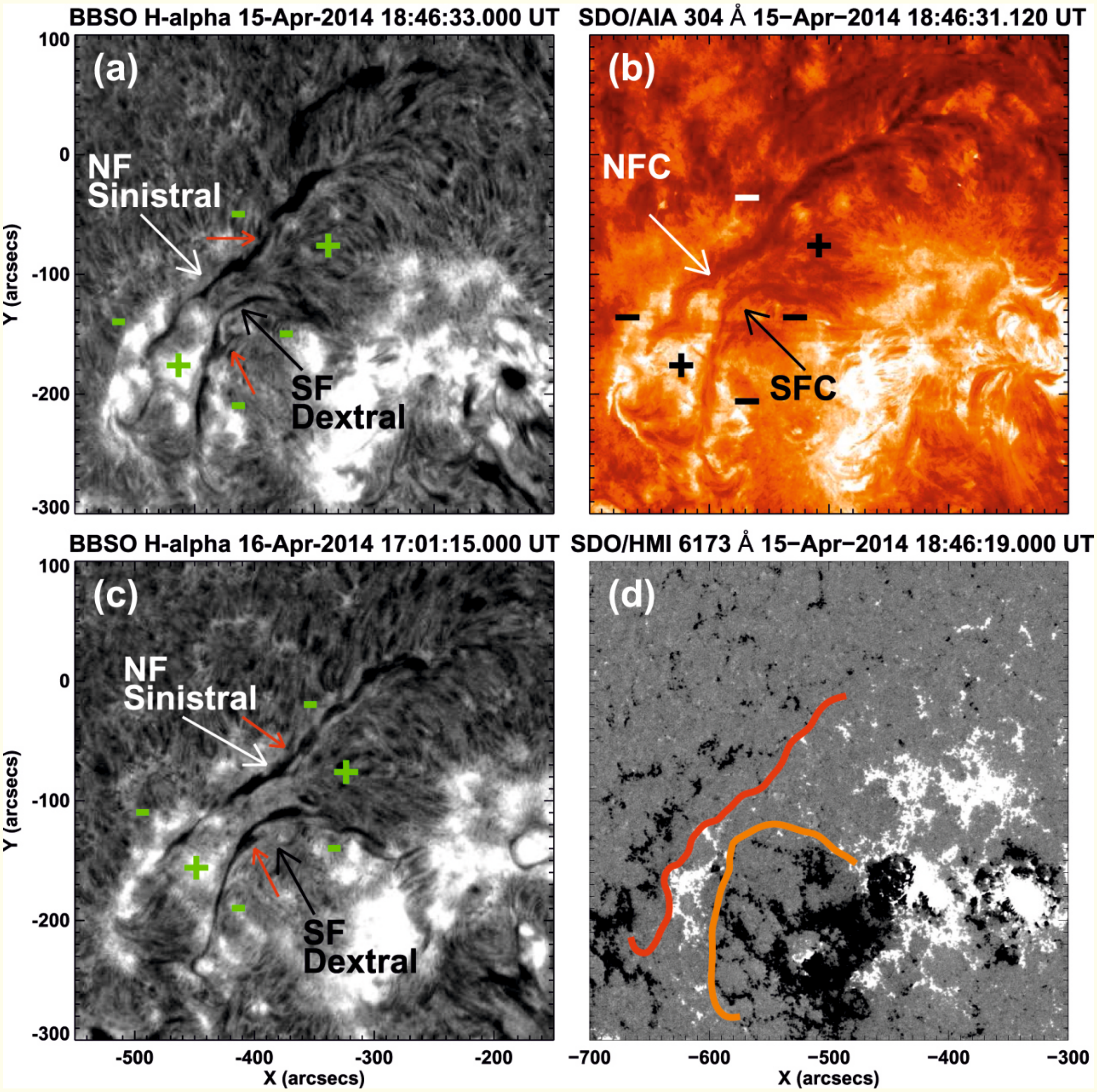


Figure 22. Big Bear Solar Observatory (BBSO) Hα images at ~18:46 on 2014 April 15 (a) and ~17:01 UT on 2014 April 16 (c), showing the presence of the northern (NF) and southern (SF) filaments. (b) SDO/AIA 304 Å images at ~18:46 UT on 2014 April 15. The northern filament channel (NFC) and southern filament channel (SFC) are shown in panel (b). The SDO/HMI line of sight magnetogram (d) with overplotted filament spines shown by red (NF) and orange (SF) colors. The filament spines are tracked from the Hα image shown in panel (a).

channel with the opposite chirality. In fact, the filament plasma penetrates into the coronal structure and propagates along the coronal field lines, which were located above the SF axis. It is strongly believe that the activations and partial eruptions of both filaments were responsible for the reconnection at the magnetic null.

Plasma of the filaments then moves along the spine line to the remote footpoint, which lies near the western end of the SF. **[**Joshi, N. C., Filippov, B., Schmieder, B., Magara, T., Moon, Y. & **Uddin, W.** (2016). *Astrophy. Jr., 825,* 123 (16pp).**]**

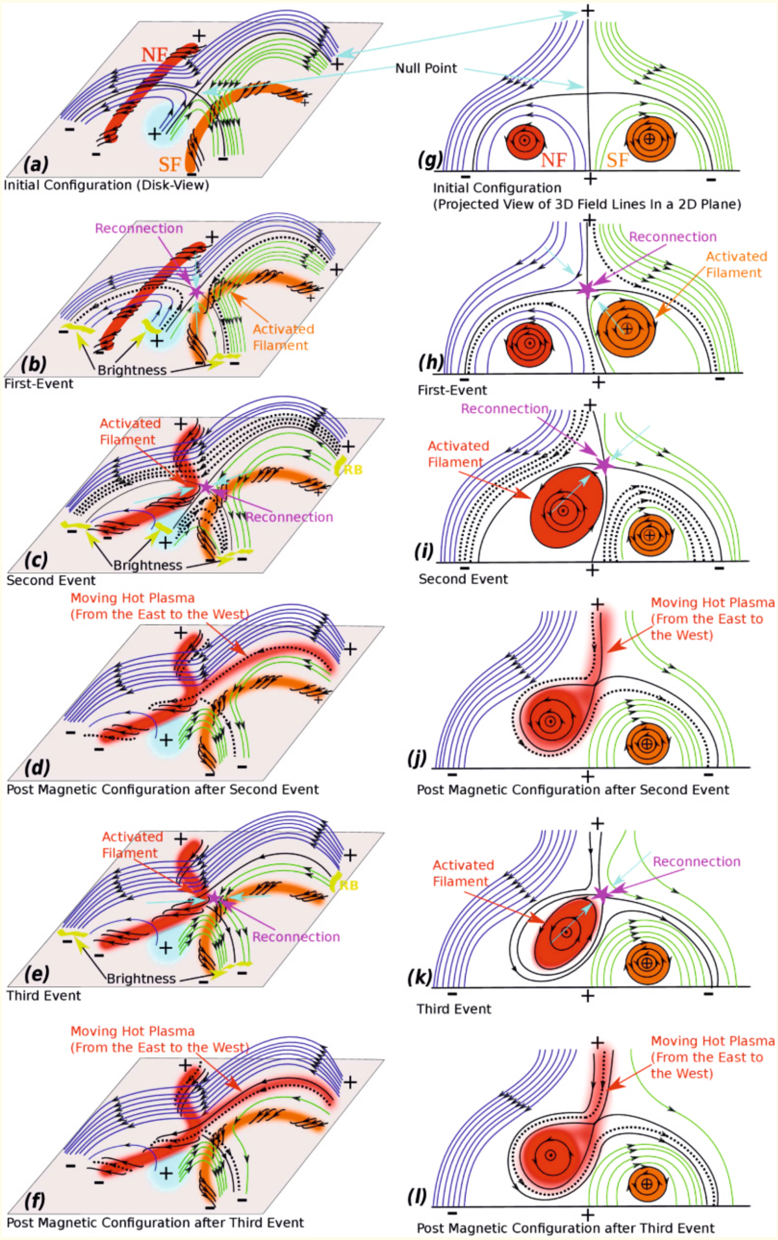


Figure 23. Schematic representation of the change in the magnetic configuration and the reconnection scenario in the 3D disk view (left column) and projected view of 3D field lines in a 2D plane (right column). The northern (NF) and southern (SF) filaments are shown by the red and orange colors, respectively. Reconnection regions are marked by the pink star, while the reconnected field lines are shown by the dotted black lines. The blue overlying arcades over the NF in panels (c) – (f) are not in the plane of reconnection.

Investigation of recurrent EUV jets from highly dynamic magnetic field region

The observations and interpretations of recurrent EUV jets that occurred between 2012 July 1 21:00 UT and 2012 July 2 10:00 UT from the western edge of the NOAA active region 11513. SDO/AIA, SDO/Helioseismic and Magnetic Imager (SDO/HMI) and Reuven Ramaty High Energy Solar Spectroscopic Imager (RHESSI) observations have been used for the present study. Observations as well as potential-field source-surface (PFSS) extrapolation suggest an open field configuration in the vicinity of the jet activity area. 18 EUV jets were observed from the western edge of the active region along the open field channel. All the jet events appeared to be non-homologous and show different morphological properties and evolution. Some of the jets were small and narrow in size while the others were huge and wide. The average speed of these jets ranges from ~ 47 to ~ 308 km s^{-1}. SDO/AIA 171 Å intensity profiles at the base of these jets show bumps corresponding to each jet, which was an evidence of recurrent magnetic reconnections. The magnetic field observation at the foot points of the jets revealed a very complex and dynamic magnetic activity which includes flux emergence, flux cancellation, dynamic motions, merging, separation, etc. It was suggested that the recurrent jets result due to recurrent magnetic reconnections among the various emerging bipolar fields themselves as well as with the open fields. [Joshi, N. C., et al. (including **Uddin, W.**) (2017). *Astrphys. Space Sci., 362*:10 (1-14pp).]

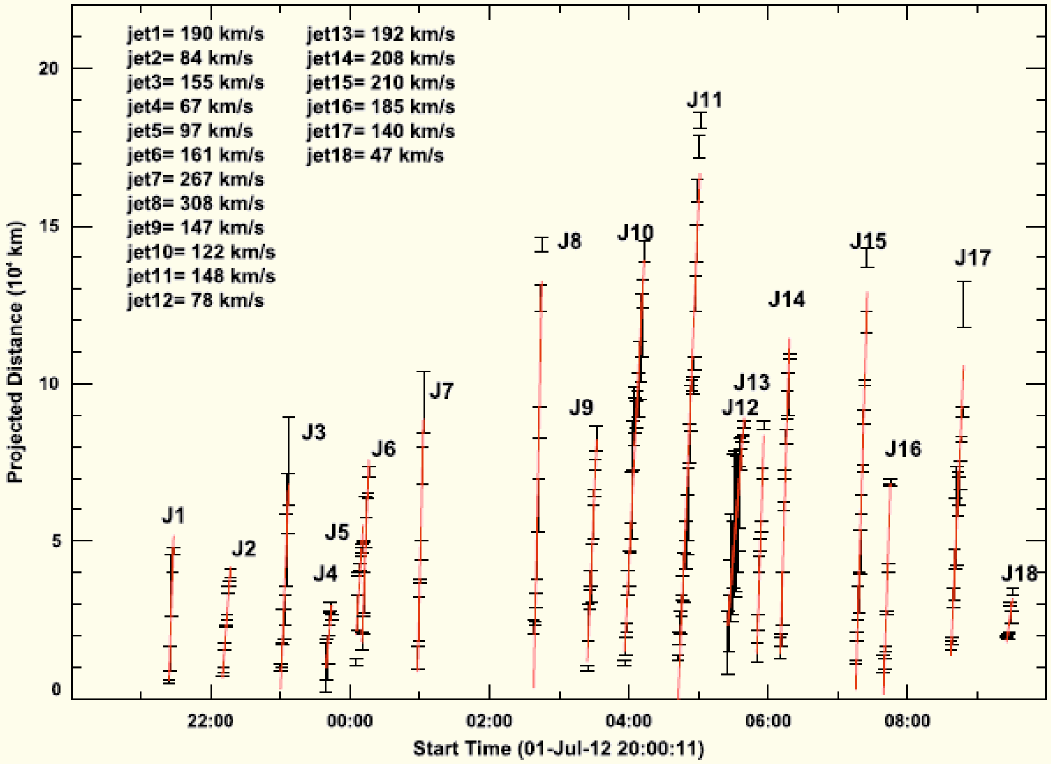


Figure 24. Projected height–time profiles of all the jets. Each height–time profile is marked with the letter 'J' followed by the jet number. SDO/AIA 171 Å images are used for these measurements. The dotted symbols show the height data points of jets, while the straight lines represent the linear fit to these data points. The error bars are also represented which show the standard deviation of the three repeated height measurements. The speeds are also represented in the figure for all the jets.

Blowout jets and impulsive eruptive flares in a blad-patch topology

A subclass of broad EUV and X-ray jets, called blowout jets, have become a topic of research since it could be the link between standard collimated jets and CMEs. It is observed that the origin of a series of broad jets, some of which are accompanied by flares and associated with narrow and jet-like CMEs. The data was analyzed in order to observe a series of recurrent broad jets observed in AR 10484 on 21–24 October 2003. In particular, one of them occurred simultaneously with an M2.4 flare on 23 October at 02:41 UT (SOLA2003-10-23). Both events were observed by the ARIES Hα Solar Tower-Telescope, TRACE, SOHO, and RHESSI instruments. The flare was very impulsive and followed by a narrow CME. A local force-free model of AR 10484 is the basis to compute its topology. The blad patches (BPs) has been observed at the flare site. This BP topology was present for at least two days before to events. Large-scale field lines, associated with the BPs, represent open loops. This was confirmed by a global potential free source surface (PFSS) model. Following the brightest leading edge of the Hα and EUV jet emission. It is temporarily associate these emissions with a narrow CME. Considering their characteristics, the observed broad jets appear to be of the blowout class. As the most plausible scenario, it was proposed that magnetic reconnection could occur at the BP separatrices forced by the destabilization of a continuously reformed flux rope underlying them. The reconnection process could bring the cool flux-rope material into the reconnected open field lines driving the series of recurrent blowout jets and accompanying CMEs. Based on a model of the coronal field, AR 10484 topology was computed at the location where flaring and blowout jets occurred from 21 to 24 October 2003. This topology can consistently explain the origin of these events.

To compare ejective aspects during two solar rotations of two distinct solar minima, a broad criterion to consider all kinds of white-light coronal ejecta, from thin collimated jets to bright and wide CMEs, going through narrow and

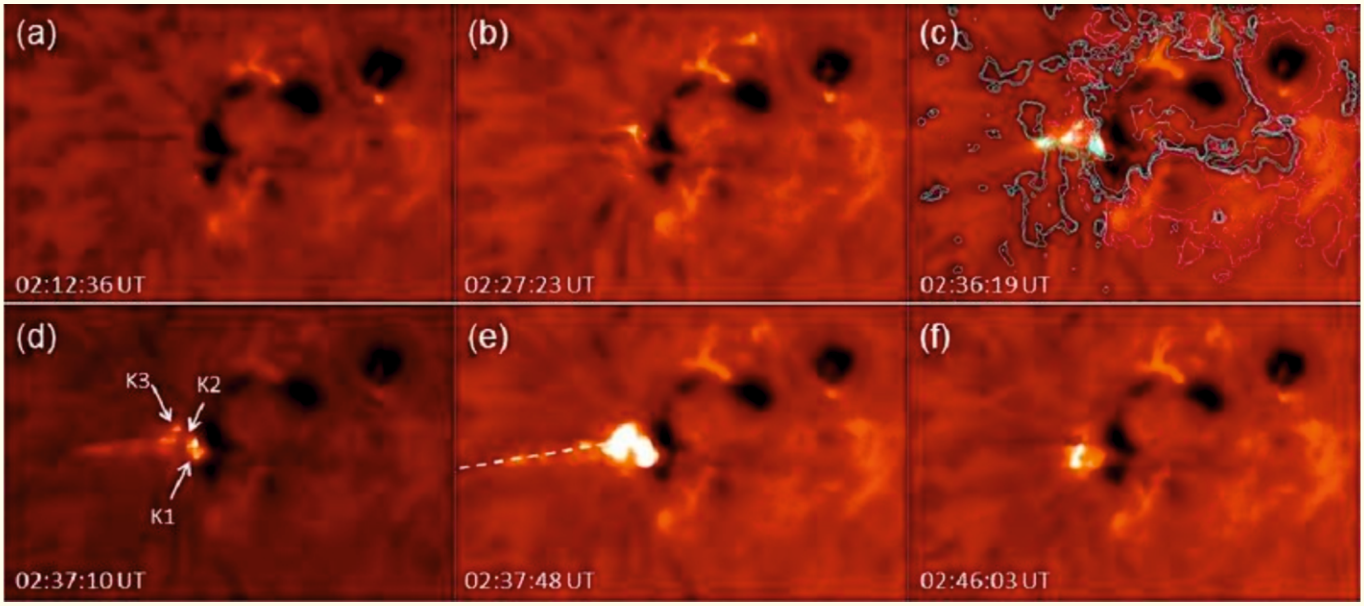


Figure 25. Evolution of the flare in Hα. Three magnetic field contours (c) in a continuous magenta (cyan) line for positive (negative) field. The three brightest kernels were labeled as K1, K2, and K3 in panel (d). The white dashed line in panel (e) indicates the direction along which the height-time measurements are performed.

faint ejecta. It is concluded that a continuum of events may exist between standard collimated jets and CMEs. Furthermore, this study clearly confirms the magnetic topologies containing BPs can also produce jets leading the ejected plasma into the open field. Precisely, these results should motivate the development of jet models including broader topologies than the classical topology based on the presence of magnetic null points. [Chandra, R. et al. (including **Uddin, W.**) (2017). *Astron. & Astroph., 598,* A41.]

Atmospheric Science

Lower Atmospheric Dynamics and Boundary Layer Studies

Time-evolution of the Local Boundary Layer (LBL) is investigated for the first time over a mountain ridge at Nainital using a Radar Wind Profiler during November 2011 to March 2012, as a part of the Ganges Valley Aerosol Experiment (GVAX). The daytime average (0500-1000 UTC) observed boundary layer height ranges from 440±197 m in November (late autumn) to 766±317 m above ground level (AGL) in March (early spring). The observations revealed a pronounced impact of mountain-topography on the LBL dynamics during March, when strong winds (> 5.6 m s^{-1}) lead to LBL heights of 650 m during nighttime. The measurements were further utilized to evaluate simulations from the Weather Research and Forecasting (WRF) model. WRF simulations captured the day-to-day variations up to an extent (r^2 = 0.5), as well as the mean diurnal variations (within 1-sigma variability). The mean biases in the daytime average LBL height vary from -7% (January) to +30% (February) between model and observations, except during March (+76%). Sensitivity simulations using a Mixed Layer model (MXL/MESSy) indicated that the springtime over estimation of LBL would lead to a minor uncertainty in simulated surface ozone concentrations. However, it would lead to a significant over estimation of the dilution of black carbon aerosols at this site. This work fills a gap in observations of local boundary layer over this complex terrain in the Himalayas, and highlights the need for year long

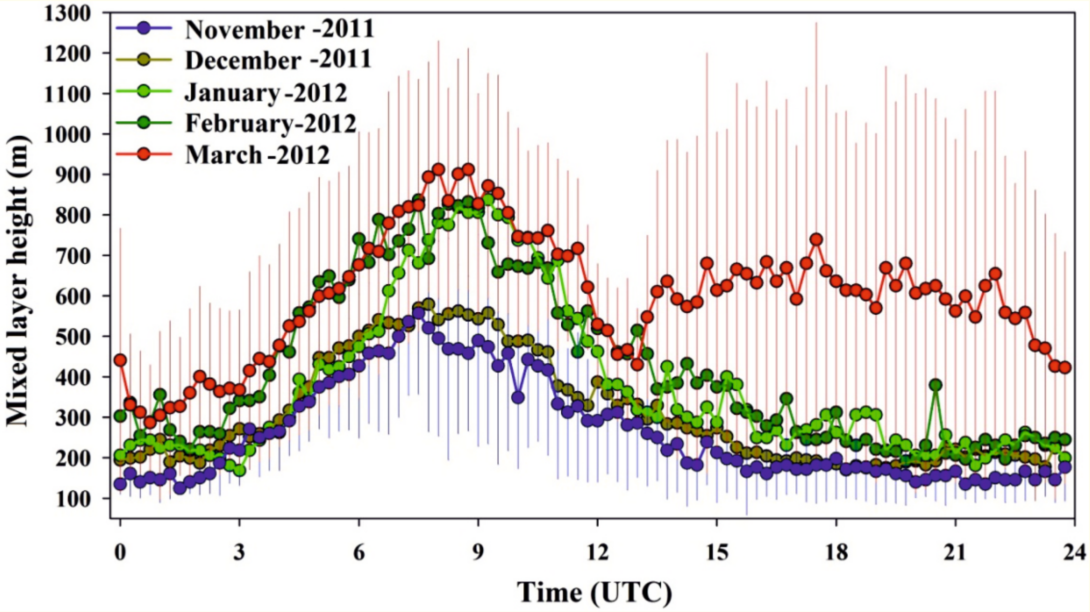


Figure 26. Monthly averaged mixed layer height determined from 15 min averaged SNR profiles, measured with RWP. For the sake of clarity, variability is only shown for November and March months.

simultaneous measurements of boundary layer dynamics and air quality to better understand the role of lower tropospheric dynamics in pollution transport. [**Singh, N.** et al. (including **Solanki, R.**)(2016). *Atmos. Chem. Phy., 16,* 10559-10572.**]**

Variations in the Cloud-base height over the central Himalayas

This study presents the measurements of cloud-base height variations over ARIES, Nainital (79.45°E, 29.37°N, 1958 m amsl) obtained from Vaisala Ceilometer, during the nearly yearlong Ganges Valley Aerosol Experiment (GVAX). The cloud-base measurements were analyzed in conjunction with collocated measurements of rainfall, in order to investigate the possible contributions from different cloud types, to the observed monsoonal rainfall during June to September 2011. The summer-monsoon of the year 2011 was a normal monsoon year with total accumulated rainfall of 1035.8 mm during June-September 2011 with a maximum in the month of July (367.0 mm) and minimum during September (222.3 mm). The first cloud-base height varied from about 31 m above ground level (AGL) to a maximum of 7.6 km AGL during the summer-monsoon period of 2011. It was found that about 70% of the total rain was observed only when the first cloud-base height varies between surface and 2 km AGL, indicating that most of the rainfall at high altitude stations such as Nainital was associated with stratiform low-level clouds. However, about 25% of the total rain fall was being contributed by clouds between 2 and 6 km. The percentage occurrences of high-altitude cumulus clouds were observed to be only 2 - 4%. This study is an attempt to fill a major gap of measurements over the topographically-complex and observationally-sparse northern Indian region providing the evaluation data for atmospheric models and therefore, have implications towards the better predictions of monsoon rainfall and the weather components over this region. **[Singh, N.** et al. (including **Solanki, R., Naja, M., Dumka, U. C., Phanikumar, D. V. & Sagar, R.**) (2016). *Current Science, 111*, 109-116.**]**

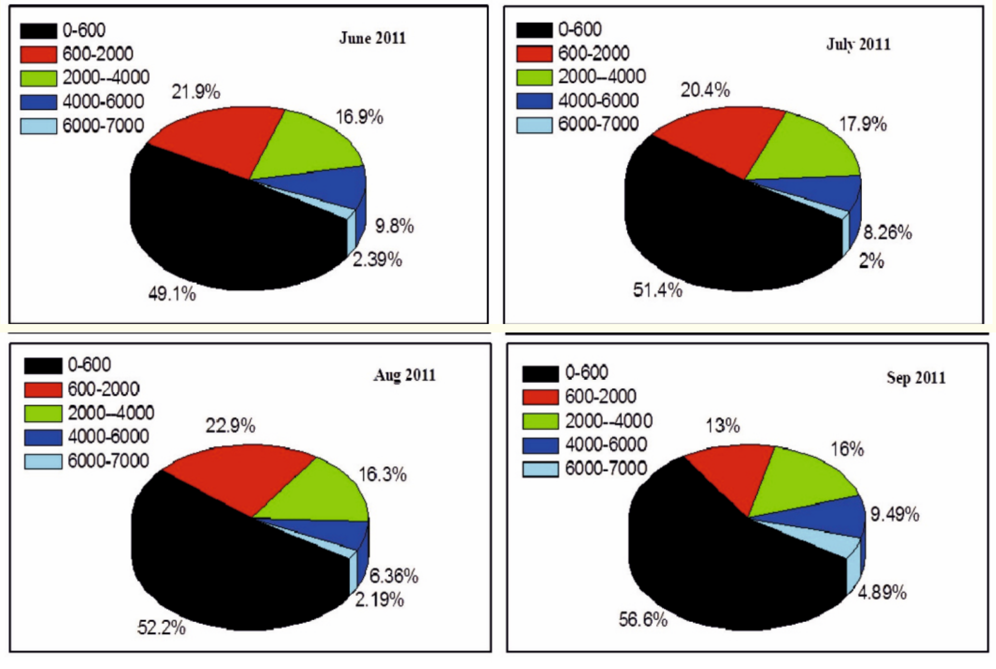


Figure 27. Percentage occurrences of the cloud types based on the cloud height measurements during summer monsoon months of 2011.

Doppler Lidar observations over a high altitude mountainous site Manora Peak in the central Himalayan region

Preliminary results of the observations and data analysis of the Doppler Lidar, installed at Nainital were presented. Strong updrafts with vertical winds in the range of ~2–4 ms^{-1} occurred during the daytime and throughout the season indicating thermally driven convection. On the other hand during nighttime, weak downdrafts persisted during stable conditions. Plan Position Indicator scan of Doppler Lidar showed north-northwesterly winds in the boundary layer. The mixing layer height, derived from the vertical velocity variance, showed diurnal variations, in the range ~0.7–1 km above ground level during daytime and very shallow during night-time. [**Phanikumar, D. V.** et al. (including **Shukla, K. K., Naja, M., Singh, N. & Sagar, R.**) (2016).*Current Science, 111,* 101-108.]

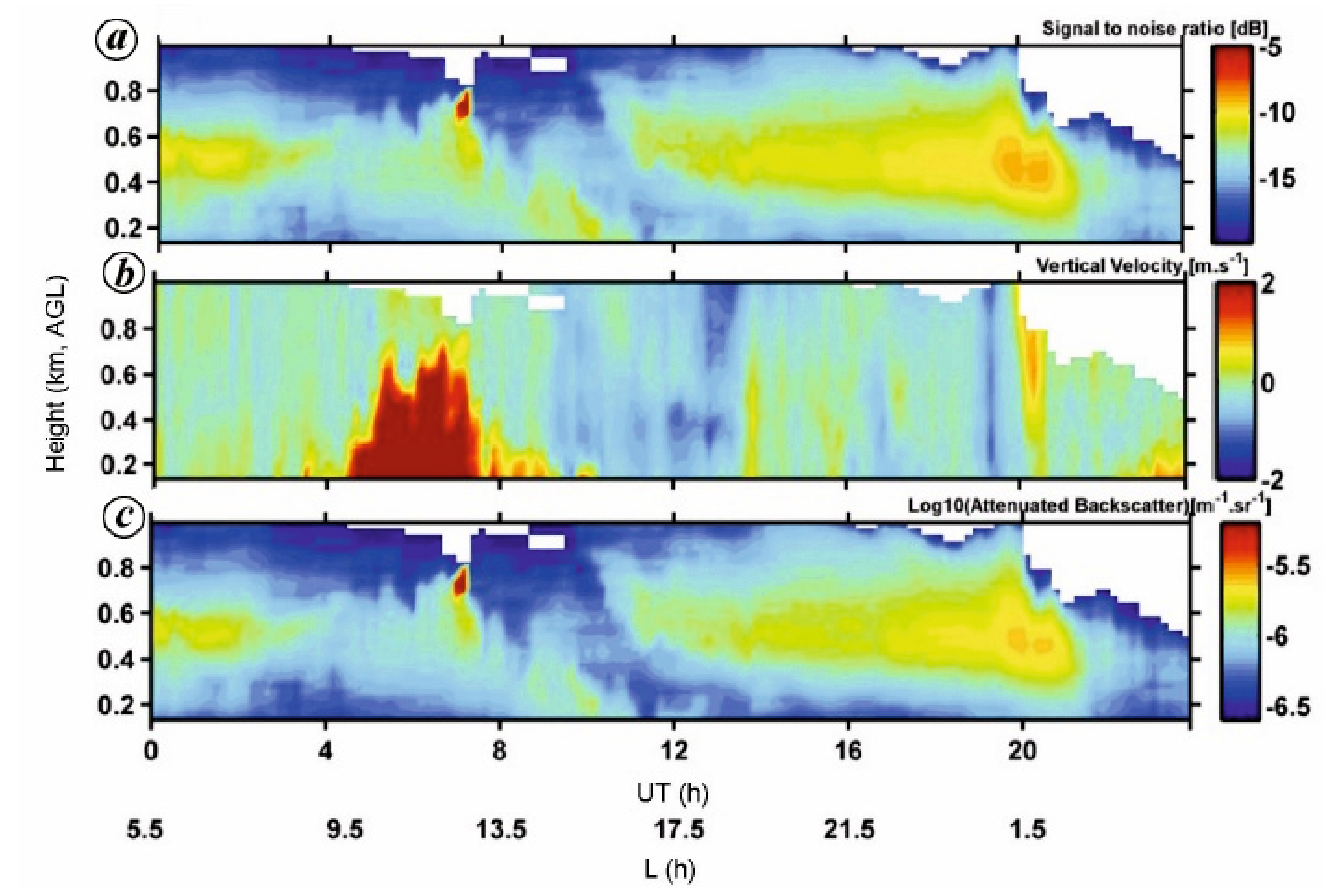


Figure 28. Diurnal variation of 10-min averaged (a) SNR, (b) vertical velocity and (c) attenuated backscatter data on 2 December 2011 over Manora Peak.

Optical and radiative properties of aerosols over Doon valley in the Shivalik range of northwestern Himalayas

Multi-year (2007-2012) measurements of columnar aerosol optical depth (AOD) were carried out from multi-wavelength radiometer (MWR) over Doon valley in the foothills of western Himalayas. A high values of 0.46 ± 0.08 and 0.52 ± 0.10 at 500nm, along with low values of Ångström exponent (0.49 ± 0.01 and 0.44 ± 0.03) during the spring (March – May) and summer (June-August), respectively, suggest a flat AOD spectrum indicative of coarse-mode aerosols abundance compared with winter (December–February) and autumn (September–November), which are mostly dominant by fine mode aerosols from urban/industrial emissions and biomass burning. The size distribution obtained from the King's inversion of spectral AOD shows the bimodal size distribution during the spring and autumn while a combination of power law and unimodal distribution during winter and summer. A high value of aerosol extinction coefficient near the surface (~0.8 -1.0 km^{-1} at 532 nm) and steep decreasing gradient above were observed via CALIPSO profiles in autumn and winter, while spring and summer exhibits elevated aerosol layers between ~1.5 and 3.5 km due to the presence of mineral dust. Similarly, the particle depolarization ratio also shows slight increasing trend with altitude, with higher

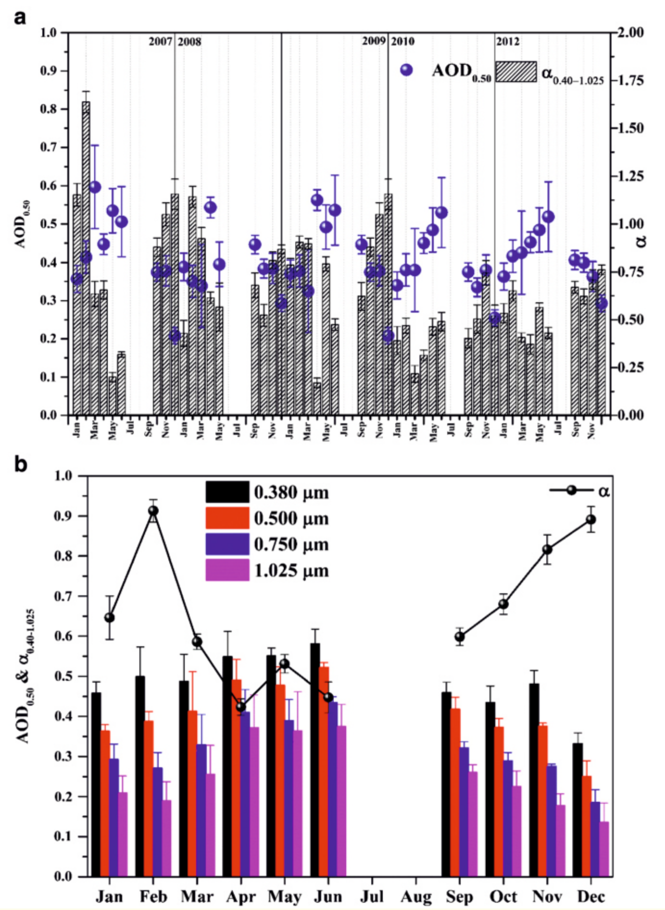


Figure 29. Temporal variability of the monthly values of AOD0.50 and α0.40–1.025 over Dehradun during 2007–2012 (a) and monthly mean variation of spectral AOD0.50 and α0.40–1.025 (b). The data for the year 2011 is missing due to technical problem in MWR and gaps in the plot are due to the Indian summer monsoon.

values in spring and summer indicative of non-spherical particles of dust origin. The climate implication of aerosols were evaluated via the aerosol radiative forcing (ARF), which was estimated via the synergy of OPAC and SBDART models. On the monthly basis, the ARF values ranges from ~ -30 to -90 W m^{-2} at the surface, while aerosols cause an overall cooling effects at the top of atmosphere (approximately -5 to -15 W m^{-2}). The atmospheric heating via aerosol absorption results in heating rate of 1.2 -1.6 K day^{-1} during March – June, which may contribute to changes in monsoon circulation over the northern India and the Himalayas. **[Dumka, U. C.,** et al. (2016). *Envi. Sci. Poll. Res., 23*, 25467-25484.**]**

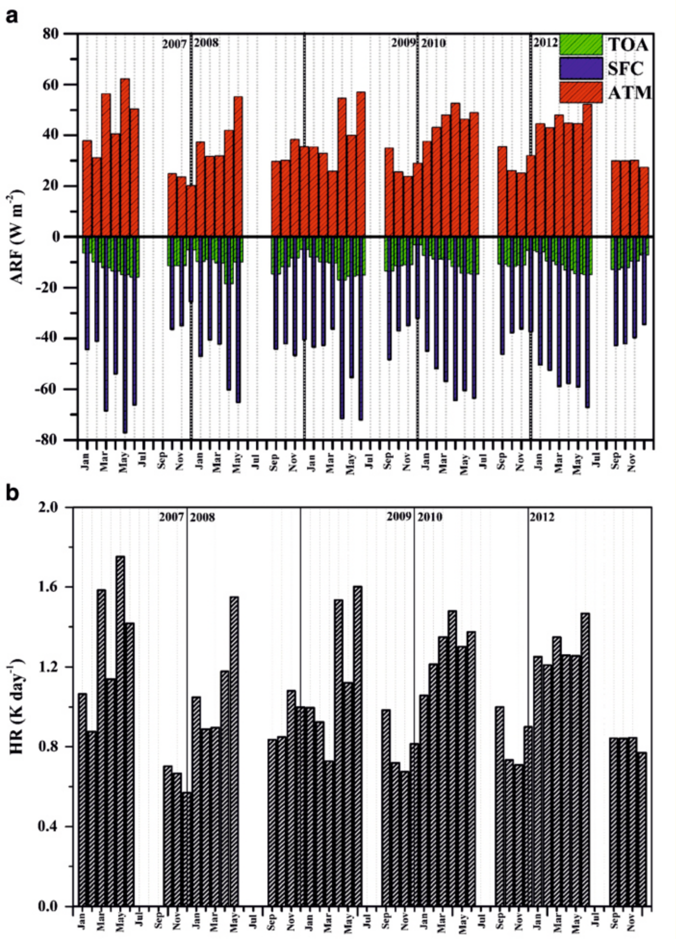


Figure 30. Monthly variation of the ARF (W m^{-2}) (a) and HR (K day^{-1}) (b) values over Dehradun during January 2007 to December 2012. The gaps in the plot are due to the absence of data during the Indian summer monsoon. The data during the year 2011 is missing due to technical problem in MWR.

Balloon-borne observations of High-frequency vertical profiling of meteorological parameters during RAWEX–GVAX field campaign at ARIES, Nainital

High-frequency (four launches per day) balloon-borne observations of meteorological parameters (pressure, temperature, relative humidity, wind speed and wind direction) are made at ARIES during an extensive field campaign (RAWEX-GVAX) from June 2011 to March 2012. These observations show wind speed as high as 84 m/s near the subtropical jet. A comparison between radiosonde winds and MERRA winds was very good (r^2=0.9) at 250 hPa when compared with that at 100 hPa (r^2=0.77) or at 500 hPa (r^2=0.63). It was shown that reanalysis wind speeds are in better agreement at 250 hPa than those above or below this height region. These observations also demonstrate that data from space based sensors should be used with care as AIRS-derived temperature profiles were negatively biased in the lower altitude region, whereas they were positively biased near the tropopause **(Figure 31)**. WRF model simulated results were able to capture variations in temperature, humidity, wind speed profile and tropopause height reasonable well. **[Naja, M.,** et al. (including **Bhardwaj, P., Singh, N., Kumar, Phani** & **Ojha, N.**) (2016). *Current Science, 111*, 132-140.**]**

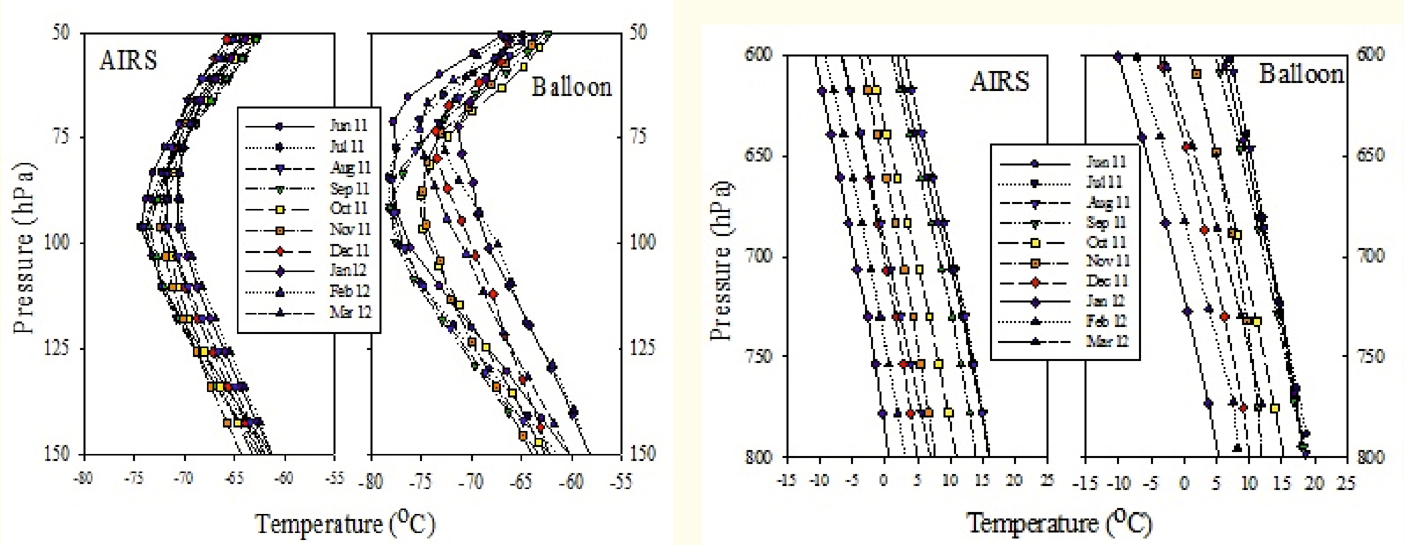


Figure 31. Radiosonde monthly average temperature (°C) profile and data retrieved from AIRS over the central Himalayas in the (a) lower troposphere (600-800 hPa) and (b) upper troposphere-lower stratosphere region (150-50 hPa) from June 2011 to March 2012.

Variabilities in trace gases and aerosols over the central Himalayas and surrounding regions

Simultaneous observations of trace gases are made over Pantnagar, Nainital and several sites in the Kathmandu valley during Suskat field campaign. Additionally, passive sampling (offline) followed by their chemical analysis was also done. NO_2 and SO_2 levels were observed to be high in urban sites (22.4 µg m^{-3} and 14.5 µg m^{-3}, when compared with those at rural (9.2 µg m^{-3} and 7.6 µg m^{-3},) regions, while a reverse is seen for ozone. Chemical analysis over Nainital shows a greater isotope ratio (−24.0‰) in winter, mostly originated from biomass burning of C_4 plants. On the contrary, smaller δ13C value (−26.0‰) in summer indicates vascular plants (mostly C_3 plants) origin. Additional study also confirms that the pollutants generated from far distant sources could reach high altitudes over the Himalayan region. Chemical analysis of rainwater samples collected from Nainital during the monsoon season (July to September) were analyzed for major anions and cations in collaboration with IITM. Principle Component Analysis (PCA) suggests that the first factor (i.e. natural sources, mainly dust) accounts for ~33% variance whereas second factor (i.e. fossil fuel and biomass burning) accounts for ~18% variance of measured ionic composition. A significant correlation was observed between SO_4^{2-} and NO_3^- (r=0.95) indicating their co-genetic sources due to the similarity in their behavior in precipitation and co-emissions of their precursors SO_2 and NO_x. **[** Hegde, P., Kawamura, K., **Joshi, H.** and **Naja, M.** (2016). *Environ. Sci. Pollut. Res.*, *23,* 6102-6118; Kiros, F. et. al. (including **Naja, M.**) (2016). *Aero. Air Qual. Res.*, *16,* 3088-3101. Bisht, D. S. et. al. (including **Joshi, H., Singh, N.** & **Naja, M.**). (2017). *Environ. Sci. Pollut. Res.*, *24*, 3959-3969.**]**

List of Publications

Refereed Journals

1. **Bhagwan, J., Gupta, A. C.,** Papadakis, I. E. & Wiita, P. J. (2016). Flux and spectral variability of the blazar PKS 2155-304 with *XMM-Newton*: evidence of particle acceleration and synchrotron cooling. *New Astronomy, 44,* 21-28.

2. Patel, M. K., **Pandey, J. C., Karmakar, S.,** Srivastava, D. C. & Savanov, I. S. (2016). Broad-band linear polarization in late-type active dwarfs. *Mon. Not. Roy. Astron. Soc., 457,* 3178-3190.

3. Kambezidis, H. D., Psiloglou, B. E., Karagiannis, D., **Dumka, U. C.** & Kaskaoutis, D. G. (2016). Recent improvements of the Meteorological radiation model for solar irradiance estimates under all-sky conditions. *Renewable Energy, 93,* 142-158.

4. **Gupta, A. C.,** et al. (including **Agarwal, A.** & **Bhagwan, J.**) (2016). Multiband optical variability of three TeV blazars on diverse time-scales. *Mon. Not. Roy. Astron. Soc., 458,* 1127-1137.

5. Kaskaoutis, D. G., Kambezidis, H. D., **Dumka, U. C.** & Psiloglou, B. E. (2016). Dependence of the spectral diffuse-direct irradiance ratio on aerosol spectral distribution and single scattering albedo. *Atmospheric Research, 178-179,* 84-94.

6. **Joshi, Y. C.,** Mohanty, A. P. & **Joshi, S.** (2016). Population I Cepheids and understanding star formation history of the Small Magellanic Cloud. *Res. in Astron. & Astrophy., 16,* 61 (8pp).

7. **Joshi, Y. C.,** Jagirdar, R. & **Joshi, S.** (2016). Photometric studies of two W UMa type variables in the field of distant open cluster NGC 6866. *Res. in Astron. & Astrophy., 16,* 63 (10pp).

8. Tiwari, S., et al. (including **Dumka, U. C.**) (2016). Nature and sources of ionic species in precipitation across the Indo-Gangetic Plains, India. *Aerosol and Air Quality Research, 16,* 943-957.

9. **Paswan, A.** & **Omar, A.** (2016). Radio continuum detection in blue early-type weak-emission-line galaxies. *Mon. Not. Roy. Astron. Soc., 459,* 233-238.

10. Tiwari, S., et al. (including **Dumka, U. C.**) (2016). Atmospheric heating due to black carbon aerosol during the summer monsoon period over Ballia: A rural environment over Indo-Gangetic Plain. *Atmospheric Research, 178-179,* 393-400.

11. **Sharma, N., Maheswar, G., Soam,** A., Lee, C. W. & Tej, A. (2016). Magnetic field geometry of an unusual cometary cloud Gal 110-13. *Astron. & Astrophy., 588,* A45 (14pp).

12. Bisht, D., **Yadav, R. K. S.** & Durgapal, A. K. (2016). Mass function study of open star clusters Haffner 11 and Czernik 31. *New Astronomy, 47,* 19-23.

13. **Sharma, S.,** et al. (including **Pandey, A. K., Gopinathan, M.** & **Yadav, R. K.**) (2016). Structural studies of eight bright rimmed clouds in the southern Hemisphere. *Astron. Jr., 151:126* (26pp).

14. **Chattopadhyay, I.** & **Kumar, Rajiv** (2016). Estimation of mass outflow rates from viscous relativistic accretion discs around black holes. *Mon. Not. Roy. Astron. Soc., 459,* 3792-3811.

15. Balona, L. A., et al. (including **Joshi, Y. C.** & **Joshi, S.**) (2016). The hot Doradus and Maia stars. *Mon. Not. Roy. Astron. Soc., 460,* 1318-1327.

16. Kim, G., Lee, C. W., **Gopinathan, M.,** Jeong, Woong-Seob. & Kim, Mi-Ryang (2016). Dense

molecular cores being externally heated. *Astrophy. Jr., 824:* 85 (24pp).

17. **Joshi, S.,** et al. (including **Joshi, Y. C.**) (2016). The Nainital-Cape Survey IV. A search for pulsational variability in 108 chemically peculiar stars. *Astron. & Astrophy., 590,* A116 (36pp).

18. **Singh, N.,** et al. (including **Solanki, R., Naja, M., Dumka, U. C., Phanikumar, D. V. & Sagar, R.**) (2016). Variations in the cloud-base hight over the central Himalayas during GVAX:association with the monsoon rainfall. *Current Science, 111*, 109-116.

19. **Naja, M.,** et al. (including **Bhardwaj, P., Singh, N., Kumar, Phani.** & **Ojha, N.**) (2016). High-frequency vertical profiling of meteorological parameters using AMF1 facility during RAWEX–GVAX at ARIES, Nainital. *Current Science, 111*, 132-140.

20. **Phanikumar, D. V.,** et al. (including **Shukla, K. K., Naja, M., Singh, N. & Sagar, R.**) (2016). Doppler Lidar observations over a high altitude mountainous site Manora Peak in the central Himalayan region. *Current Science, 111*, 101-108.

21. **Kumar, Parveen, Chand, H.** & Gopal-Krishna (2016). Intranight optical variability of radio-quiet week emission line quasars-IV. *Mon. Not. Roy. Astron. Soc., 461,* 666-673.

22. **Bhattacharjee, S., Kumar, A. & Naja, M.** (2016). Array factor optimization of an active planar phased array using evolutionary algorithm. *International Jr. Antennas, 2,* 1-11.

23. **Karmakar, S.,** et al. (including **Pandey, J. C., Pandey, S. B., Misra, K. & Joshi, S.**) (2016). LO Peg: surface differential rotation, flares, and spot-topographic evolution. *Mon. Not. Roy. Astron. Soc., 459,* 3112-3129.

24. **Gupta, A. C., Kalita, N.,** Gaur, H. & Duorah, K. (2016). Peak of spectral energy distribution plays an import ant role in intra-day variability of blazars? . *Mon. Not. Roy. Astron. Soc., 462,* 1508-1516.

25. Bisht, D. S., et al. (including **Dumka, U. C.**)(2016). Tethered balloon-born and ground-based measurements of black carbon and particulate profiles within the lower troposphere during the foggy period in Delhi, India. *Sci. Total Envir., 537,* 894-905.

26. **Joshi, Y. C.,** Dambis, A. K., **Pandey, A. K.** & **Joshi, S.** (2016). Study of open clusters within 1.8 kpc and understanding the Galactic structure. *Astro. & Astrophy., 593,* A116 (1-13 pp).

27. Lee, S. J., **Chattopadhyay, I., Kumar, R.,** Hyung, S. & Ryu,D. (2016). Simulationsof viscous accretion flow around black holes in tow dimensional cyclindrical geometry. *Astrophy. Jr., 831:33* (22pp).

28. **Joshi, A., Pandey, J. C.,** Singh, K. P. & Agrawal, P. C. (2016). PALOMA: a magnetic CV between polars and intermediate polars. *Astrophy. Jr., 830:*56 (11pp).

29. Zola, S., et al. (including **Gopinathan, M., Joshi, A. & Pandey, J. C.**) (2016). A search for QPOs in the blazar OJ287: preliminary results from the 2015/2016 observing campaign. *Galaxies, 4, 41* (1-7pp).

30. Savanov, I. S., et al. (including **Karmakar, S., Pandey, J. C., Pandey, S. B., Joshi, S. & Misra, K.**) (2016). Photometric observations of Lo Peg in 2014-2015. *Acta Astronomica, 66,* 381-390.

31. **Jaiswal, S. & Omar, A.** (2016). Hα imaging survey of wolf-rayet galaxies: morphologies and star formation rates. *Mon. Not. Roy. Astron. Soc., 462,* 92-114.

32. **Dumka, U. C.,** et al. (2016). Columnar aerosol characteristics and radiative forcing over the Doon Valley in the Shivalik range of northwestern Himalayas. *Envi. Sci. Poll. Res., 23*, 25467-25484.

33. Messina, S., Naves, R. & **Medhi, B. J.** (2016). Is the pictoris member GJ 3039AB a physical binary? What the rotation periods tell us?. *New Astronomy, 48,* 5-11.

34. Messina, S., et al. (including **Medhi, B. J.**) (2016). The rotation-lithium depletion correlation in the pictoris association and the LDB age determination. *Astron. & Astrophy., 596,* A29 (1-7pp).

35. Das, A., Das, H. S., **Medhi, B. J.** & Wolf, S. (2016). Magnetic field geometry of the large globule CB 34. *Astrophys Space Sci., 361:* 381 (1-12 pp).

36. Hay, K. L., et al. (including **Joshi, Y. C.**) (2016). WASP-92b, WASP-93b and WASP-118b: three new transiting close-in giant planets. *Mon. Not. Roy. Astron. Soc., 463,* 3276-3289.

37. **Yadav, R. K.,** et al. (including **Pandey, A. K.** & **Sharma, S.**) (2016). A multiwavelength investigation of lthe H II region S311: young stellar population and star formation. *Mon. Not. Roy. Astron. Soc., 461,* 2502-2518.

38. **Singh, N,** et al. (including **Solanki, R.**)(2016). Boundary layer evolution over the central Himalayas from radio wind profiler and model simulations. *Atmos. Chem. Phy., 16,* 10559-10572.

39. Abbott, B. P., et al. (including **Pandey, S. B.**). (2016). Localization and broadband follow-up of the gravitational-wave transient GW 150914. *Astrophy. Jr. Letter., 826,* L13 (8pp).

40. Abbott, B. P., et al. (including **Pandey, S. B.**). (2016). Supplement: Localization and broadband follow-up of the gravitational-wave transient GW 150914 (2016, ApJL, 826, L13). *Astrophy. Jr. Suppl. Series, 225,* 8 (8pp).

41. Roy, R., et al. (including **Bose, S., Kumar, B.** & **Pandey, S. B**.) (2016). SN 2012aa: a transient between type ibc core-collapse and superluminous supernovae. *Astron. & Astrophy., 596,* A67.

42. Chandra, R., Chen, P. F., Fulara, A., Srivastava, A. K., & **Uddin, W.** (2016). Peculiar stationary EUV wave fronts in the eruption on 2011 May 11. *Astrophy. Jr., 822,* 106 (8pp).

43. Joshi, N. C., Filippov, B., Schmieder, B., Magara, T., Moon, Y. & **Uddin, W.** (2016). Interaction of two filament channels of different chiralities. *Astrophy. Jr., 825,* 123 (16pp).

44. Roy, S., et al. (including **Chand, H**.) (2016). Probing magnetic fields with square kilometer array and its precursors. *Jr. Astphys. Astro., 37:*42.

45. McHardy, I. M. et al. (including **Chand, H**.) (2016). The origin of UV-optical variability in AGN and test of disc models: XMM-Newton and ground-based observations of NGC 4395. *Astron. Nachr., 337*, 500-506.

46. Bisht, D., **Yadav, R. K. S.** and Durgapal, A. K. (2016). UBVI photometric study of open star clusters Ruprecht 25 and Czernik 6. *New Astron., 49,* 1-7.

47. Elsanhoury, W. H. et al. (including **Yadav, R. K. S.**) (2016). 2MASS photometry and kinematical studies of open cluster NGC 188. *New Astron., 49,* 32-37.

48. Elias-Rosa, N. et al. (including **Misra, K.**) (2016). Dead or Alive? Long-term evolution of SN 2015bh (SNhunt275). *Mon. Not. Roy. Astron. Soc., 463,* 3894–3920.

49. Chandra, P. et al. (including **Misra, K.**) (2016). Explosive and Radio-Selected Transients: Transient Astronomy with Square Kilometre Array and its Precursors. *Jr. Astroph. & Astron., 37*: 30.

50. Hegde, P., Kawamura, K., **Joshi, H.** and **Naja, M.** (2016). Organic and inorganic components of aerosols over the central Himalayas: winter and summer variations in stable carbon and nitrogen isotopic composition. *Environ. Sci. Pollut. Res.*, *23*, 6102-6118.

51. Kiros, F. et al. (including **Naja, M.**) (2016). Variability of Anthropogenic Gases: Nitrogen Oxides, Sulfur Dioxide, Ozone and Ammonia in Kathmandu Valley, Nepal. *Aero. Air Qual. Res.*, *16,* 3088-3101.

52. Richichi, A., et al. (including **Pandey, A. K.** & **Sharma, S**.) (2017). Evidence of asymmetries in the Aldebaran photosphere from multiwavelength lunar occultations. *Mon. Not. Roy. Astron. Soc., 464,* 231-236.

53. Kushwaha, P., **Gupta, A. C.,** Misra, R. & Singh, K. P. (2017). Multi-wavelength temporal variability of the blazar 3C 454.3 during 2014 activity phase. *Mon. Not. Roy. Astron. Soc., 464,* 2046-2052.

54. **Soam, A.,** Lee, C. W., **Maheswar, G.,** Kim, S., **Neha, S** & Kim, Mi-R. (2017). Probing the magnetic fields in L1415 and L4389. *Mon. Not. Roy. Astron. Soc., 464,* 2403-2418.

55. Dambis, A. K., Glushkova, E. V., Berdnikov, L. N., **Joshi, Y. C.** & **Pandey, A. K.** (2017). Investigation of open clusters based on IPHAS and APASS survey data. *Mon. Not. Roy. Astron. Soc., 465,* 1505-1517.

56. **Soam, A., Maheswar, G.,** Lee, C. W., **Neha, S.** & Andersson, B. –G. (2017). Magnetic field structure of IC 63 and IC 59 associated with H II region Sh 185. *Mon. Not. Roy. Astron. Soc., 465,* 559-568.

57. Patel, P. N., **Dumka, U. C.,** Kaskaoutis, D. G., Babu, K. N. & Mathur, A. K. (2017). Optical and radiative properties of aerosols over desalpar, a remote site in western India: Source identification, modification processes and aerosol type discrimination. *Sci. Total Envir., 575,* 612-627.

58. Tiwari, S, et al. (including **Dumka, U. C.**) (2017). Assessment of PM2.5 and PM10 over Guwahati in Brahmaputra River valley: temporal evolution, source apportionment and meteorological dependence. *Atmosph. Pollu. Rese., 8,* 13-28.

59. Joshi, N. C., et al. (including **Uddin, W**.) (2017). Investigation of recurrent EUV jets from highly dynamic magnetic field region. *Astrphys. Space Sci., 362:10* (1-14pp).

60. Chen, J., et al. (including **Dumka, U. C**.) (2017). A review of biomass buring: emissions and impacts on air quality, health and climate in China. *Sci. Total Envir., 579,* 1000-1034.

61. **Mishra, A.,** et al. (including **Omar, A.**) (2017). GMRT HI study of giant low surface brightness galaxies. *Mon. Not. Roy. Astron. Soc., 464,* 2741-2751.

62. **Gupta, A. C.** et al. (including **Agarwal, A., Mishra, Alka,** and **Pandey, Ashwani**) (2017). Multiband optical variability of the blazar OJ 287 during its outbursts in 2015–2016. *Mon. Not. Roy. Astron. Soc., 465,* 4423-4433.

63. Valeev, A. F. et al. (including **Joshi, Arti** and **Pandey, J. C.**) (2017). Search for and study of photometric variability in magnetic white dwarf. *Astrophy. Bull., 72,* 44-50.

64. Chandra, R., et al. (including **Uddin, W**.) (2017). Blowout jets and impulsive eruptive flares in a bald-patch topology. *Astron. & Astrophy., 598,* A41 (1-15 pp).

65. Goyal, A. et al. (including **Joshi, S.**) (2017). Multiwavelength Variability Study of the Classical BL Lac Object PKS 0735+178 on Timescales Ranging from Decades to Minutes. *Astrophy. Jr., 837*:127 (19pp).

66. Sariya, D. P., Jiang, Ing-Guey and **Yadav, R. K. S.** (2017). A Proper Motions Study of the Globular Cluster NGC 3201. *Astron. Jr., 153,* 134 (10 pp).

67. Bisht, D. S. et al. (including **Joshi, H., Singh, N.** & **Naja, M.**). (2017). Chemical characterization of rainwater at a high-altitude site "Nainital" in the

Central Himalayas. *Environ. Sci. Pollut. Res., 24,* 3959-3969.

Circular/ Bulletins/ Conference Proceedings

1. Devara, P. C. S, et al. (including **Dumka, U. C.**) (2016). Fog aerosol characterization experiments over panchgaon, Haryana. *Proceedings of Indian Aerosol Science and Technology Association, 22,* 195-198.

2. Devara, P. C. S, et al. (including **Dumka, U. C.**) (2016). Odd-even scheme for combating air pollution in and around Delhi NCR. *Proceedings of Indian Aerosol Science and Technology Association, 22,* 199-202.

3. Dumka, U. C., Devara, P. C. S, Kaskaoutis, D. G. & **Kumar, Sarvan** (2016). Scattering coefficient over Panchgaon a remote location in northwestern Indo-Gangetic plain. *Proceedings of Indian Aerosol Science and Technology Association, 22,* 385-387.

4. **Kumar, Sarvan**, Siingh, D., Singh, R. P., Singh, A. K. & **Dumka, U. C.** (2016). Influence of meteorological parameters and aerosol optical depth on lighting over Indo-Gangetic plain. *Proceedings of Indian Aerosol Science and Technology Association, 22,* 392-394.

5. **Dumka, U. C.,** et al. (including **Kumar, Sarvan**) (2016). Characteristics of carbonaceous aerosols over panchgaon a remote location in Northwestern Indo-Gangetic plain. *Proceedings of Indian Aerosol Science and Technology Association, 22,* 569-570.

6. Devara, P. C. S., Alam, M. P., Paul, T., Srivastava, A. K. & **Dumka, U. C.** (2016). Particulate matter and black carbon aerosols during winter 2015-16 over a rural station. *Proceedings of Indian Aerosol Science and Technology Association, 22,* 655-658.

7. **Bangia, T., Yadava, S., Kumar, Brijesh**, Ghanti, A. S. & Hardikar, P. M. (2016). Customized overhead cranes for installation of India's largest 3.6m optical telescope at Devasthal, Nainital, India. *Proc. of SPIE, 9906,* 990620-1-13.

8. **Karmakar, S.** & **Pandey, J. C.** (2016). Swift observations of CC Eri: x-ray superflare. *The 19the Cambridge Workshop on Cool Stars Stellar Systems and the Sun, Zenodo, 1*,8.

9. Wright, S. A., et al. (including **Pandey, S. B.)** (2016). The infrared imaging spectrograph (IRIS) for TMT: latest science cases and simulations. *Proc. of SPIE, 9909,* 990905-1-15.

10. **Gopinathan, M., Sahu, S., Yadava, S., Jangid, P., Medhi, B. J.,** Rao, P., **Kumar, B., Omar, A. & Uddin, W.** (2016). Synchronization of off-centered dome and 3.6m Devasthal optical telescope. *Proc. of SPIE, 9913,* 991340-1-13.

11. **Bheemireddy, K. R., Gopinathan, M., Pant, J., Omar, A., Kumar, B., Uddin, W.** & Kumar, N. (2016). The first aluminum coating of the 3700 mm primary mirror of the Devasthal Optical Telescope. *Proc. of SPIE, 9906,* 990644-19.

Ph.D. THESES

Awarded

1. Study of aerosols characteristics over Central Himalayas, **Hema Joshi,** (Supervisor & Co-Supervisor: **M. Naja** and H. C. Chandola), *Kumaun University,* July, 2015. (Awarded April, 2016).

2. Multiwavelength investigation of core-collapse supernovae, **Subhash Bosh**, (Supervisor & Co-Supervisor: **Brijish Kumar** and H. C. Chandola), *Kumaun University,* August, 2015. Awarded June, 2016).

3. A study of dynamical aspects of aerosols over the central Himalayan region, **Krishna Kumar Shukla,** (Supervisor : **D. V. Phanikumar**), *Pt. Ravishankar*

Shukla University, December, 2015. Awarded October, 2016).

4. Multi-wavelength studies of Blazars, **Aditi Agarwal,** (Supervisor & Co-Supervisor: **A. C. Gupta** and Prof. U. S. Pandey), *Deen Dayal Upadhyay Gorakhpur University,* July, 2016. Awarded March, 2017).

Submitted

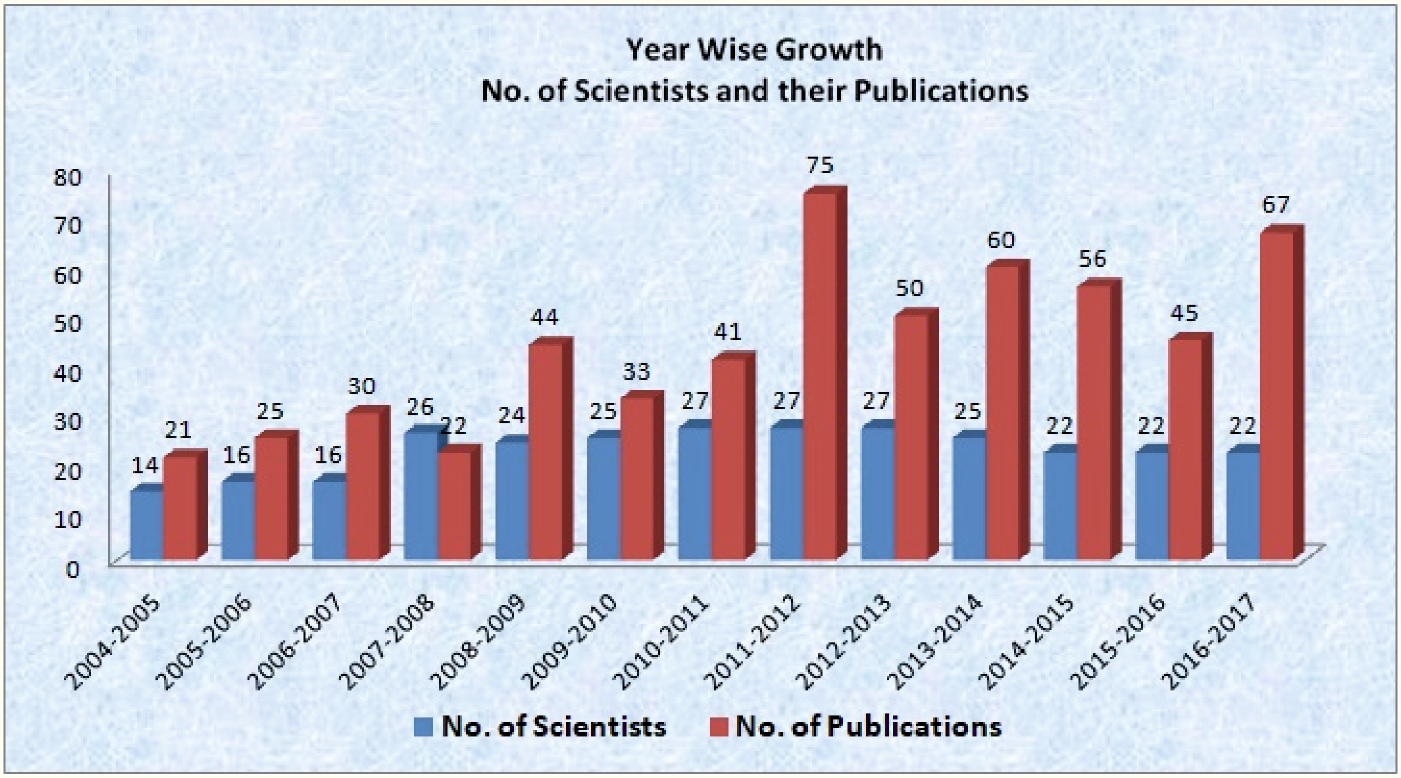
1. Multi-wavelength studies of active galactic nuclei, **Jai Bhagwan**, (Supervisor : **A. C. Gupta**), *Pt. Ravishankar Shukla University,* March, 2016.

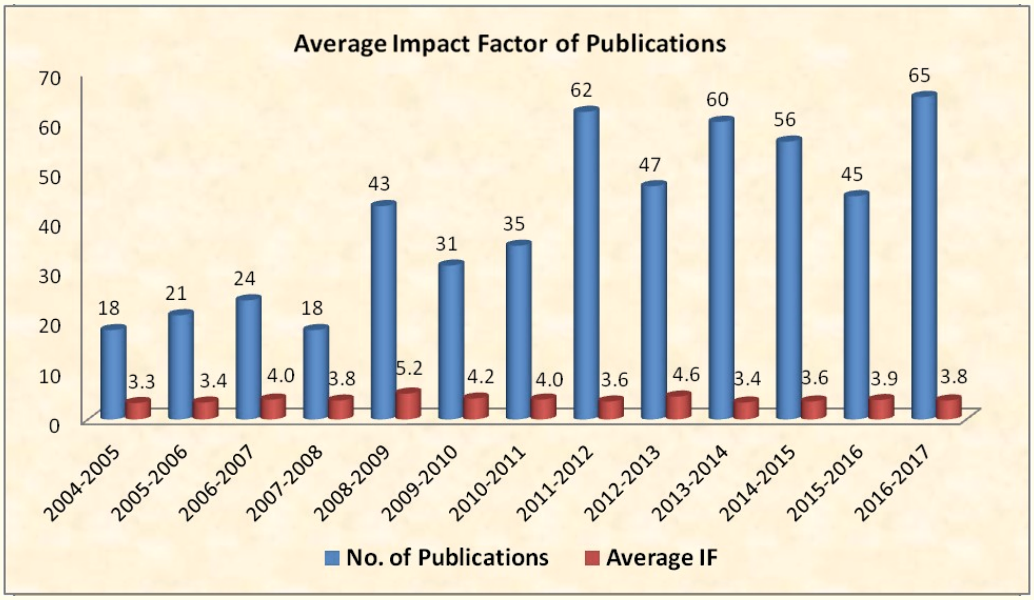
2. Study of the tropospheric trace gases over the Indian subcontinent, **Piyush Bhardwaj**, (Supervisor & Co-Supervisor: **Manish Naja** and H. C. Chandola), *Kumaun University,* July, 2016.

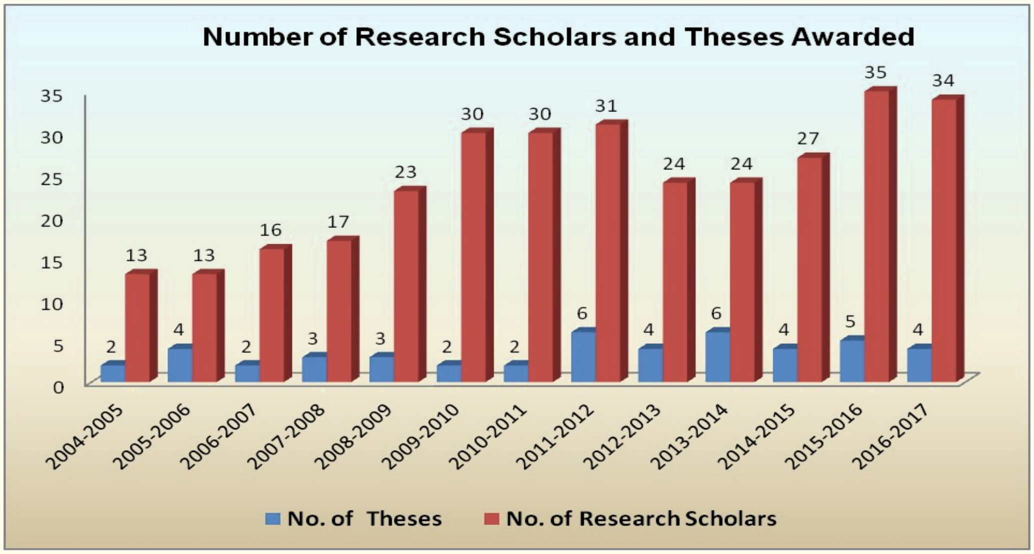
3. Study of aerosol distribution and associated meteorology over the Central HImalayas, **Raman Solaki**, (Supervisors: **Narendra Singh** and S. K. Dhaka), *Department of Physics & Astrphysics, University of Delhi,* September, 2016.

4. Studies of nearby star forming galaxies, **Sumit Kumar Jaiswal**, (Supervisor : **Amitesh Omar**), *Pt. Ravishankar Shukla University,* August, 2016.

5. 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.







Summary

1.	Total Number of Publications in Refereed Journals	67
2.	Number of Publications in Circulars/Bulletin	11
3.	Ph.D. Theses Awarded	4
4.	Ph.D. Theses Submitted	5

International and National Research Projects

In year 2016-2017 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: Magnetic activities in low mass stars
PI (ARIES): Jeewan C. Pandey
PI of the collaborating institute: Igor Savanov, Institute of Astronomy, Moscow, Russia
Funding Agency: DST, Govt of India
Project Code: DST/RUS/RFBR/P-167

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: Stellar Variability and Rotational Activities in the Kepler field
PI (ARIES): Santosh Joshi
Affliation of the collaborating PI: Tezpur university
Funding Agency: DST, Govt of India

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

International Liquid Mirror Telescope: status report

The 4m International Liquid Mirror Telescope (ILMT) project is a collaboration between 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) and the Aryabhatta Research Institute of Observational Sciences (ARIES, India).

The ILMT will be entirely dedicated to projects of high scientific interest dealing with astrometric or photometric variability both in galactic and extragalactic astrophysics. For zenith-pointing observations Liquid Mirror Telescopes (LMTs) can deliver the same performance as classical telescopes with much lower cost and greater simplicity of operation. The 4m ILMT is an instrument that will be entirely dedicated to photometric and astrometric variability survey of a narrow strip of the sky (about half a degree) passing through the zenith. Each night, a long CCD image recorded under the best photometric conditions (atmospheric seeing and extinction) will be compared to a reference one and any transient source or highly variable object should be easily detected, and with 3.6m DOT, a follow-up strategy can also be easily implemented. We expect to get first light before the monsoon of 2018. A brief summary of the status report during 2016-17 is given below.

(a) ILMT enclosure and auxiliary building

The civil work design and completion up to the plinth level of the ILMT house was done by ARIES civil section. For 'manufacturing, supply, and erection' of the ILMT structure a contract was already signed with the M/s Pedvak Hyderabad. The work is divided into three part – telescope enclosure, telescope control room and compressor room. All these work have been completed by M/s Pedvak and building was ready to conceive the telescope by November 2016. The picture of the completed ILMT enclosure and auxiliary building is shown in **figure 32**. The telescope parts was transported from the base camp to the ILMT site on 4th March 2017.

Figure 32. Aerial view of the ILMT building with its roof open (right) and the 1.3m telescope (left) [Image courtesy: Prof. Jean Surdej].

Figure 33. Big blue container in front of the compressor room and ILMT building, shifted from base camp to the ILMT site on 04 March 2017 for assembling the telescope mechanical structure.

(b) Air Compressor pneumatic air control system

One compressor is needed to operate the air bearing of ILMT. However, in order to avoid any interruption of the mirror rotation (cf. during the maintenance of the compressed air system), it is best to have two parallel air systems. These two air compressors and two air tanks have been installed during 27 February – 01 March 2017 by Gardner-Denver company, New Delhi. Additionally, pneumatic air control system has been installed with additional valves, air dryers and air filters to make sure that the air bearing will be operating under optimal and safe conditions.

Figure 34. Compressor room with the two air compressors and air tanks.

Figure 35. Erection of the ILMT structure on 05 March 2017.

(c) Installation of ILMT mechanical structure

During 04-20 March 2017, AMOS, ARIES and Liege University teams have contributed to the erection of the ILMT structure. Figures below illustrate the progressive installation such as: four inferior pillars, the lateral reinforcing bars, the four superior pillars and the spider structure to hold the optical corrector. After unpacking the optical corrector, the latter has been assembled with a tip-tilt and focus adjusting device. This whole system has subsequently been mounted on the structure of the prime focus holder. The next AMOS mission to start the motor of air bearing, will begin in early 2018 so as to ensure the first light before the monsoon of 2018.

Figure 36. The AMOS pneumatic air control system installed in the ILMT control room.

Figure 37. View of the ILMT mirror, the air bearing and four safety yellow pillows to prevent any switchover of the mercury bowl.

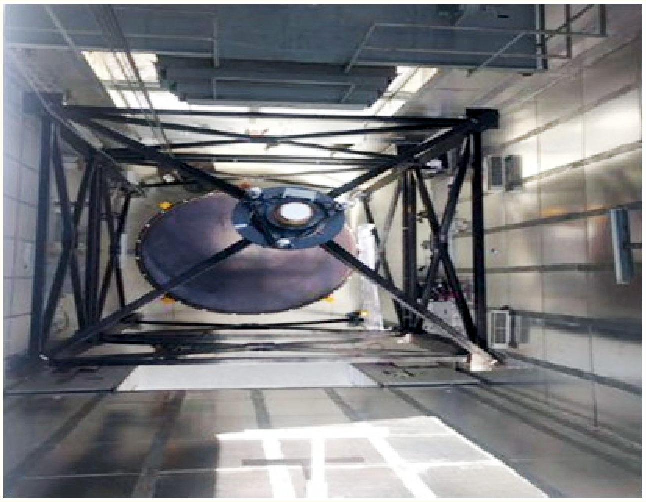


Figure 38. View of the ILMT from the top of the roof. The optical corrector is superimposed over the mirror. The folding platform is visible on the top.

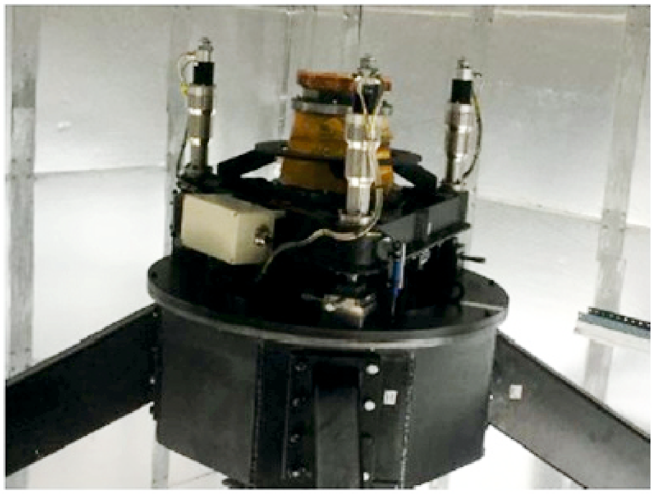


Figure 39. The optical corrector assembled with the tip-tilt and focus adjusting device has been lifted and mounted on the prime focus holder.

ARIES ST Radar (ASTRAD)

StratosphereTroposphere (ST) Radar (206.5 MHz) is being installed at ARIES, Nainital for observations of vertical profiling of wind. The activities during 2016-17 are:

- A test experiment was carried out using TRMs from CUSAT, Cochin at ARIES, Nainital and it was concluded that DSP subsystem needs improvement in EMI/EMC shielding. A need of clutter fence was also highlighted and it was decided to complete its installation with highest priority.

- M/s ECIL took back (July 2016) the DSP subsystem to Hyderabad for modifications, particularly to improve its EMI/EMC shielding to avoid unwanted leaking of strong RF signal during radar receive mode. M/s ECIL has modified the DSP subsystem and conducted various tests **(23-28 October 2016)** at Hyderabad. EMI/EMC tests were carried out on individual units as well as on integrated subsystem. It is observed and noted that the central patch does not appear on the DRx spectrum plot when proper care has been taken of grounding and shielding of various components including cables interconnecting sub units of DSP systems.

- ARIES has also installed the clutter fence around the antenna array on the roof top **(Figure 40)**. Single TRM experiment clearly shows that the installation of fence has led to the significant reduction in the clutter strength. After conducting the similar experiments couple of times at different location in and around the ASTRAD antenna array, it is quantified that fencing work has led to reduction in the strength of clutter by 20-25 dB.

- Following the clutter fence work, ARIES played a leading role in making the 7 clusters operational (out of total 12 clusters). ECIL team had replaced the faulty TRMs in the 7 clusters (343 TRMs) from the outer 5 clusters (245 TRMs). Thereafter, ARIES team took the entire responsibility of the calibration following predetermined steps and worked very extensively for nearly two months. After performing

Figure 40. Recently installed clutter fence along the periphery of ASTRAD antenna array on the roof-top of the ASTRAD building.

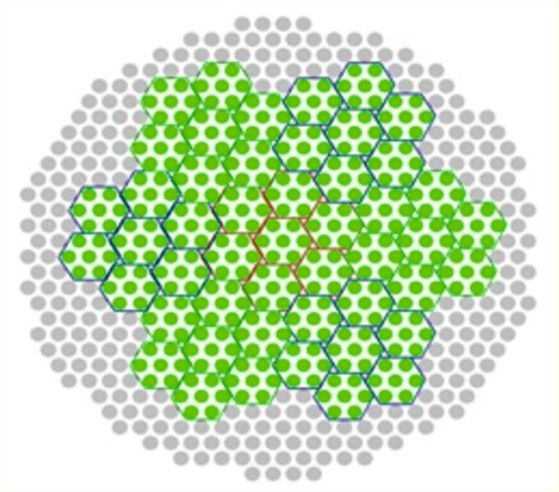


Figure 41. Screen shot from radar controller (RC), showing readiness (green) of seven clusters of ASTRAD. One cluster consists of 49 TRMs and thereby making total 343 TRMs.

the calibration and rectification/replacement jobs, the individual cluster (1 to 7) were initially radiated one by one. Once the performance of the individual clusters was ensured, all the 7 clusters (343 TRMs) were radiated in an integrated fashion **(Figure 41)**.

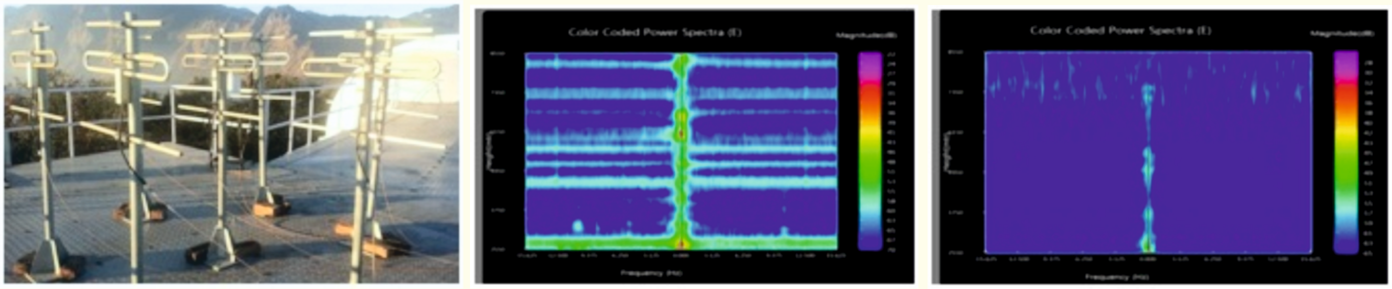
- Prof Avinash Deshpande (RRI, Bengaluru) visited the ASTRAD facility for a week in December 2016. During the period of his stay, series of experiments were conducted using ASTRAD system to explore the possibilities of radio astronomy research. This activity has also helped us in characterizing the system performance in receive mode.

- During the process, a cluster of seven TRMs was also tested by ARIES team from the Atmospheric Science Building (**Figure 42**) (from where low altitude surrounding mountains are seen) and promising results in terms of the lower levels of center patches were seen when compared to those at ASTRAD building. All these activities led to the modifications, particularly in the improvement of EMI/EMC shielding of the DSP subsystem.

- **Endurance test:** After trial operation for five days with different experimental specification files, the 72 hrs endurance test (using 7 clusters) was also done by ARIES to assess the durability and stability of each sub system. During the endurance test, health and performance of each sub system were monitored critically and abnormalities/malfunctions were noted and examined.

- **Profiles with seven clusters:** ST Radar has been operated for about 430 hours, during 20 January – 31 March, 2017 and average height coverage has been 8.3±1.9 km with maximum height up to about 12 km during the observation period **(Figure 43)**. Despite multiple limitations, operation with seven clusters produced a bunch of promising Doppler spectrum profiles. Beam symmetry in east-west and north-south directions are clearly evident with height coverage up to 10-11 km. Moreover, observed pattern is also consistent with the general patterns in winter over this region. It is anticipated that further fine-tuning (removing interference, zero clutter and other noisy signals) may improve the height coverage considerably.

- **Comparisons with balloon-borne in-situ winds observation:** Radar extracted wind profiles were compared with the in-situ balloon-borne wind observations **(Figure 44)** during the readiness of seven clusters, endurance test and after the completion



Antenna on the roof top of Atmospheric Science building

Received spectra at ASTRAD building

Received spectra on the top of Atmospheric Science building

Figure 42. A test setup (seven units) on the roof top of atmospheric science building (area with a relatively less clutter). A comparison of received spectra between ST Radar site and atmospheric science building confirmed the need of clutter fencing at the ST Radar site.

of endurance test. The height coverage (10-11 km) obtained with seven clusters at max 6.4 % duty ratio (roughly half power) is reasonably good.

- In the process of the readiness of 7 clusters, ARIES has also installed indigenously developed power supply display **(Figure 45)** and in-line surge arrestor with grounding network in one cluster (49 units) for improving the electrical performance of the system. Now, there is a plan to implement this setup in remaining 11 clusters (539 units).

- Students from different engineering colleges did project using ASTRAD system and became familiar with basic operation of the wind profiler radar. This training is the part of human resource development in the area of doing research using wind profile radar.

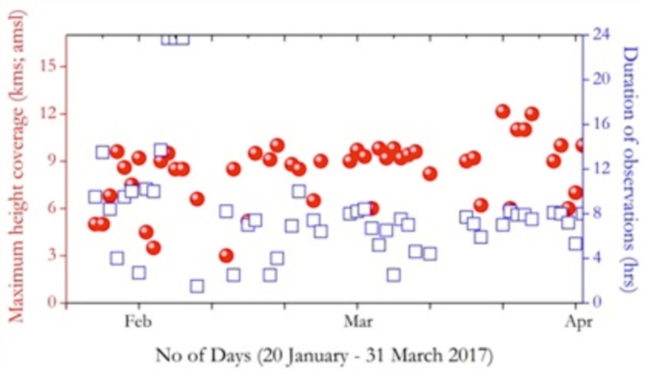


Figure 43. Height coverage and radar operation hours of ASTRAD.

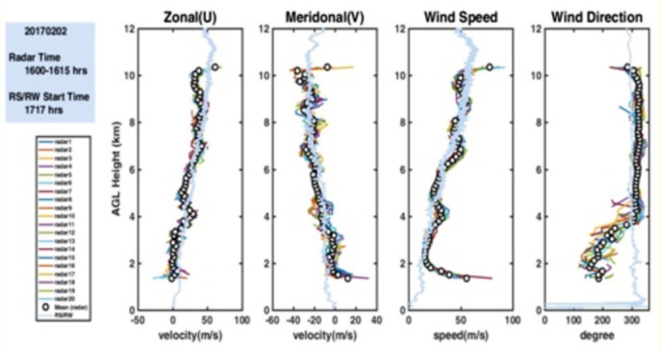


Figure 44. Comparison between balloon-borne winds (light blue) and radar winds (color lines and black circles) on 2 February, 2017.

Figure 45. ARIES has installed indigenously developed power supply display (in one cluster).

Status report on the upcoming instruments

4Kx4K CCD imager

The 4KX4K CCD Imager was mounted at the axial port on 18-19 March 2017 and several tests were conducted related to the performance of the telescope and the camera itself after re-coating of the M1 mirror. The imager was mounted at the axial port of the 3.6m DOT after the proposed AMOS Mission to replace Ball screws, replacing GPS card related issues during Feb-March 2017. The telescope related tests using the 4KX4K CCD included in/out-focus images and images related to the pointing and tracking of the telescope. It was decided by the authorities that the 4KX4K CCD Imager will be one of the first light instruments available for observations during first cycle of observations starting from 1st April 2017.

On 19th March 2017, pointing model for the CCD imager was generated and analyzed using s/w T-point before implementing to the TCS. Later on, during next several night, sky images were acquired both in open and closed loop conditions and at various zenith distances. The pointing of the telescope was generally found to be OK in the field of the CCD imager. The open loop tracking accuracy was also noticed to be fine though limited by the given seeing conditions both in binned and un-binned modes of observations. Also, bias and sky-flat frames in different filters were taken to test the camera performance in several possible combinations of gain and read-out noise values. Images in various filters with exposure times of 60 sec to 600 sec were acquired to check for the tracking of the telescope both in open and closed loop conditions. The circularity and radial profiles of many stars in the

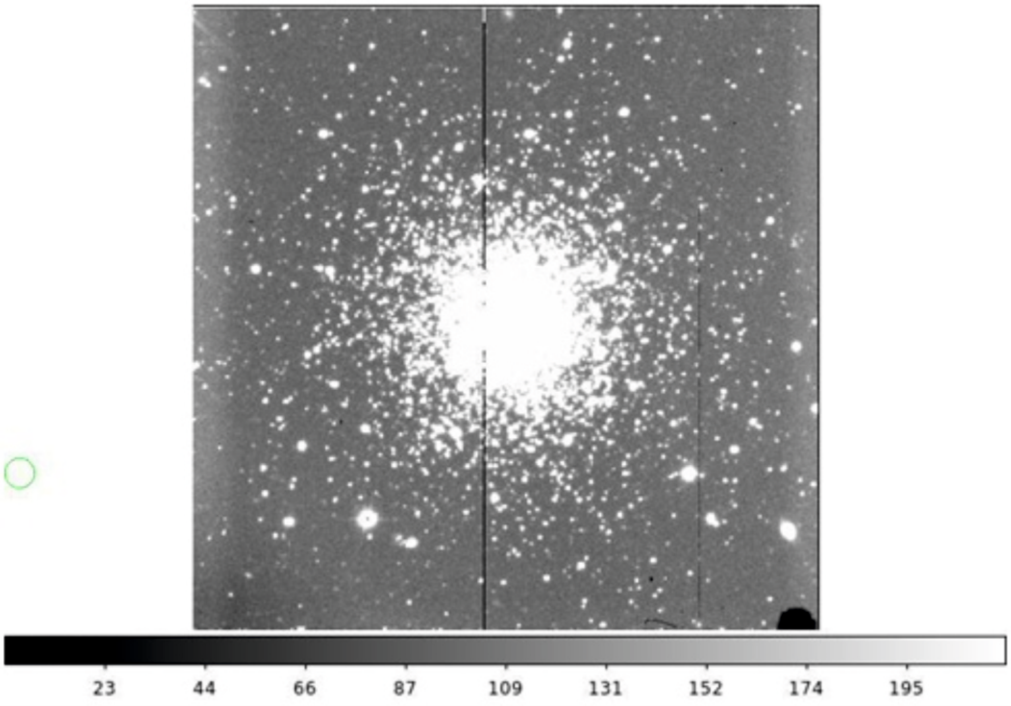


Figure 46. An example of the *B*-band frame pre-processed (cleaned, trimmed and cosmic-rays removed) of the Globular cluster field NGC 4147 taken in closed loop conditions having a single exposure of 600sec with the 4KX4K CCD imager mounted at the axial port of the 3.6m DOT on 23rd March 2017.

fields of observations (both NGC 4147 and Landolt PG standard fields) done for the calibration purposes were checked and verified using standard IRAF routines. The FWHM of stars were found to be nearly similar within the single frame of observations. The range of FWHM varies from frame to frame from 1.6 arcsec to 1.2 arcsec later in the night as seeing improves. In later observations, FWHM of < 1 arcsec was also noticed.

Attempts were also made to calibrate Globular cluster field NGC 4147 by acquiring data in B and R filters with an exposure time of 60 sec to 600 sec to cover both bright and faint stars in the field. For the calibration purposes, Landolt standard field PG1525 and PG1528 in BVR filters having a good color range around similar airmass values were observed. The pre-processing of the images was done using the bias and flat frames observed in respective filters using standard IRAF routine called "ccdproc" after trimming the images to remove the over-scan area. The task "cosmicrays" was used to remove the cosmic hits in various exposures and images were stacked wherever required. After the pre-processing is done, the DAOPHOT-II FORTRAN subroutines in sequential standard order (ie. Daogrow, ndaomatch, ndaomster, nccdstd, nccdlib, nfinal...etc) were used to calculate the transformation coefficients determined using the observed Landolt standard fields. These transformations were then applied to the observed globular cluster field NGC 4147 to calibrate the field.

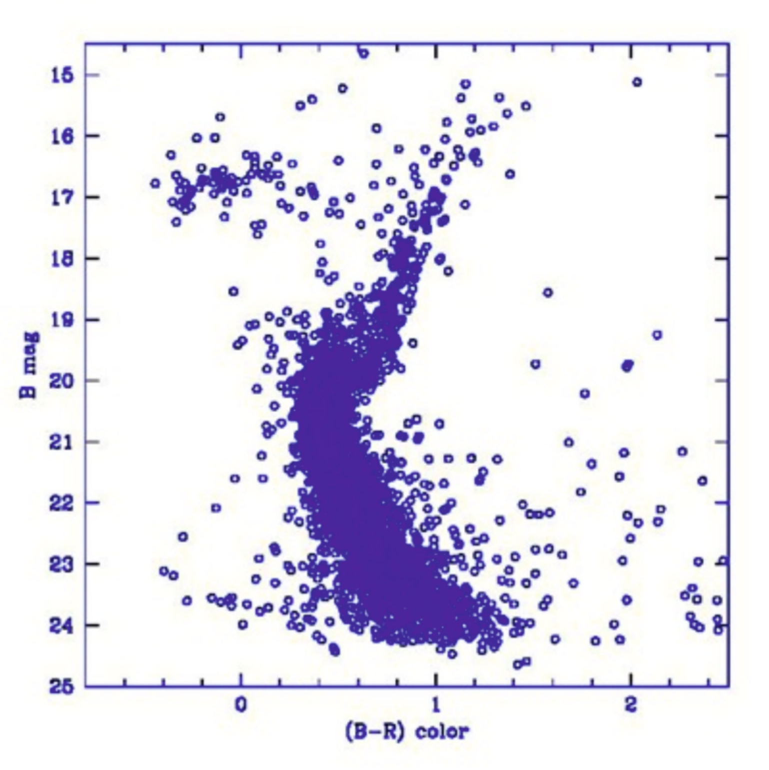


Figure 47. The color-magnitude diagram (CMD) of the Globular cluster NGC 4147 as obtained using the present calibration data taken using the 4KX4K CCD mounted at the axial port of the 3.6m DOT. The total number of common stars plotted (detected in both the filters) are around 3500 with a photometric accuracy of < 0.2 mag. The number of stars having B < 24 mag are around 150. There are many more detections for which error could not be established using the present data set. The scattering in the CMD could be due to membership issue which has not been accounted for at this stage of calibration. The main branch and other features typical for this cluster are clearly identified using our data set observed in B and R filters. If we go deeper in good seeing conditions, even fainter point sources could be detected with an improved photometric accuracy.

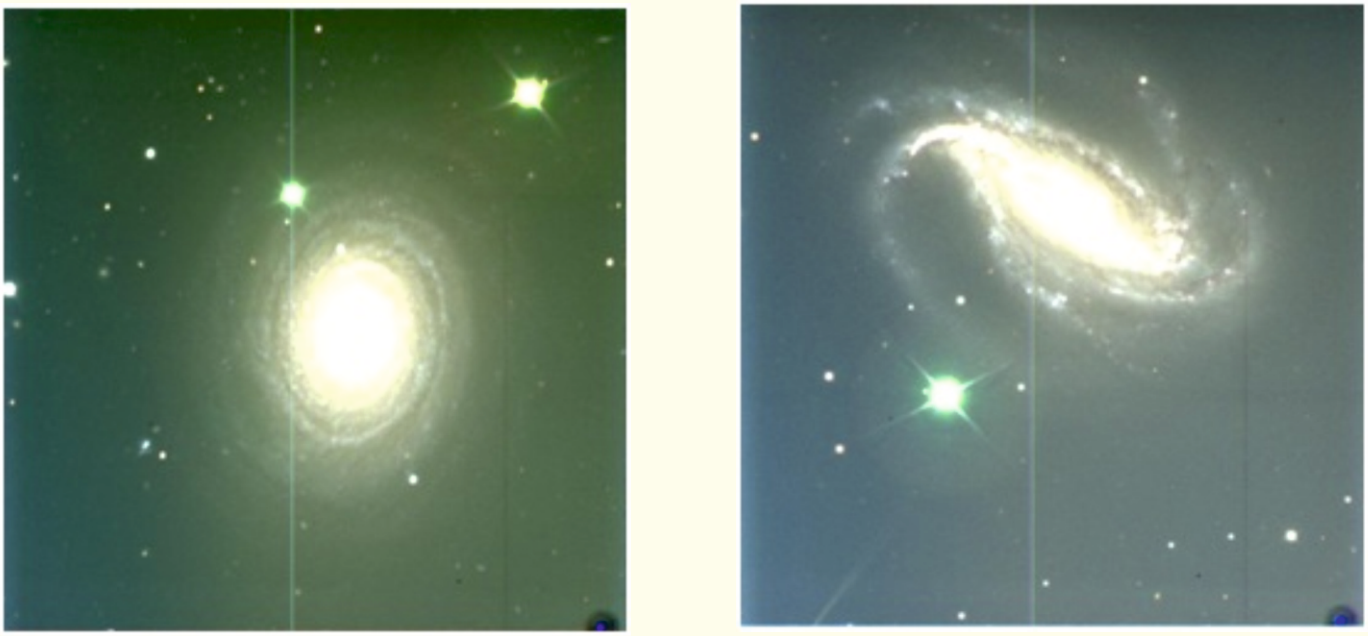


Figure 48. Colour composite RGB images of NGC 488 (left, 3x200 sec) and NGC 613 (right, 3x200 sec) as observed with the 4Kx4K CCD Imager mounted at the axial port of the 3.6m DOT during March 2017.

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

A spectrograph similar to FOSC has been designed, developed, and assembled at ARIES, Nainital through in-house research and development activities. This instrument is a low-resolution (R~2000) 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. The instrument was tested on the 3.6m DOT,and first engineering lights in imaging and spectroscopy modes were obtained in early 2016. The quality of the test images was satisfactory within the seeing limitations.Various mechanical and opto-mechanical tests are being performed on this instrument using the 3.6m DOT. The internal spectral calibration unit with a motorized focus unit is being manufactured in ARIES workshop using the CNC machine. The precision optics for the calibration unit and a wedge-prism for the spectroscopy have been manufactured within the country. A large-format closed-cycle cryogenically cooled 4Kx4K CCD camera is under development in ARIES clean room in a technical collaboration with the

Figure 49. The FOSC-type instrument mounted at the Cassegrain focus of the 3.6m DOT for conducting various engineering tests. The anti-flexure units (black pipes) are mounted on the sides of the spectrograph to prevent mechanical flexure during the movement of the spectrograph.

engineers from the Herzberg Institute of Astrophysics, Canada. The following modes of the science operations will be 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 in single color-band or in the prism-spectroscopy (multi-color) mode using an electron-multiplying frame-transfer CCD camera.

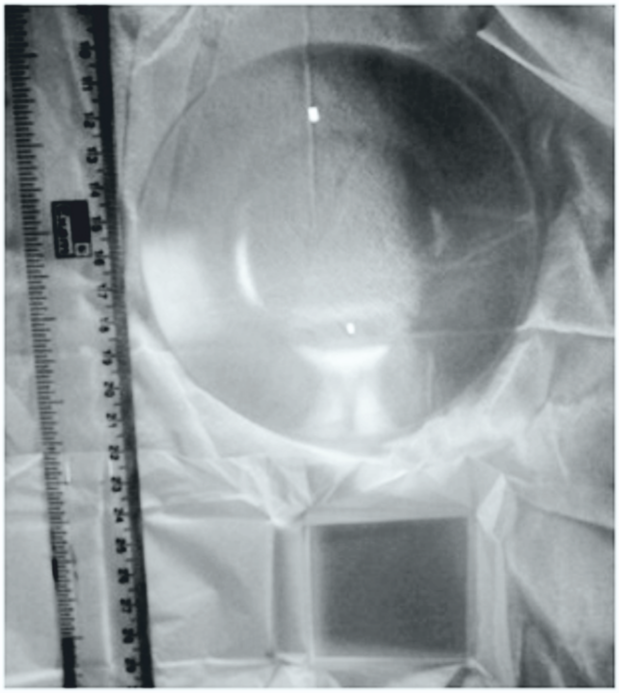


Figure 50. The lens for the spectral unit and the wedge-prism for the spectroscopy were manufactured in Dehradun, Uttarakhand.

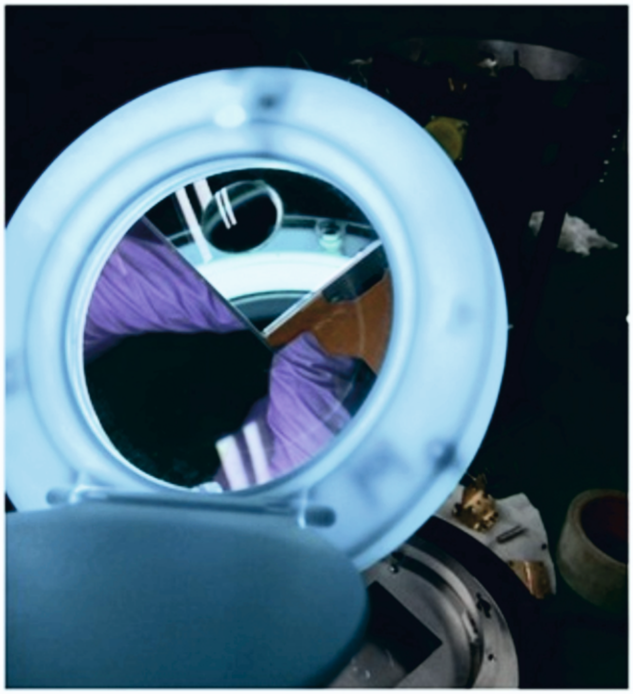


Figure 51. The assembly of the 4096x4096 CCD chip in the camera being performed inside the ARIES clean room facility.

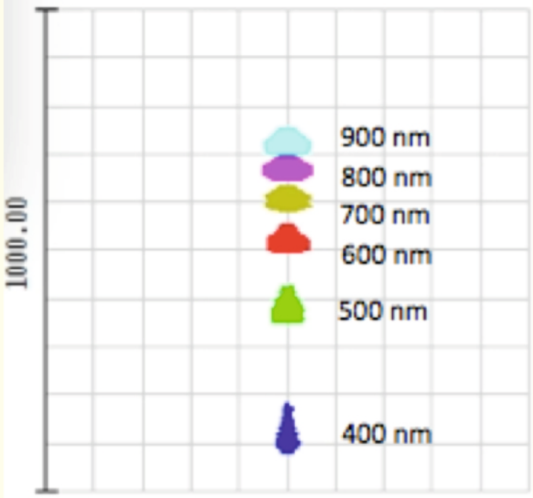


Figure 52. The simulated prism spectrum formed on an image size 1 mm x 1 mm, using the wedge-prism in the FOSC-type spectrograph. This spectrum can be used to extract multi-colors at milli-second cadence using an electron-multiplying frame-transfer CCD camera.

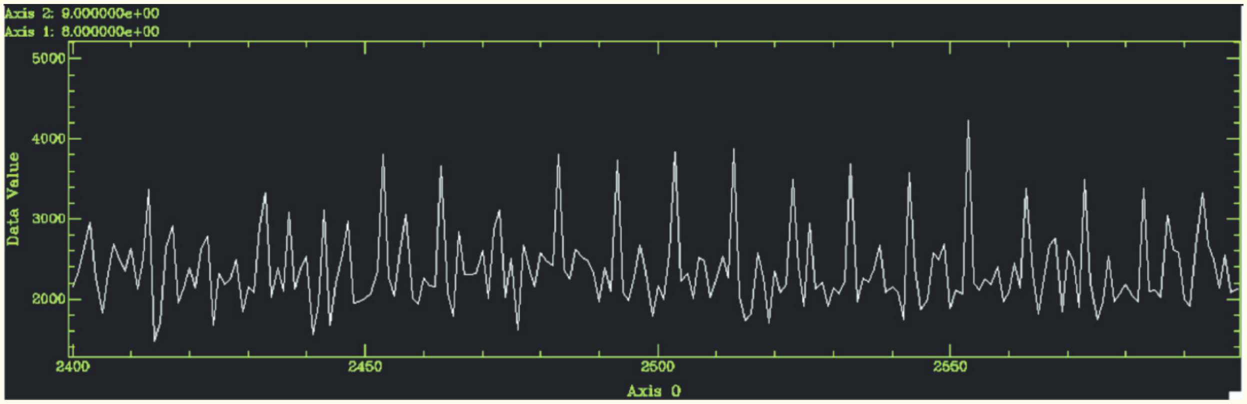


Figure 53. The individual pulses from the Crab-pulsar (PSR0531+21; average V-mag ~ 16.7) detected using the 3.6m DOT, using a test-up with the electron-multiplying frame-transfer CCD camera for FOSC. Each data-record is of ~3.37 ms duration. The main pulse emission is separated by 10 frames or a period of 33.7 ms.

TIFR-ARIES Near Infrared Spectrometer (TANSPEC)

TANSPEC is being built in collaboration with MKIR, Hawaii for the 3.6m Devasthal Optical Telescope (DOT). It will be a unique spectrograph which provides simultaneous wavelength coverage from 550 nm to 2540 nm, and a resolving power of R ~ 2750. Spectrograph operates in two modes which images the spectrum on to a 2Kx2K H2RG array. In cross-dispersed (XD) mode combination of a grating and two prisms are used to pack all the orders on to the H2RG array at a resolution of R ~ 2750. It also has a low resolution prism mode (R ~ 150) for high throughput observations. TANSPEC consists of an independent imaging camera with a 1Kx1K H1RG detector. The reflected beam from slit (built-in slit viewer) is imaged to this camera through a filter wheel which consists of broad band r', i', Y, J, H, Ks and narrow band H2 & BrG filters. This camera has a field of view of 1x1 arcmin^2, and is used for guiding the telescope (IR guider) as well as imaging field for photometry. It also functions as a pupil viewer for instrument alignment on the telescope. For calibration, a uniform flat field from an integrating sphere outside the dewar as an identical f/9 beam from telescope will be imaged. Wavelength calibration will be done by Argon and Neon lamps. Spectroscopy sensitivity (100-σ in 1 hour, 1" seeing) is expected to be 15.4 mag (R ~ 2750), whereas in prism mode (R ~ 100) it would be 17.3 mag in the J-band. TANSPEC will be used for a wide range of studies from local star formation to extra-galactic astronomy.

Simultaneous coverage of wavelength from 550 nm to 2540 nm makes TANSPEC a unique instrument and ideal for studies which require simultaneous measurement of lines in optical and near-infrared. TANSPEC present status (July 2017) and planned work: MKIR has received all parts for the instrument with the exception of a few of the parts for the electronics mounting frame that are being manufactured. The assembly of the cryostat and all the mechanisms has been completed **(Figures 54 and 55)**. As of July 2017, the mechanism software testing has been completed. MKIR is now proceeding to the mechanism cold test which will take place over the next two weeks. With successful completion of the cold mechanism test MKIR will move onto the installation of the optics and detectors which are all in hand. The array readout software was completed and has been tested on the warm MUXs. MKIR is expecting about one month to install and check the alignment of the optics. MKIR will then do a cold test of the complete instrument about the end of August 2017. From that point MKIR will be addressing issues discovered in the cold tests until we pass the acceptance tests as specified in the contract. TANSPEC is

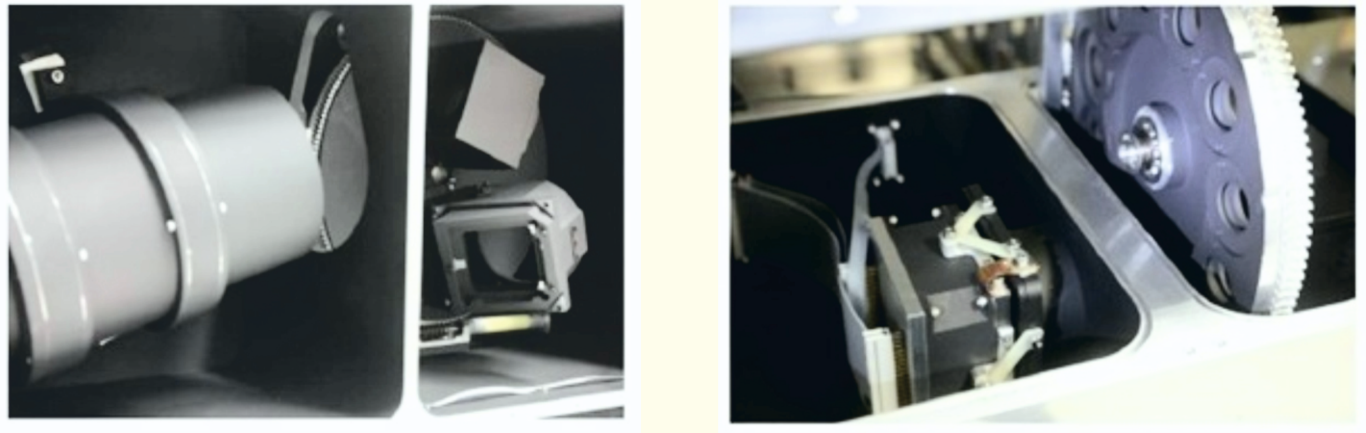


Figure 54. TANSPEC mechanism ready for the cold test.

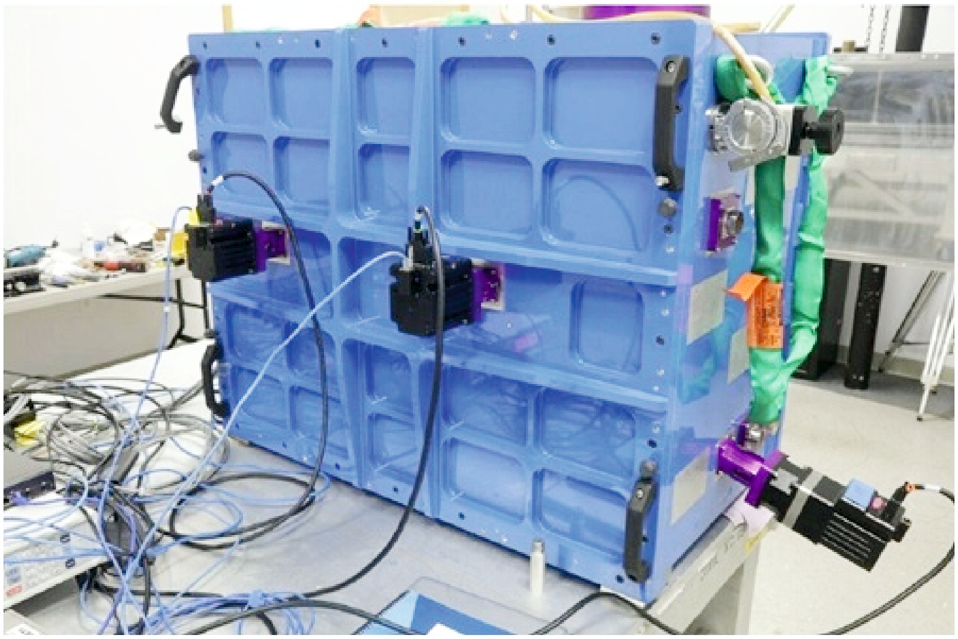


Figure 55. The assembly of the cryostat and all the mechanism ready for the cold mechanism test.

expected to be shipped to DOT by December 2017. It will be ready for tests on telescope during the end of next observing cycle and observatory time will be necessary for its tests during January – February, 2018.

Summary:

TANSPEC overall progress is on schedule. TANSPEC first cool down tests were completed successfully in January 2017. MKIR will do a cold test of the complete instrument (after installation of the optics and detectors) about the end of August, 2017. The instrument will be shipped to the DOT in December, 2017. We would be looking TANSPEC at the earliest on the 3.6meter telescope of late January, 2018. Test run and calibration nights for TANSPEC on the DOT is proposed on end of January 2018 (full moon ± 6 days).

Thirty meter telescope – a status report

ARIES as one of the founder PI institutes, is involved towards the project since very beginning of the project. Ongoing activities at ARIES related to the TMT project were presented in detail during 29th GC meeting of ARIES. During last one year, major achievement by ARIES is the successful completion of the contract with the two firms (M/s Godrej Mumbai and Avasarala Bangalore) to manufacture the prototypes of 6 sets of segment support assemblies. ARIES has actively participated during weekly Monday core-group I-TMT meeting along with bi-weekly video-conferencing with the project office in Pasadena and institutes participating in India. Also, Director ARIES and co-ordinator of TMT related activities at ARIES regularly participate to the project management board meetings to take decisions on the various technical and administrative aspects related to the project.

The Science Advisory Committee (SAC) is a committee of the Thirty-Meter Telescope International Observatory LLC (TIO) Board of Directors. The SAC is an advisory committee, representing the scientific interests of the TIO Members, including making recommendations to the Board regarding science priorities and instrumentation. India has a team of scientists representing the SAC and Dr. S. B. Pandey is one of the member from ARIES. The detailed about SAC responsibilities are outlined at http://www.tmt.org/about-tmt/science-advisory-committee. SAC has also recommended to form International Science Developmental Teams (ISDTs) throughout the world to work and develop different science cases.

Figure 56. Artist's Rendering of the Thirty Meter Telescope (Image Source: www.google.com)

Report from existing observing facilities

1.04m Sampurnanand Telescope

Since 1972, the 1.04m Sampurnanand Telescope (ST) located at ARIES, Manora Peak, Nainital continued to be utilized as a main observing facility in the optical domain by the students and scientists of ARIES. The preventive maintenance and the telescope image quality tests were carried out regularly by the scientists and the engineering staff of the ST. The problems related to the image quality and telescope pointing were satisfactorily rectified by the ARIES team.

The performance of the major back-end instruments Tek 1K CCD and ARIES Imaging Polarimeter (AIMPOL) was good. A new PyLoN 1300x1340 CCD from Princeton Instruments was procured and characterized during 2016-17 observing run. Different scientific programs such as study of star-clusters, young star-forming regions, HII regions, AGN and brown dwarfs, optical counterpart of gamma ray bursts (GRBs), supernovae and X-ray sources, polarimetric studies of open clusters, star-forming regions and late type stars were carried out with ST.

Joint Time Allocation Committee (JTAC) allotted nearly 50% of telescope time for CCD imaging, nearly 40% time for imaging polarimetry and 10% time was reserved for Target of Opportunity (ToO) observations. During the period of 2016-17, a total of 103 clear nights were observed out of 273 allotted nights. There were 9 publications in refereed journals during 2016-17 based on the data taken from ST. The total research output of the ST has reached nearly 364 scientific publications in different refereed journals and 45 PhD theses.

The 1.04m primary mirror (M1) of ST was aluminised on 08 September 2016 after a gap of four years. Several new technical, engineering and scientific staff were included in the team and trained in the execution. One new additional hoist (mainly for safety purpose) was installed in the 1.04m telescope house on the reverse roof of dome. Proper supporting staff had to be contracted on day to day basis as per requirements of handling, transporting and assembly of heavy, delicate and precision instruments, components and optics, in particular.

After completion of the aluminisation and repairing mirror support assembly, the optical alignment of the telescope was done sucessfully. Good image quality (FWHM of the stellar image up to 1.4 arcsec) as well as mechanical stability of the telescope were achieved.

1.3m Devasthal Fast Optical Telescope

The 1.3m Devasthal Fast Optical Telescope (DFOT) located in Devasthal, ARIES is operational since 2010. A regular maintenance/checkup and cleaning of the primary mirror of the telescope is carried out each year after the end of monsoon period. Routine preventive maintenance of the telescope, backend instruments and updating the pointing model are also done regularly.

Several new initiatives to improve and upgrade the 1.3m telescope were taken and some of them are listed below.

Wireless dome movement: Because of the coiling cable arrangement for the dome movement, the problem due to shorting/mixing/twisting of cables was occurring frequently. This has been rectified by changing the wiring arrangement completely and using the limit switches and blade contacts. The hanging wire attached to the dome for its movement has been removed.

Automatic mechanical dome lock: An arrangement to automatically lock the dome, when the dome is closed, was implemented. It will open when the shutter is opened and then the dome can be moved.

Filter automation (Electro-mechanical and software controlled): The imager designed by DFM needs to be moved by hand pedal to move the filters. The manual filter movement was cumbersome and time taking. An arrangement to move the filters using DC motors and controlled by a panel placed inside the observing room was made which takes about 80sec to move from one filter to another. Recently the system was upgraded and the filter movement time is reduced to 14sec.

Online web portal for the 1.3m weather station: The weather station has been integrated with the all sky camera and dedicated web portal has been created which gives graphical information of the weather parameters.

Development of web based interfaces for 1.3m telescope: Web based interfaces such as online observation logs, online list of publications/documents, online observed nights, online feedback/maintenance facility, online weather station, online data archive, online documentation etc. has been developed.

Observatory Control System: Observatory Control System (OCS) simplifies the observations taken through three interfaces i.e., Telescope Control System (TCS), instrument interface and filter interface and puts necessary information in the image header. OCS is being developed indigenously and is operational.

Repair works: Telescope and its control unit along with various instruments/cameras such as auto-guider camera, all-sky camera, 512x512 camera, 2Kx2K camera, weather station were repaired successfully.

Infrastructural works: Several steps have been taken to develop the infrastructure at 1.3m telescope building such as creation of office/lab space, purchase of mechanical/electrical trolley, purchase of computers/ workstation for data archiving and data handling for the observers, purchase of furniture and other necessary items.

A total of 113 clear nights were observed out of 127 allotted nights during 2016-17. The data acquired with the 1.3m telescope has resulted in 40 publications in refereed journals.

3.6m Devasthal Optical Telescope Facility

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

The 3.6m DOT project was completed in 2016. The telescope has been put into regular operation since March 2016. The activities of this national facility is also monitored periodically by a ten member Project Management Board (PMB) chaired by Prof. P. C. Agrawal and co-chaired by Prof. S. Ananthakrishnan. The day-to-day activities related to scientific, technical and financial aspect of the project is executed by Astronomer In-charge under the guidance and supervision of the Director, ARIES. The PMB met at one occasion, i.e. on 14th July 2016 during the financial year.

During the previous financial year, rigorous tests were conducted to verify the performance of telescope and the telescope was accepted in February 2016 and subsequently, the technical activation of the facility took place on 30th March 2016. During the current financial year April 2016 – March 2017, following activities were performed.

Instrument test runs with the 3.6m telescope: The back-end instruments viz 4K-Imager, TIRCAM2 (TIFR

Infrared Camera-II) and FOSC (Faint Object Spectrograph and Camera) were tested with the telescope for interface and on-sky performance. The 4K-Imager was mounted with telescopes on 31 Mar 2016, 3-5 Oct 2016, 24-27 Oct 2016, 2-3 Nov 2017 and 22-31 Mar 2017. The characterization of instrument was well achieved by the team. The faintest point source observed at B-band was 24.0+/-0.2 mag in 25-min summed exposure. The TIRCAM2, a near infrared imaging camera developed by TIFR was mounted with the telescope during 1-7 Jun 2016 and 7-17 Jan 2017. During later run, a discussion meeting/training was also organized between ARIES and TIFR team for the mounting and operation of TIRCAM2 with the telescope. With TIRCAM2, one could reach sensitivity of 17 mag in J and 15.3 mag in K for 100sec and 150sec exposures respectively in typical seeing conditions. The FOSC instrument was mounted in the month of May 2016 and Feb 2017 to check the instrument interface with the telescope and to do anti-flexure calibrations.

Replacement of UMAC and GPS Card: The replacement of UMAC card was achieved successfully during 13-16 May 2016. This was a complex process. The replacement of malfunctioning GPS (Geo-positioning System) card was done by ARIES team with remote assistance from AMOS, Belgium during 20-22 December 2016. The task of configuration of a spare TCS PC was also achieved successfully.

M1 coating and SAF Ballscrew replacement: The aluminium coating of primary mirror (M1) of 3.6m telescope and replacement of Sensor Arm Focus (SAF) ballscrew was performed during 1-21 March 2017. From AMOS, Mr.Jonathan de Ville (Mechnaical engineer) and Mr. Christian Bastin (electronics/system) supervised the activities. The activities were executed by the engineering team of ARIES. Overall coordination of the activities (scientific, technical, administrative) was done by Astronomer in-charge (ADOT) in consultation with Director ARIES. During engineering-heavy activities period from 1st to 17th Mar 2017, the scientist from ARIES also participated and interacted with the engineering and technical team at site, to get acquainted with the working and scientific principle of each module of telescope. The sky tests of telescope was performed during nights of 18, 19, 20 and 21st March 2017. The IMAGER was mounted on 18th March and most of the tests were also performed using this instrument. The imager team was also present during test nights to take training from AMOS and sort out any technical issue on working of telescope and imager instrument together. During scientific-heavy activities from the night of 18th March to 1st April, all the prospective users of telescope (scientists from ARIES) were requested to get training on working of telescope and imager, so that they could get confidence while using the telescope for their allotted nights by DTAC (DOT Time allotment Committee) for 2017A-early science cycle.

The key tasks performed during March Mission are summarised as follows . (1) M1 dismounting and coating : (a) M1 axial fixed point-1 regluing; (b) M1 axial actuator repair; (c) M1 restrainers adjustment; (d) M1 cell refurbishment; (e) M1 axial fixed point-2 needle replacement; (2) SAF Ball screw replacement: (a) Replacement and functional tests; (b) Good health procedure; (c) Performance tests; (3). Camera shutter replacement and cleaning (4) Miscellaneous Activities: (a) Update of old GPS card; (b) Active Optics System (AOS) update; (c) Software installation; (d) Issue in PLC module of ARISS (Adapter Rotator Instrument Support Structure) Cabinet (e) M2 hexapod issue; (5) Sky tests; (a) Pointing test; (b) Telescope alignment using AOS-Wave-front System) WFS; (c) Other tests and training (6) Documentation : A detailed digital recording of the activities was done in three modes i.e. still camera is used to record key snapshots of stage completion, the handicam was used to do continuous recording of certain stage activity, the web cameras are used to record the whole day event continuously. (7) sky tests: The pointing model was created again for the AGU guider and for imager separately. Initial pointing model for imager was done with 30 stars and later on we added 40 more stars.

The pointing accuracy of the telescope was checked and it was found to be at par with the results achieved during acceptance of telescope. The image quality of telescope, particularly the M1 open loop parameters were recomputed using wave front system of telescope. The RMS wavefront error was achieved close to 50nm using AGU-WFS. This value is at par with that achieved during acceptance of telescope Long exposure images were taken with 4k Imager with guider in night of 1st April 2017 Images of Full Width at Half Maximum (FWHM) 0.7 arcsec in R-band were recorded.

Call for announcement for Observing cycle 2017A – Early Science (April-May 2017): In anticipation of timely and successful completion of coating activity, the Devasthal Time allotment Committee (DTAC) announced the call for observing proposals from 3.6m DOT for early science for the period April-May 2017. Meetings were held in February and March to finalise the submission, and review for proposals. The scheduling of nights in 3.6m DOT was prepared by end of March 2017. A rigorous training schedule was prepared and executed to train users of 3.6m DOT from ARIES. This training was imparted by the 3.6m DOT scientific team to other scientist member of the institute. The newly appointed night operation team was also trained during several nights/day in month of March 2017. The manuals for operation of various units of 3.6m DOT facilty were prepared and put in place.

Miscellaneous activities: Update on 3.6m DOT facility was presented at different forums during the financial year. Five contributions related to various components of the facility viz telescope performance, synchronisation of dome with telescope, aluminium coating of 3.6m primary mirrors, friction characterization of telescope, customized overhead cranes were presented in the SPIE Conference on Astronomical Telescope and Instrumentation held during 26 Jun-1 Jul 2016, at Edinburg, United Kingdom. The work on 3.6m DOT facility was also presented at the Indo-Belgium BINA Workshop held during 15-19 Nov 2016 at ARIES Nainital.

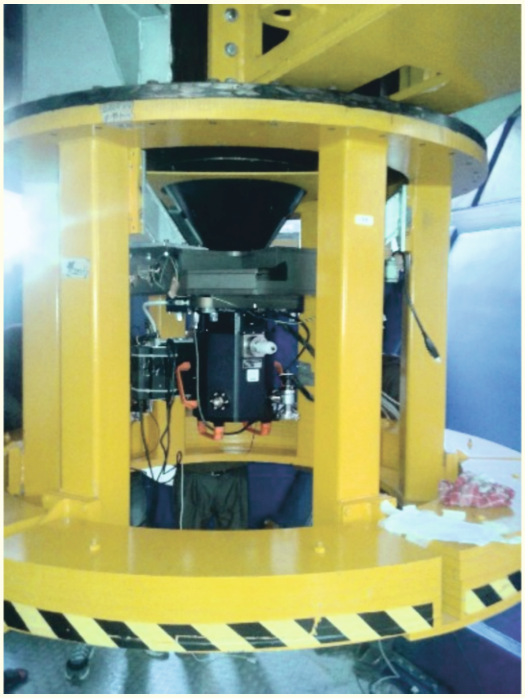


Figure 57. Picture of 4K Imager mounted with the 3.6m DOT for test and calibration.

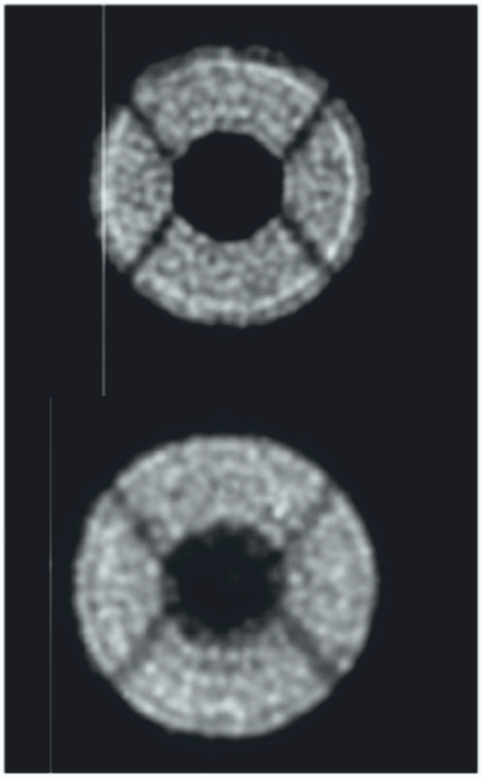


Figure 58. The in-focus and out-focus images were recorded using 4k CCD imager in night of 20th March 2017. This indicates satisfactory alignment of primary and secondary mirrors of 3.6m DOT.

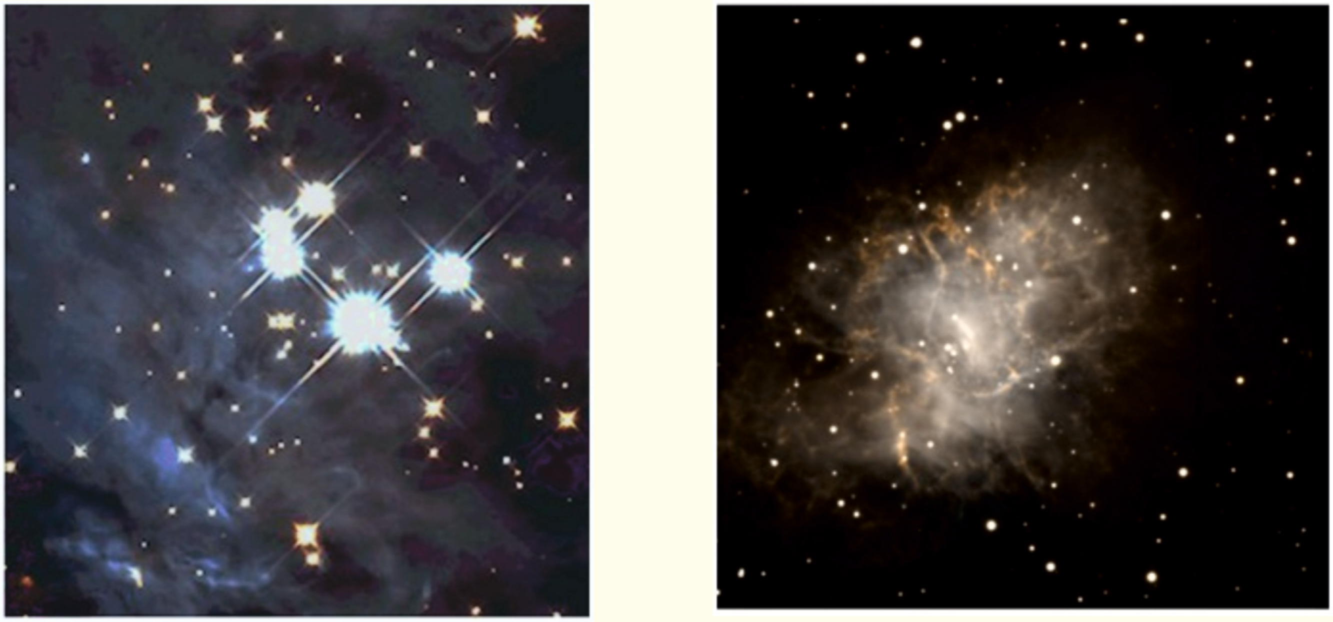


Figure 59. JHK Color composite picture of Trapezium Star Forming Region (left) observed with TIRCAM2 and the BR composite color image of a supernova remnant (Crab nebula) (right) observed with 4K IMAGER instrument.

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 60. The 15cm Coudé solar tower telescope for solar observations.

Report from the Labs

Electronics Lab:

The electronics laboratories (lab) at ARIES broadly cater towards 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. Initially, the central electronics lab was being utilized for this purpose but a few years back the scientific and engineering team shifted to newly developed office rooms and labs in the ST Radar building. These 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 overlap 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 61**) 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 3.6 m DOT and related instruments and auxiliary facilities are demanding distributed control electronics handling multiple tasks there is a strong requirement of real time operating systems (RTOS) and more powerful development platform rather than simple low cost microcontroller. Hence the embedded systems labs will be upgraded in a phased manner with the necessary software and hardware for implementing RTOS and tools required for FPGA and DSP based development work.

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 separate lab is being developed by partitioning the central electronics lab which will be equipped with tools like mixed signal oscilloscope, advanced function generators, programmable high accuracy power supplies, LCR meters, high accuracy bench top multimeter, vibration free bench, serial decoder and protocol analyser, test cameras, precision drilling and cutting tools etc. along with facilities like three phase supply, pneumatic supply, industrial PC with special interfacing ports etc. A full-fledged lab with the above tools and spares would be ready by the end of November 2017.

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. The section is located in the central electronics lab building.

Figure 61. Embedded systems lab in the 1.04m building.

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. 3.6m Primary mirror realuminisation

The aluminium coating on the primary mirror of telescope gets damaged over the period of time due to oxidation, dust, humidity etc. This results in the subsequent deterioration in the reflectivity values of the mirror. Hence to restore the reflectivity values of the mirror, it is required to coat the mirror surface with fresh aluminum coating. The 3.6m primary mirror of Devasthal Optical Telescope was recoated in March 2017. Following tasks have been executed prior/during the realuminisation activity.

(A) Status of the primary mirror before recoating: Primary mirror of 3.6m telescope was inspected for its reflectivity and it is found that the old coating has accumulated a large amount of dust which results in reduced reflectivity (approx 35%) of primary mirror. A small patch in the primary mirror was cleaned and reflectivity was measured again. Clean patch showed typical reflectivity of approximately 70%. So to improve the reflectivity of primary mirror it was decided to remove the old aluminium coating and apply a fresh coating to the mirror.

(B) Refurbishment of Devasthal coating plant: There was a leakage in the water pipeline used to cool the magnetron during the sputtering process. Due to which refurbishment of Devasthal coating plant was required. Magnetron was send to Hind High Vacuum (HHV) for repair. Repaired magnetron was reassembled into the coating plant and tested. Mass flow controller to control the flow of argon during IB cleaning and sputtering was also found to be faulty and was replaced. Testing and maintenance of coating plant continued for several weeks with HHV service engineer. Several other small components, connectors, gauges were also repaired/replaced. After repair, coating chamber was operated for many cycles to test the coating quality. For each cycle, glass samples were placed in coating chamber and after coating samples were tested for coating quality and reflectivity. The coating plant was made functional before the 3.6m primary mirror coating mission.

(C) Since mirror cleaning and coating removal process needs to be finished in one go, so proper procurement and arrangement of items (chemicals, tissues, cottons, distilled water etc) becomes very critical. So a through procedure for mirror cleaning and coating removal was prepared. A detailed list of items and quantity to be used during the process was prepared, procured and arranged well before the start of mirror cleaning process.

(D) Mirror cleaning, coating removal and realuminisation: Primary mirror was placed in the washing unit and a thorough cleaning procedure was followed which included removal of the old aluminum coating. The entire process lasted for about 7 hours. Cleaning and coating removal was done by using standard cleaning chemicals of high purity grade e.g. KOH, Acetone, HNO_3 etc, soap solution and distilled water.

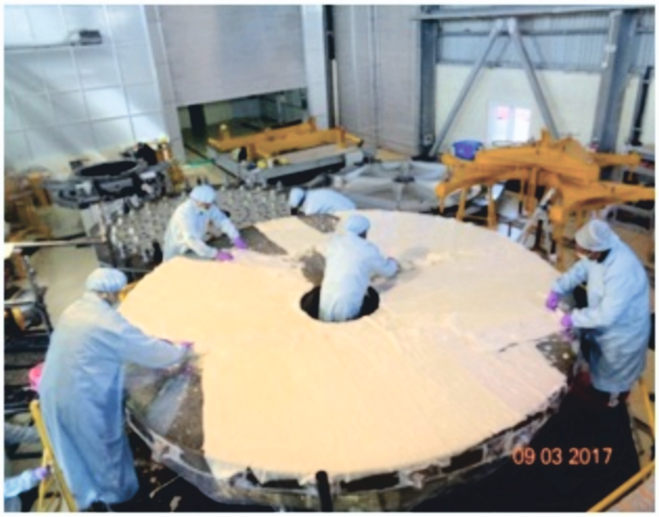


Figure 62. Cleaning mirror surface using soap solution and cotton pads.

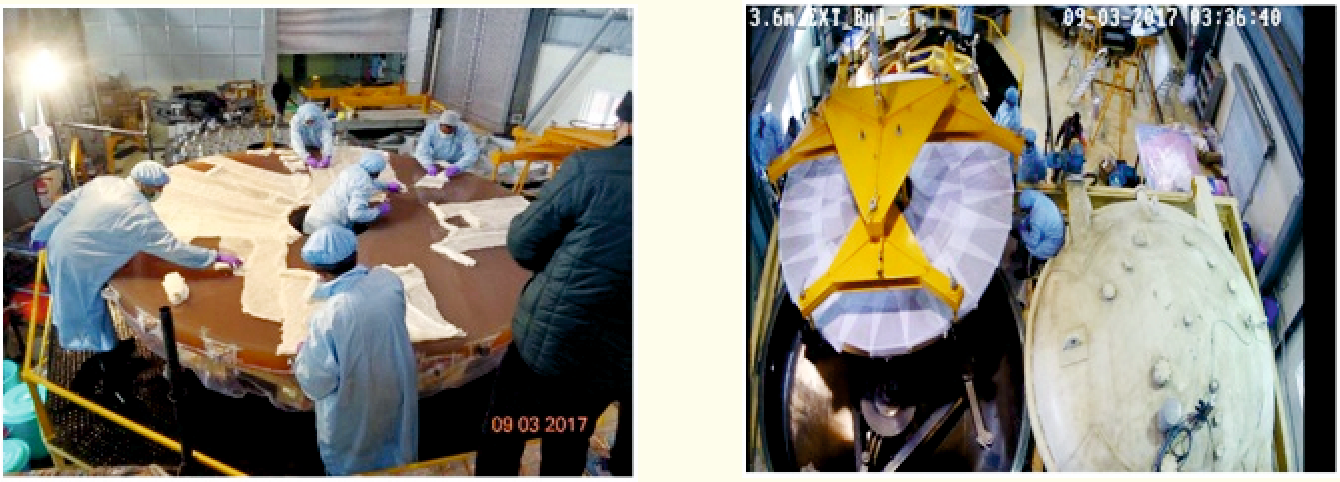


Figure 63. Removing old coating using KOH solution (left); placing mirror inside coating chamber using crane (right).

A good number of cotton pads were prepared and used during the cleaning procedure. Lint free tissues were used to dry the mirror surface after cleaning. The whole procedure was very delicate and requires utmost care while executing the steps. After cleaning the mirror was immediately placed into the coating chamber.

The coating process was carried out under precisely controlled high vacuum conditions using magnetron sputtering technique. Initially coating chamber was evacuated to vacuum level of $1x10^{-5}$ mbar using rotary, roots and cryo pumps. Ion beam cleaning was done in rough vacuum conditions, later the sputtering process was carried out in 10^{-3} mbar vacuum conditions with the help of one cryo pump.

Visual inspection of mirror surface shows a very good quality of coating. Mirror surface was fairly covered with aluminium layer with no left out areas in between. Scotch tape test was carried out to test the adhesion of the aluminum coating. Scotch tape was applied with gentle pressure at the edges of the coating and then removed. The test shows that aluminium does not come out during this process. So aluminium coating shows good adhesion to mirror surface. Reflectometer was used to measure reflectivity of primary mirror. The reflectivity value was above 60% at 365 nm wavelength, increasing to above 75 % at visible region and achieves peak value of about 86% towards redder wavelength.

2. 3.6m mirror mounting/dismounting, telescope/cell alignment

For realuminisation of 3.6m primary mirror, the mirror needs to be dismounted from the mirror cell and after fresh aluminisation the mirror needs to be aligned back in the system. This activity was performed in the supervision of AMOS engineer. Following steps were performed during this mission.

(i) Mirror cell was taken out from the telescope and placed on the six mounting posts located at extension building.

(ii) Mirror was detached from mirror cell: aperture stop, secure guards, radial pads, axial fixed points, restrainers etc. were loosened in a pre defined sequence.

(iii) Mirror is transported to the washing unit using mirror lifting tool and extension building crane.

(iv) Mirror cell is inspected; all radial pads, actuator, candles, fixed points etc were inspected and cleaned where necessary.

(v) After fresh coating, mirror is again placed precisely to the mirror cell and all the supporting pads, points, restrained were fixed again in a predefined sequence.

(vi) Mounting the mirror cell to the telescope centre piece.

(vii) An in-situ cleaning of pick off mirror (POM), side port fold mirrors (SPFM) etc. in the ARISS structure were also carried out.

3. 1.04m primary mirror realuminisation, telescope alignment and image testing

Primary mirror of 1.04m telescope was inspected for its reflectivity and it was found that the old coating has accumulated a large amount of dust which results in reduced reflectivity. So to improve the reflectivity of primary mirror a fresh coating was applied to the mirror.

Following steps were performed during this mission:

(i) Primary mirror cell was removed from the telescope.

(ii) Primary mirror was placed in the washing unit and a thorough cleaning procedure was followed which included removal of the old aluminum coating. Cleaning and coating removal was done by using standard cleaning chemicals of high purity grade e.g. KOH, Acetone, HNO_3 etc, soap solution and distilled water. A good number of cotton balls were prepared and used during the cleaning procedure. Lint free towels were used to dry the mirror surface after cleaning. The whole procedure is very delicate and requires utmost care while executing the steps. After cleaning the mirror was immediately placed into the coating chamber.

Figure 64. Cleaning M1 using soap solution (left), using KOH soaked cotton pads to remove old coating (centre) and rinsing with distilled water after coating removal (right).

After coating primary mirror was mounted back to the mirror cell. Preliminary alignment of primary mirror inside the mirror cell was performed. Mirror cell was integrated to the telescope. Precise alignment of the telescope was carried out by moving the secondary mirror of the telescope. A detailed alignment procedure using laser light, alignment telescope, centre piece etc was carried out. Finally defocus images were taken and analysed and further fine movement in the secondary mirror was applied to get the best image quality.

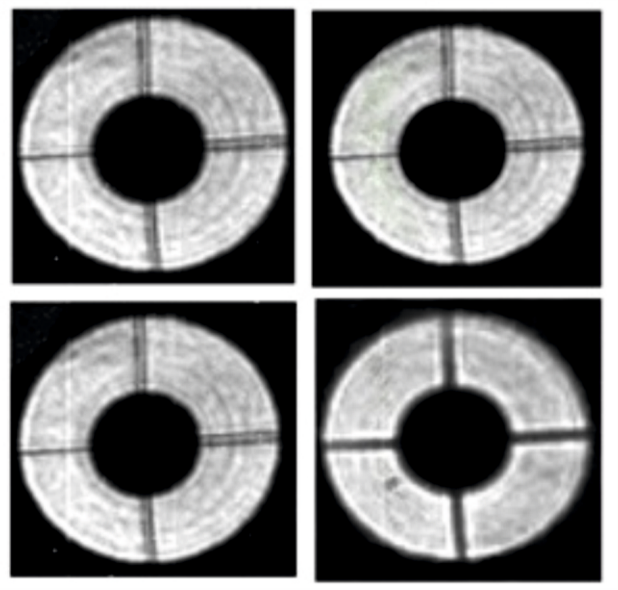


Figure 65. Defocussed images taken from 1.04m telescope.

4. 1.3m primary mirror cleaning and reflectivity measurement

In the visual inspection of 1.3m primay mirror it was found that it has accumulated a lot of dust. However the primary mirror has a protective SiO_2 coating, therefore we decided to clean the mirror using distilled water and soap solution instead of removing the coating. Instead of dismounting the mirror, like the case of 1.04m & 3.6m, incase of 1.3m insitu cleaning of primary mirror is possible. Corrector lens at the location of cassegrain port is removed and one person can go inside the cassegrain hole and perform the cleaning operation. One person can pass the cleaning items from the top location using a scaffolding platform. A thorough cleaning procedure was followed during the washing of primary mirror. Distilled water, soap solution, cotton pads etc were used during the cleaning. Lint free tissues were used to dry the mirror surface. Reflectivity value of above 85% was achieved across all the bands.

5. Calibration Unit

Optical design of calibration unit has been finialised using zemax software. The purpose of the calibration unit is to provide flat fielding and wavelength calibration facility to Faint Object Spectrograph and Camera (FOSC) instrument. There is a space of 440 mm from instrument flange to telescope focus. A fold mirror will be used in this space and light will be directed to the instrument. Calibration optics will simulate the f/9 telescope beam, illuminating the instrument pupil in the same way as light from an astronomical source. Light from the calibration sources will be diffused for uniform illumination. Arc line and halogen lamps will be used for line and flat field calibration. Specifications of flat fold mirror and calibration lens have also been finalised and their procurment is under process.

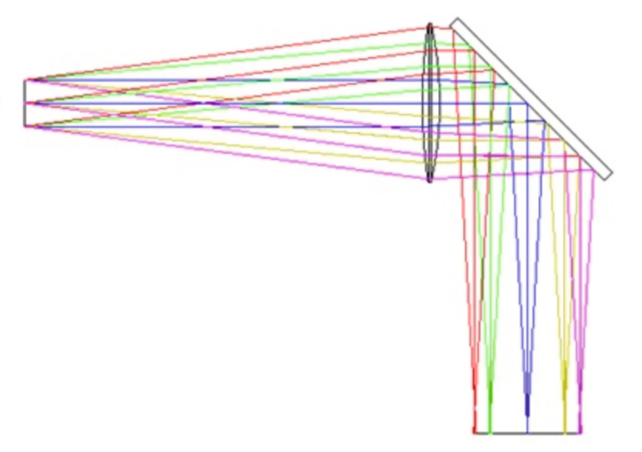


Figure 66. Optical ray diagram of calibration unit.

6. Precise optical alignment of FOSC was carried out. FOSC was mounted on the 3.6m telescope and few star images were taken using a test camera.

7. 4Kx4K CCD of imager was evacuated and CCD was cooled to -120°C using liquid nitrogen. Dry nitrogen purging was also used to remove moisture from CCD window. Further, imager instrument was mounted on 3.6m telescope and made ready for observations.

8. Guide port fold mirror was mounted and aligned to the 1.3m telescope system.

9. Refletometer, CO_2 snow cleaning gun, SDSS filters, narrow band filters, etc. have been procured.

Mechanical Engineering Section

To fulfill the stringent requirements in astronomical and atmospheric instrumentation a fairly well equipped mechanical section has been established. Mechanical section is actively involved in design , development and maintenance activities viz. 3.6m telescope, IMAGER, ADFOSC, 1.3m telescope , 40" telescope ,CCD attachments, Encoder system and optical alignment. The 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. 3D modeling (Pro E, UG), detailing (Auto Cad), structural analysis (Ansys) and master cam programming are successfully done in the section. Dome and enclosure installation for large and small telescopes were done by involving private firms. Infrastructure development and maintenance of the institute campus is also undertaken by the mechanical section. From time to time, the section conducts training programmes and also provides guidance to short term project students.

Major Contribution

1. 3.6m Telescope Aluminizing

4 tons optical mirror and allied mechanisms were successfully dismounted from the telescope and reassembled back after completion of aluminizing, replacing ball screw etc.

Figure 67. 3.6m telescope mirror handling.

2. ILMT Telescope

Transportation of ILMT containers and installation of ILMT telescope has been successfully completed with AMOS team at Devasthal.

3. ADFOSC

Design, analysis, development, inspection and supervising the complete process of calibration unit was done in-house for 3.6m telescope.

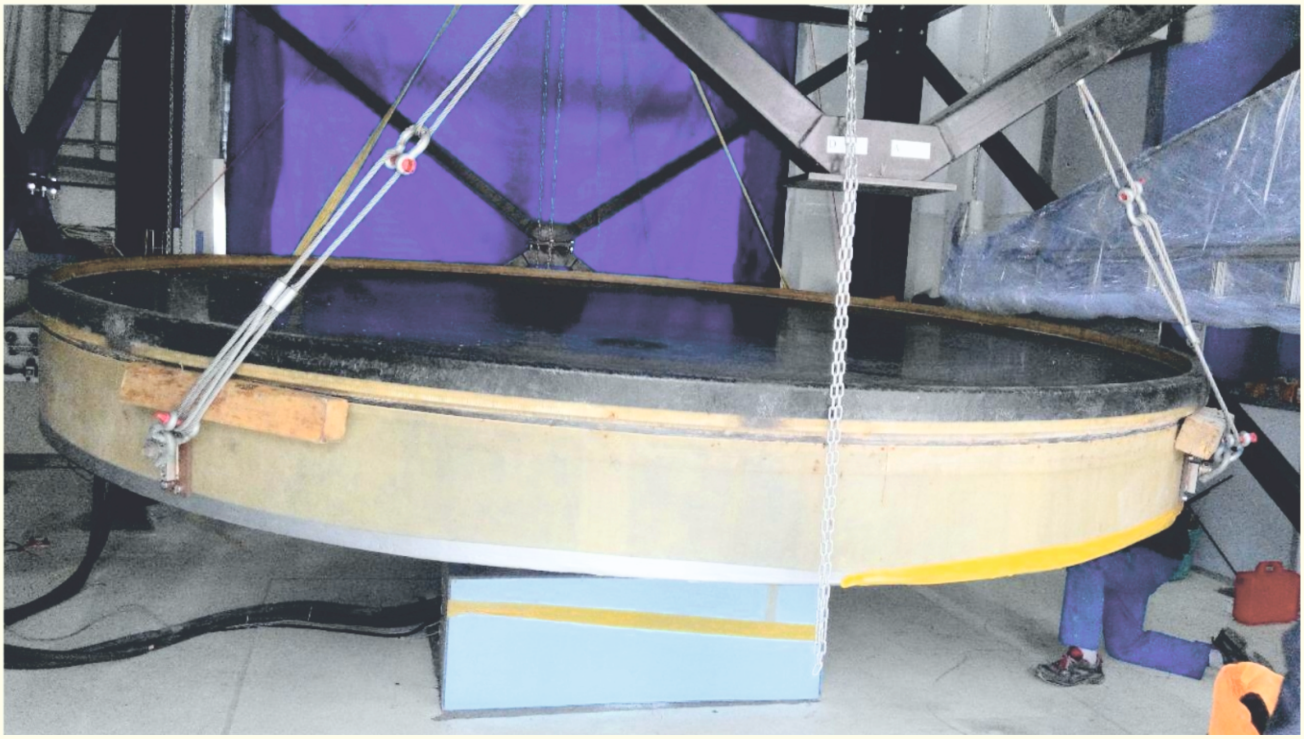


Figure 68. ILMT mirror bowl.

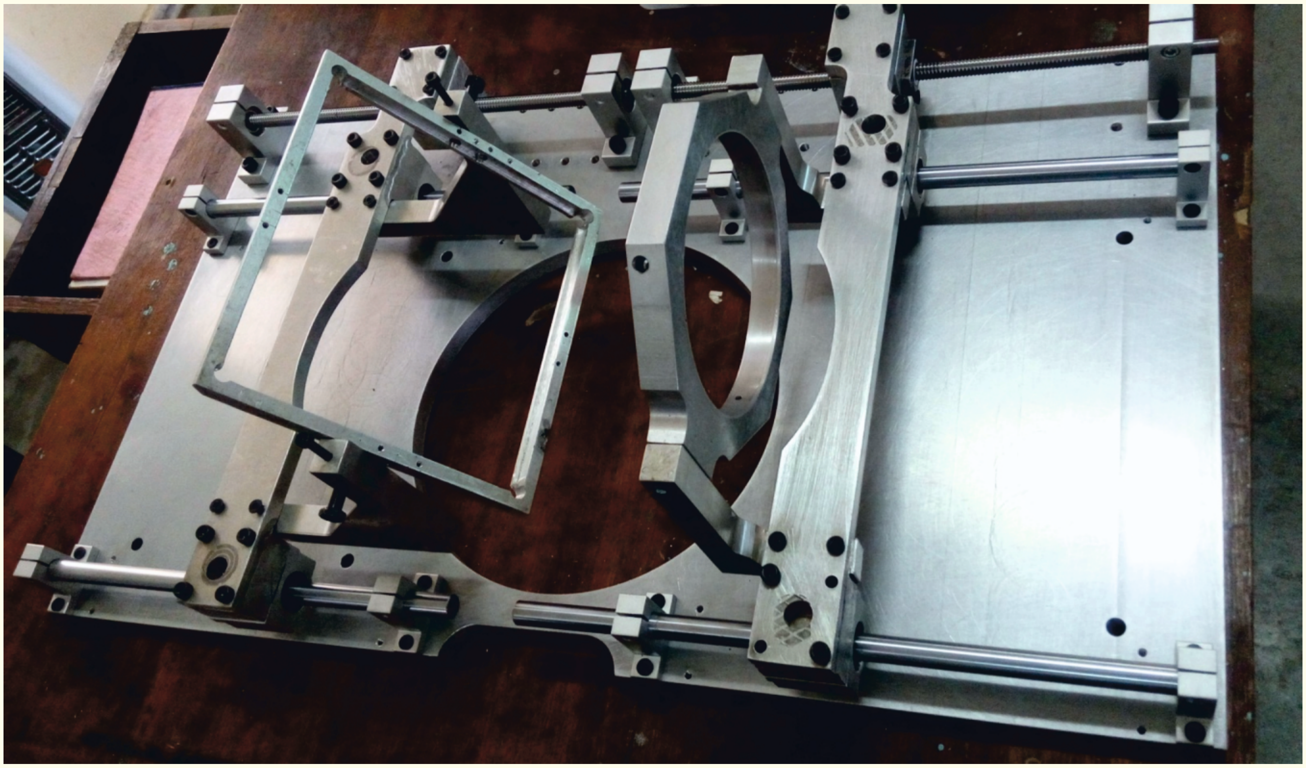


Figure 69. Calibration unit of ADFOSC.

4. IMAGER

Design and analysis, manufacturing and testing of updated IMAGER instrument was completed successfully.

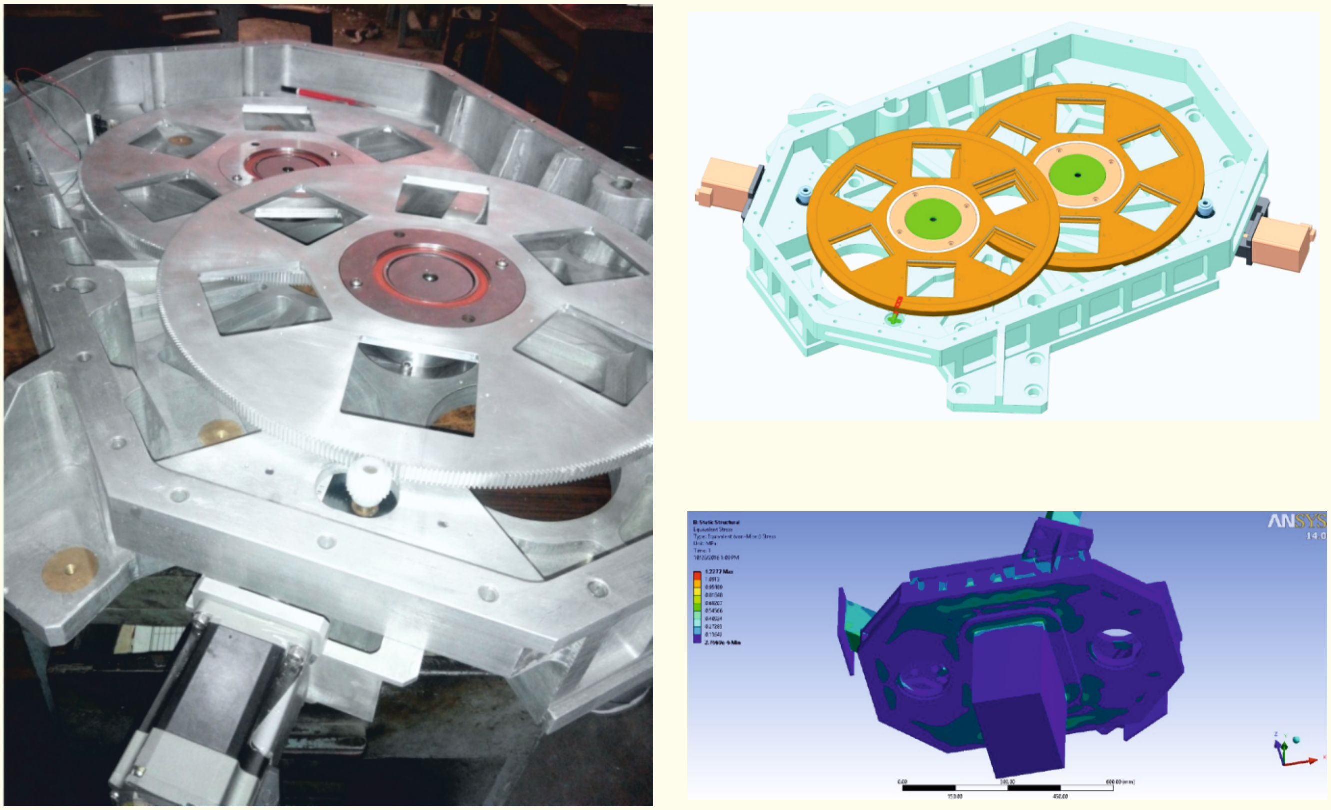


Figure 70. Updated design and assembled components of imager unit.

5. Cable Anti-twister

Requirement of cable anti-twister was felt for routing critical cables such as helium supply lines, Cryo lines, fiber cables etc. used in ADFOSC, TANSPEC, IFS test instruments etc. for their operation with the 3.6m telescope. It was decided to indigenously design and in-house manufacture of cable anti-twister at ARIES with provision for routing cables of various back end instruments.

Purchase of raw materials etc. was undertaken and in-house manufacturing of the components of cable Anti-twister was made at mechanical workshop of ARIES. Manufactured and fabricated components were assembled in mechanical workshop and initial testing of cable anti-twister arrangement was carried out. Components and sub-assemblies were transported from mechanical workshop at Manora Peak to 3.6m telescope enclosure at Devasthal. A Lifting arrangement was specifically made from 11m platform of 3.6m telescope enclosure, passing through the pier hole to lift and assemble cable anti-twister components. Assembly of cable anti-twister components at azimuth rotator flange was carried out and connected to plates passing through pier hole up to cage with flexible chain links. Preliminary testing of cable-anti-twister was carried out with four free hanging dummy power cables from its four holes by rotating telescope in azimuth from 0 to 270 degree and also from 0 to - 270 degree.

On 06 January 2017, the working of cable anti-twister was demonstrated with azimuth rotation for TIRCAM-2 Instrument to TIFR team for two power cables and one internet cable.

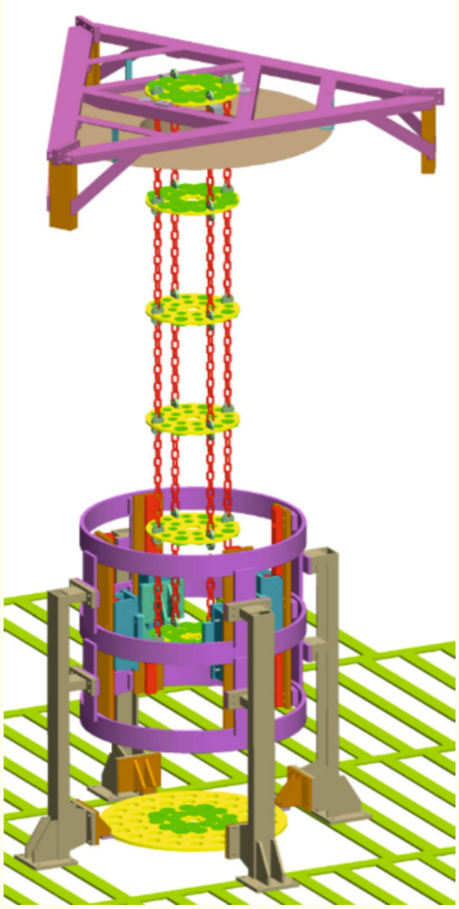


Figure 71. Design of Cable Anti-Twister.

6. Others

Maintenance of domes, telescopes and its accessories of 1.04m Sampurnanand telescope , 1.3m telescopes and 3.6m telescope.

Computer Lab

Computer division is the backbone of ARIES which provides various computing and network services through Information & Communication Technologies for its staff members including scientists, engineers, students, technical and administrative staff. Computer centre administers and manages the entire campus computer network which includes departments/sections, main administrative building, hostels and the guest house.

The division helps in providing management and support to servers, storage device, work stations, desktop and laptop computers, printers, plotters, scanners, DSLAM, software and network (wired & wireless) infrastructure time to time along with setup, maintenance and support.

The division also provides secured network services including the design 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) and conducting periodical training programs. The IT group has been in the forefront of deploying information technologies to help our scientists/Engineers to be in their chosen area of research/work.

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

An advance setup of computers, network, servers, workstations, printers, video-conference has been established at Devasthal. We have a PTP Microwave link between Nainital & Devasthal. Internet & Telephone facilities are being provided at Devasthal using this link since last 10 years. Recently we have installed a new 10Mbps ILL at Devasthal.

Technical Activities

- Wired and Wireless Networking Solutions & Services.
- Software Development & Data Base Management.
- Windows and Linux Server Administration.
- Internet Connectivity to all Scientists, Engineers, Staff and Students of ARIES.
- Infrastructure Procurement, Set-up, Installation, Management and Maintenance.
- E-Administration Services including Software and Hardware installations, printers, scanners and all other computer related devices.
- E-mail Service for ARIES Staff members including Scientists, Engineers , Technical and Administrative Staffs and Students.
- Technical support in Video Conferencing / Seminars/ Training Schools/ Scientific Workshop.
- 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.

Figure 72. Server at Computer section..

Knowledge Resource Center

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 2016 – 2017, the following information resources were added:

Books	:42
Subscription to Journals	:74 (Print + Online) + Full Text Databases
Publications in refereed journals	: 67
Theses awarded	: 04

The collection at the end of the period is

Books	: 10,896
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 73. 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 (Chairman)
Dr. Sneh Lata
Dr. S. B. Pandey
Dr. J. C. Pandey
Dr. Biman J Medhi
Dr. Narendra Singh
Dr. Saurabh

Mr. Ramdayal Bhatt, secretary to the AC

Major academic activities of 2016-2017 are listed below:

[A] Joint Entrance Screening Examination (JEST)

AC conducted the JEST 2017 examination at Nainital centre.

[B] PhD entrance interviews

AC organizes interviews every year to select PhD students as Junior Research Fellows (JRFs) in ARIES. AC members screened the applications and interviews were conducted during 04-08 July 2016. Students who are MSc in physics/astrophysics and have qualified JEST/NET/GATE were 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 2016, following 5 students have jointed ARIES as JRFs.

[1] Mr. Alaxender Panchal

[2] Mr. Arpan Ghosh

[3] Mr. Krishan Chand

[4] Mr. Priyanka Srivastava

[5] Ms. Sadhana Singh

[C] Summer Project Students

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

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

Academic Committee has made the detailed course work structure in Astronomy & Astrophysics, and Atmospheric Science for the PhD students joining ARIES. Committee conducts the trimester pattern 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 2016-2017, AC conducted the examination and project presentations of the first year batch and JRF to SRF review of the batch introduced in 2014-15. Following students successfully negotiated the Pre PhD course work, and entered the main PhD programme of ARIES:

[1] Ms. Bharti Arora

[2] Mr. Gaurav Singh

[3] Mr. Jayanand Maurya

[4] Ms. Priyanka Jalan

[5] Mr. Rakesh Pandey

[6] Ms. Shilpa Sarkar

[7] Mr. Tirthendu Sinha

[E] PhD Thesis awarded

Following four students of ARIES defended their PhD thesis during 2016-17.

(1) Dr. Hema Joshi

(2) Dr. Subhash Bose

(3) Dr. Krishna Kumar Shukla

(4) Dr. Aditi Agarwal

Following five students submitted their PhD thesis during 2016-17.

(1) Mr. Jai Bhagwan

(2) Mr. Piyush Bhardwaj

(3) Mr. Raman Solanki

(4) Mr. Sumit Kumar Jaiswal

(5) Ms. Nibedita Kalita

[F] Post Doctoral Fellows

The application for the post doctoral fellows are processed by the AC. Under the guidance of the Director, the AC arranges the expert committee and the interview cum presentation of the applicants is held. AC also manages the annual reviews of the post doctoral fellows. The post doctoral at ARIES are:

[1] Dr. Srabanti Ballav

[2] Dr. Alka Mishra

[3] Mr. Krishna Kumar Shukla

[4] Mr. Subhash Bose

[5] Mr. Rajiv Kumar

[6] Ms. Hema Joshi

[7] Dr. Sarvan Kumar

[8] Mr. Piyush Bhardwaj

[G] Conducting the Annual Student/Postdoc Reviews

Every year around the month of July/August, AC under the guidance of the Director, forms the expert panels, select the examiners, and furnish the details of the Junior and Senior Research Fellows of the Institute to conduct their annual reviews. The recommendations on upgrading their fellowships, thesis submissions etc are based on the significant review process organized by the committee. In 2016 the following students have been promoted to SRF after the review process:

[1] Mr. Kuldeep Singh

[2] Ms. Anjasha Gangopadhyay

[3] Mr. Vineet Ojha

[4] Ms. Raya Dastidar

[5] Ms. Sapna Mishra

[6] Ms. Piyali Saha

[7] Ms. Ekta Sharma

[8] Mr. Pankaj Sanwal

[9] Mr. Ashwani Pandey

[H] Several scientific colloquia and seminars were delivered by visitors from different institutions and universities and also by ARIES faculty members and PhD students and postdocs.

[I] Orientation Programme 2016

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 2016 was conducted on 19th August 2016.

Public Outreach Activities

Public Outreach is an ongoing program at ARIES. Department of Science and Technology (DST) also supports these activities to increase general awareness about astronomy and basic sciences amongst common people. A science center with an exhibition hall, lecture hall, planetarium and a 14inch telescope are the major attractions of the science center. Night sky viewing and planetarium shows provide an excellent learning opportunity to school students and general visitors. On the occasion of popular astronomical events like eclipses, planetary events etc. special arrangements are made for the public in the science center. Apart from this, relevant information on astronomical events is also communicated to the print and electronic media. Popular talks in the nearby schools and colleges are also arranged. During 2016-17, the science center educated about 7800 visitors out of which 60% were students from various schools/colleges throughout the country.

Popular Science Programmes

1. Transit of Mercury observation camp

One day Mercury Transit observation camp was organized on 09 May 2016. In this program about 30 student were participated in this program centered around the rare astronomical transit phenomena while Mercury crossing the Sun's disk. beside that student were shown planetarium show, our observational facilities. One small lecture about mercury transit also given to them.

Figure 74. School students watching transit of Mercury through telescope.

2. National Science Day Celebration

This programme was organized on 28 February 2017 on the occasion of National Science Day under the theme "Science and Technology for Specially-abled person". About 30 students of classes 8 - 12 from National Association for the Blind, Greater Haldwani were invited. A short documentary about "ARIES" and the installation of the 3.6m Telescope was shown to the students followed by a popular astronomy lecture, a visit to 1.04m ST and other observing facilities at ARIES.

Figure 75. Students of National Association for the Blind on the occasion of National Science Day.

3. Brahmand Darshan

A joint programme by Dainik Jagaran, Uttarakhand Tourism Department, Association of Hotels in Kumaun and ARIES was organized during 03-04 December 2016 to promote astronomy tourism/ astrophotography in

Uttarakhand. About 30 enthusiastic people from across the country gathered in Mukteshawar to participate in this programme. In addition to this, a painting competition and other activities were also organized for students from nearby schools. To promote such activities in Kumaun region, ARIES hosted the prize distribution ceremony for the winners.

4. Science Exhibitions

ARIES participated in four exhibitions in different parts of the country to showcase the facilities and different activities including Indian Science Congress-2017 at Tripati, International Trade Fair at Delhi, India International Science Festival (IISF) at NPL Delhi December 2017 and Sansad Kisan Mela at Jhunjhunu during 20-22 January 2017.

In addition, ARIES outreach team also contributed in the programme, “Cosmos from my terrace” on 7th March 2017 organized by Vigyan Prasar. Under this programme Vigyan Prasar provides telescopes to schools for a duration of one year and the students carry out small observational projects related to astronomy. ARIES also plays a vital role in this programme by providing resource persons.

Figure 76. School students actively participating in the drawing competition organized by the Brahmand Darshan team.

5. 7th ARIES Training School of Observational Astronomy (ATSOA)

ARIES training school in Observational Astronomy (ATSOA), our annual programme, was held during February 22-March 03 2017. About 40 post graduate science students from different universities/institutions participated in ATSOA. The main aim of the school is to increase awareness of astronomy research through lectures and hands on data analysis sessions in optical astronomy. Our current understanding of the Universe depends not only on continuous growth of observational facilities, but also on the number of people utilizing them. The present era has seen a surge in current/ upcoming observational facilities both nationally and internationally. Given the vast volume of data that will be produced by the upcoming facilities, there is a need to motivate and train the younger generation to take up active research. In this context, the participants carried out projects under the supervision of ARIES PhD students and made a final presentation of the projects.

Figure 77. ATSOA participants visiting the 1.04m ST facility.

Report on International Meeting held at ARIES (BINA Workshop)

An Indo-Belgian bilateral project entitled "Belgo-Indian Network for Astronomy and Astrophysics (BINA)" No. DST/INT/Belg/P-02/2014 was approved by the International Division, Department of Science and Technology (DST; Govt. of India) and the Belgian Federal Science Policy Office (BELSPO; Govt. of Belgium) for a period of three years. The BINA is a consortium of astronomers from seven Indian institutes led by ARIES (PI: Dr. Santosh Joshi) and two Belgian institutes led by Royal Observatory of Belgium (PI: Dr. Peter De Cat).

To achieve the goals of the BINA project, the first BINA workshop was held at Nainital (India) from 15-18 November 2016. It was jointly supported by DST (Govt. of India), BELSPO (Govt. of Belgium) and the host institute ARIES, Nainital. The scientific rationale of this workshop was "Instrumentation and Science with the 3.6m DOT and 4.0m ILMT telescopes".

About 107 astronomers originating from 8 different countries (India, Belgium, Russia, Japan, China, South Africa, Thailand and Taiwan) participated in the first BINA workshop. The first BINA workshop was inaugurated by Prof. S. K. Ghosh, Director of the National Centre for Radio Astrophysics of the Tata Institute of Fundamental Research (NCRA-TIFR, Mumbai, India). During the workshop, scientists discussed the preliminary results obtained with the newly developed instruments (ADFOSC and Imager) for the 3.6m DOT and the future prospects in using the 4.0m ILMT.

During the first three days of the workshop, the BINA participants presented the scientific highlights of their works and future projects with the 3.6m DOT and 4.0m ILMT. A special session for school children was also organized during which a public lecture on the "Music of the Stars" was delivered by eminent scientist Prof. Chris Engelbrecht from the University of Johannesburg (South Africa). About 150 students from various schools attended the public lecture on the evening of 17 November 2016. On 18 November 2016, a full day visit to Devasthal Observatory was organized.

A special poster session was also held where about 40 participants summarized the work presented in their posters. In order to make the poster presentation more attractive, the organizers announced the best poster award in each category - galactic astrophysics, extra-galactic astrophysics, and instrumentation. The winners in each of these category were PoChieh Huang (Institute of Astronomy, National Central University, Taiwan), Dr. Kuntal Misra (ARIES, Nainital, India), and Mr. Bikram Pradhan (STAR Institute, Liège University, Belgium), respectively.

Dr. Arbinda Mitra (Adviser & Head, International Bilateral Cooperation) and Dr. S. K. Varshney (Adviser, International Bilateral Cooperation) also participated in this workshop as DST representatives. They addressed the participants of the first BINA workshop and briefed them about various on-going bilateral projects run by DST with other countries. Dr. S. K. Varshney distributed the best poster awards on 17th November 2016.

The second BINA workshop will be held in September 2018 at the Royal Observatory of Belgium (ROB; Brussels, Belgium) during which scientists will review the progress of the network in terms of scientific output and development of new instruments.

Figure 78. Inauguration of the First BINA workshop.

Figure 79. Visit of BINA Participants at Telescopes Site.

Figure 80. Group Photographs of Participants of the first BINA Workshop.

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 (23)

Anil K. Pandey
(Director)
Alok C. Gupta
Brijesh Kumar
Indranil Chattopadhyay
Mahendra Singh *(till 31-07-2016)*
Narendra Singh
Shashi Bhushan Pandey
Umesh C. Dumka

Amitesh Omar
D. V. Phanikumar
Jeewan C. Pandey
Maheswar Gopinathan
Ramakant Singh Yadav
Saurabh
Wahab Uddin
(Acting Director till 05-03-2017)

Biman J. Medhi
Hum Chand
Kuntal Mishra
Manish Naja
Santosh Joshi
Snehlata
Yogesh C. Joshi

Satish Kumar *(till 31-03-2017)*
(Information Scientist)

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 (14)

Ravinder Kumar
(Registrar)
Abhishek Kumar Sharma
Hansa Karki
Mohan Singh Bisht
Rajendra Prasad Joshi

Bharat Singh
(Asstt. Registrar)
Anand Singh Bisht
Mahesh Chandra Pande
Praveen Solanki
Vijay Kumar Meena

Bhuwan Chandra Arya *(till 30-09-2016)*
Manjay Yadav
Rajeev Kumar Joshi
Virendra Kumar Singh

Scientific and Technical (36)

Abhijit Misra
Arjun Singh
Bharat Bhushan
Darwan Singh Negi
Girish Kumar
Ishwari Dutt Joshi
Kanti Ram Maithani
Naveen Chandra Arya
Pawan Tiwari
Rajdeep Singh
Ravindra Kumar Yadav
Tileshwar Mahto

Anant Ram Shukla
Ashok Kumar Singh
Bipin Chandra Pant
Girija Nandan Pathak
Harish Chandra Tewari
Javed Alam
Lalit Mohan Dalakoti
Nitin Pal
Pradip Chakarborty
Rajan Pradhan
Sanjay Kumar Singh
Uday Singh

Anil Kumar Joshi
Babu Ram
C. Arjuna Reddy
Girish Chandra Giri
Hemant Kumar
Kanhaiya Prasad
Manoj Kumar Mahto
Parmatma Saran Yadav *(till 31-07-2016)*
Prashant Kumar
Rajendra Prasad
Srikant Yadav
Vinod Kumar Sah

Laboratory Assistant/Attendants (13)

Ashok
Basant Ballabh Bhatt
Girish Chandra Badhani *(till 30-06-2016)*
Harish Chandra Arya
Lalit Lal Sah *(till 31-03-2017)*
Laxman Singh Kanwal
Mohan Singh Rana
Rakesh Kumar
Ram Ashish Ram
Ramdayal Bhatt
Shyam Giri
Shyam Lal
Suresh Chandra Arya

Post Doctoral Fellows/Research Associate (08)

Dr. Alka Mishra
Mrs. H. Joshi *(till 20-09-2016)*
Mr. K. K. Shukla *(from 30-06-2016)*
Mr. Piyush Bhardwaj
Mr. Rajiv Kumar *(from 07-07-2016)*
Dr. Sarvan Kumar *(from 20-06-2016)*
Dr. Sarabanti Ballav
Mr. Subhash Bose (till 24-06-2016)

Research Scholars (32)

Ms. Abha Monga
Mr. Abhishek Paswan
Ms. Aditi Agarwal *(till 08-09-2016)*
Ms. Anjasha Gangopadhyay
Mr. Arpan Ghosh
Ms. Arti Joshi
Mr. Ashwini Pandey
Ms. Bharti Arora
Ms. Ekta Sharma
Mr. Gaurav Singh
Mr. Jayanand Maurya
Mr. Krishan Chand
Mr. Kuldeep Singh
Ms. Mridweeka Singh
Mr. Mukesh K. Vyas
Ms. Neha Sharma
Mr. Pankaj Sanwal
Mr. Parveen Kumar
Ms. Piyali Sah
Mr. Piyush Bhardwaj *(till 28-09-2016)*
Ms. Priyanka Jalan
Mr. Rakesh Pandey
Mr. Raman Solanki *(till 28-03-2017)*
Ms. Raya Dastidar
Ms. Sadhana Singh
Ms. Sapna Mishra
Ms. Shilpa Sarkar
Mr. Subhajeet Karmakar
Mr. Sumit K. Jaiswal *(till 31-12-2016)*
Mr. Surendra V. Singh *(till 08-07-2016)*
Mr. Tirthendu Sinha
Mr. Vineet Ojha

Visits by ARIES Members

International Visits

Dr. A. K. Pandey	Univ. of Tokyo, Japan	21 Jan. - 08 Feb., 2017
Mr. Abhishek Paswan	Venice, Italy	10 - 13 Oct., 2016
Dr. Alka Mishra	SHAO, Shanghai, China	14 – 30 Dec., 2016
Dr. Alok C. Gupta	SHAO, Shanghai, China	01 Jun, 2016 – 27 May, 2017
	Kuche, Xinjiang Provice, China	01 – 05 Aug., 2016
	Guiyang, China	07 – 11Nov., 2016
	Shandong Univ., Weihai, China	03 – 06 Jan., 2017
	Guangzhou Univ., China	16 – 23 Jan., 2017
Mr. B. Krishna Reddy	Edinburgh, United Kingdom	26 June – 01 July, 2016
		29 – 30 Mar., 2017
Dr. Indranil Chattopadhyay	UNIST, South Korea	25 Sept. – 01 Oct., 2016
Dr. Kuntal Misra	STScI, Baltimore, MD, USA	23 – 25, May, 2016
	La Reunion Island, France	20 – 24 Feb., 2017
Dr. Manish Naja	Boulder, Colorado, USA	24 Sept. – 15 Oct., 2016
Mr. Purshottam	Edinburgh, United Kingdom	26 June – 01 July, 2016
Dr. Santosh Joshi	North West Univ., Mafikeng, SA	21 – 23 Mar., 2017
	Univ. of Johannesburg, SA	24 – 26 Mar., 2017
	SAAO; Univ. of Capetown, SA	27 – 31 Mar., 2017
Dr. Saurabh Sharma	San Pedro de Atacama, Chile	28 Nov. - 02 Dec., 2016
Dr. Srabanti Ballav	JAMSTEC, Yokohama, Japan	21 – 30 Mar., 2017
Mr. Subhajeet Karmakar	Uppsala Univ., Sweden	05 – 11 June, 2016
Dr. T. S. Kumar	Edinburgh, United Kingdom	26 June – 01 July, 2016
	Durham Univ., Durham	02 – 29 July, 2016
Dr. Umesh C. Dumka	Fudan Univ., Shanghai, China	29 – 30 Dec., 2016
Dr. Yogesh C. Joshi	SAO, Nizhney Novogored, Russia	30 Sept. - 14 Oct., 2016
	North West Univ., Mafikeng, SA	21 – 23 Mar., 2017
	Univ. of Johannesburg, SA	24 – 26 Mar., 2017
	SAAO; Univ. of Capetown, SA	27 – 31 Mar., 2017

National Visits

Ms. Aabha Monga	Univ. of Kashmir, Srinagar SCOSTEP-ISWI, Sangli B. M. Birla Auditorium, Jaipur	09 - 13 May, 2016 07 - 17 Nov., 2016 06 - 10 March, 2017
Mr. Abhishek Paswan	B. M. Birla Auditorium, Jaipur	06 - 10 Mar., 2017
Ms. Anjasha Gangopadhyay	Univ. of Kashmir, Srinagar CREST, Hosekote, Bangalore	09 - 16 May, 2016 28 - 30 Sept., 2016 08 – 10 July, 2016 24 - 27 Feb, 2017
Ms. Arti Joshi	Univ. of Kashmir, Srinagar TIFR, Mumbai	09 - 13 May, 2016 10 - 13 Jan., 2017 18 - 21 Jan., 2017
Dr. Brijesh Kumar	DST, Delhi IIA, Bengaluru	13 - 15 July, 2016 11 - 14 Feb., 2017
Mr. Chandra Prakash	NPL, New Delhi Sri SV Univ., Tirupati	07 - 11 Dec., 2016 03 - 07 Jan., 2017
Dr. Hum Chand	Univ. of Kashmir, Srinagar Delhi Univ., Delhi IUCAA, Pune	09 - 14 May, 2016 04 - 08 July, 2016 15 - 27 Jan., 2017
Dr. Indranil Chattopadhyay	Univ. of Kashmir, Srinagar SINP, Kolkata TIFR, Mumbai NCRA, Pune PRSU, Raipur IUCAA, Pune	08 - 16 May, 2016 08 - 23 June, 2016 08 - 15 Jan., 2017 14 - 18 Mar., 2017 20 - 26 Mar., 2017 27 - 30 Mar., 2017
Dr. Jeewan C. Pandey	Delhi University, Delhi	20 - 22 Feb., 2017
Mr. Kuldeep Singh	TIFR, Mumbai	10 - 13 Jan., 2017
Dr. Kuntal Misra	Univ. of Kashmir, Srinagar NCRA, Pune ICTS, Bengaluru	10 - 13 May, 2016 28 - 30 Nov., 2016 20 - 23 Mar., 2017
Mr. Mukesh K. Vyas	TIFR, Mumbai	10 - 13 Jan., 2017
Mr. Pankaj Sanwal	Univ. of Kashmir, Srinagar	08 - 14 May, 2016

Mr. Pradip Chakraborty	Univ. of Calcutta, Kolkata	04 - 05 Feb., 2017
Ms. Priyanka Jalan	IUCAA, Pune	01 Jan. - 05 Feb., 2017
Ms. Raya Dastidar	CREST, Hosekote, Bangalore	04 Apr., 2016 28 Nov. – 03 Dec., 2016
	Univ. of Kashmir, Srinagar	09 - 16 May, 2016
Dr. Santosh Joshi	Delhi Univ., Delhi	10 - 16 Feb., 2017 20 - 21 Mar., 2017
Ms. Sapna Mishra	IUCAA, Pune	15 - 27 Jan., 2017
Ms. Shilpa Sarkar	TIFR, Mumbai	10 - 13 Jan., 2017 18 – 21 Jan., 2017
	B. M. Birla Auditorium, Jaipur	06 – 10 Mar., 2017
Dr. Sarvan Kumar	BHU, Varanasi	01 - 15 Aug., 2016
	PRL, Ahmadabad	06 - 08 Dec., 2016
Dr. Saurabh Sharma	TIFR, Baloon Facility, Hyderabad	18 Oct., 2016
	IIST, Thiruvanantpuram	06 - 07 Dec., 2016
	ARCI, Gurgaon	15 July, 2016
Mr. Subhajeet Karmakar	Univ. of Kashmir, J&K	09 - 13 May, 2016
	TIFR, Mumbai	10 – 13 Jan., 2017
Dr. T. S. Kumar	Univ. of Kashmir, Srinagar	10 – 13 May, 2016
	IIT, Gandhinagar	17 - 22 Jan., 2017
Dr. Tarun Bangia	Schindler Lift, Pune	09 Dec., 2016
Mr. Vineet Ojha	TIFR, Mumbai	18 - 21 Jan., 2017
Dr. Yogesh C. Joshi	IIA, Bengaluru	07 - 10 Sept., 2016
	IIST, Thiruvanantpura	04 - 08 Dec., 2016
Dr. Wahab Uddin	IIA, Bengaluru	12 Feb., 2017

Visitors at ARIES

From Abroad

Prof. Anna Pospieszalska	Liegé University, Belgium	15 – 18 Nov., 2016
Mr. Bikram Pradhan	Liegé Univ., Belgium	10 May – 10 June, 2016 25 - 27 Feb., 2017 31 Mar. – 10 Apr., 2017
Prof. Chris Engelbrecht	Univ. of Johannesburg, South Africa	15 – 18 Nov., 2016
Dr. David Mktrchian	NARIT, Taiwan	15 – 18 Nov., 2016
Dr. Drisya Karinkuzhi	Université libre de Bruxelles, Belgium	14 – 18 Nov., 2016
Dr. Evgenii Semenko	SAO, Russia	15 – 18 Nov., 2016
Mr. Hamano Satoshi	Kyoto Sangyo Univ., Japan	15 – 18 Nov., 2016
Prof. Jean Surdej	Liege Univ., Belgium	10 May – 10 June, 2016 12 – 19 Nov., 2016 24 – 27 Feb., 2017 22 – 29 Mar., 2017 31 Mar. – 11 Apr., 2017
Prof. Katrien Kolenberg	University of Leuven, Belgium	14 – 18 Nov., 2016
Prof. K. Ogura	Kokugakuin University, Japan	23 – 25 Nov., 2016
Prof. Luis C. Ho	KIAA, Beijing, China	31 Jan. – 02 Feb., 2017
Ms. Marjorie Decleir	Gent University, Belgium	14 – 19 Nov., 2016
Prof. Michaël De Becker	Liegé University, Belgium	17 – 19 Nov., 2016
Ms. Nareemas Chelaeh	ROB, Belgium	14 – 18 Nov., 2016
Prof. N. Kobayashi	Kiso Observatory, Japan	15 – 18 Nov., 2016
Dr. Olivier Absil	Liegé University, Belgium	14 – 19 Nov., 2016
Dr. Peter De Cat	ROB, Belgium	14 – 18 Nov., 2016
Prof. Patricia Lampens	ROB, Belgium	14 – 18 Nov., 2016
Mr. PoChieh Huang	Institute of Astronomy, Taiwan	15 – 18 Nov., 2016
Mr. Pradip Gatkine	Univ. of Maryland, USA	04 – 07 July, 2016
Dr. Ramkesh Yadav	NARIT, Taiwan	15 – 18 Nov., 2016
Mr. R. Kanazawa	Japan	23 – 25 Nov., 2016
Mr. Simoue Brundmonti	Switzerland	17 July – 24 Aug. 2016

Ms. Teresa Jorge	Switzerland	17 July – 24 Aug. 2016
Prof. Thomas Peter	ETH, Switzerland	08 – 23 Aug., 2016

From other Indian Institutions

Mr. A. Deshpande	RRI, Bangalore	03 – 07 Dec., 2016
Mr. Abhishek Mandal	IIRS, Dehradun	23 – 25 Jan., 2017
Mr. Abhay Kohali	IUCAA, Pune	11 – 14 Mar., 2017
Mr. Adarsh Kashyap	Delhi Univ., Delhi	15 – 18 Nov., 2016
Prof. A. C. Pandey	Univ. of Allahabad, Allahabad	22 – 23 Oct., 2016
Dr. A. K. Chattopadhyay	DST, New Delhi	31 Aug. – 01 Sept., 2016
Prof. A. K. Pati	IIA, Bangalore	05 – 08 Oct., 2016
Mr. A. K. Mathur	SAC, Ahmedabad	20 – 24 Nov., 2016
Mr. A. M. Mazarbhulya	Assam Univ., Silchar	28 – 30 Dec., 2016
Prof. A. N. Ramaprakash	IUCAA, Pune	15 – 18 Nov., 2016
Prof. Ajith Parmeshwaran,	ICTS-TIFR, Bangalore	26 – 29 Oct., 2016
Mr. Alik Panja	SN Bose, Kolkata	17 – 18 Dec., 2016
Dr. Aravinda Mitra	DST, New Delhi	16 – 17 Nov., 2016
Prof. Archana Pai	IISER, Trivandrum	26 – 29 Oct., 2016
Prof. Arun Manglam	IIA, Bangalore	18 – 19 Nov., 2016
Dr. Ashish Raj	Lucknow	24 – 28 Nov., 2016 24 – 28 Feb., 2017
Mr. Avishek K. Jha	New Delhi	03 – 04 Dec., 2016
Dr. Brajesh Kumar	IIA, Bangalore	15 – 18 Nov., 2016 30 Dec., 2016 – 02 Jan., 2017
Dr. Bebi	Delhi University, Delhi	25 – 28 June, 2016 16 – 19 Feb., 2016
Dr. B. C. Bhatt	IIA, Bangalore	15 – 18 Nov., 2016
Mr. Bhupendra B. Singh	IITM, Pune	12 – 14 July, 2016 10 July – 01 Sept. 2016 08 – 13 Nov., 2016
Mr. Devendra Bisht	PRL, Ahmedabad	15 – 18 Nov., 2016
Prof. D. K. Ojha	TIFR, Mumbai	08 – 10 June, 2016 15 – 18 Nov., 2016

Prof. D. Narasimha	TIFR, Mumbai	15 – 18 Nov., 2016
Mr. D. S. Duggal	New Delhi	08 – 09 April, 2016
Mr. Ganesh S. Meshram	TIFR, Mumbai	31 May, 2016
Ms. Garima Yadav	HNBGU, Srinagar	31 July – 12 Aug. 2016
Prof. Gopal Krishna	CBS, Mumbai	15 – 18 Nov., 2016
Mr. Harsh	IITM, Pune	10 July – 01 Sept. 2016
Mr. Hem Chandra	HNBGU, Srinagar	31 July – 12 Aug. 2016
Prof. Ishwara Chandra CH	NCRA-TIFR, Pune	15 – 18 Nov., 2016
Mr. Kaushal Sharma	Delhi Univ., Delhi	15 – 18 Nov., 2016
Dr. K. D. Purohit	HNBGU, Srinagar	31 July – 06 Aug. 2016
Mr. K. N. Babu	SAC, Ahmedabad	20 – 24 Nov., 2016
Prof. K. Venketeshwar	TIFR, Hyderabad	27 – 30 May, 2016
Dr. L. P. Verma	MBPG, Haldwani	17 – 18 Nov., 2016
Dr. Margarita SafOnova	IIA, Bangalore	15 – 18 Nov., 2016
Prof. M. K. Das	Delhi Univ., Delhi	15 – 18 Nov., 2016
Mr. Milind B. Naik	TIFR, Mumbai	31 May, 2016
Dr. Mousumi Das	IIA, Bangalore	15 – 18 Nov., 2016
Mr. M. Venkat Raman	NARL, AP	05 May, 2016
Dr. Neelam	Delhi Univ., Delhi	15 – 18 Nov., 2016
Dr. N. Dashora	NARL, Tirupati	13 Aug., 2016
Prof. N. K. Chakradhari	Raipur Univ., Raipur	17 May – 13 June, 2016
Prof. Nissim Kanekar	NCRA, Pune	26 – 29 Mar., 2017
Mr. P. Chetan	New Delhi	08 – 09 April, 2016
Prof. P. B. Rao	NRSC, Hyderabad	19 – 21 Feb., 2017
Mr. P. Halder	Assam Univ., Silchar	28 – 30 Dec., 2016
Dr. Priya Hasan	MANUU, Hyderabad	15 – 18 Nov., 2016
Prof. P. Parihar	IIA, Bangalore	14 – 23 May, 2016
Dr. Parijat Thakur	GGCU, Bilaspur, Chhatishgadh	15 – 18 Nov., 2016
Mr. Piyush Patel	SAC, Ahmedabad	20 – 24 Nov., 2016

Mr. Praveen Arya	New Delhi	11 – 13 April, 2016
Mr. Rajesh Kumar	DST, New Delhi	15 Nov. – 02 Dec., 2016
Dr. Ramkrishna Das	SN Bose, Kolkata	17 – 18 Dec., 2016
Mr. Ravi Kumar	IITM, Pune	12 Aug. – 01 Sept., 2016
Mr. R. Kumar	IITM, Pune	12 – 14 July, 2016 08 – 13 Nov., 2016
Prof. R. Srianand	IUCAA, Pune	22 – 29 May, 2016
Mr. Rahul Anand	Gorakhpur Univ., Gorakhpur	15 – 18 Nov., 2016
Mr. Raja Muthu Kumar T.	Tamilnadu	30 April – 01 May, 2016 29 – 30 June, 2016
Prof. Rajesh Nayak	IISER, Kolkata	26 – 29 Oct., 2016
Mr. Ramesh Chandra	DST, New Delhi	15 Nov. – 02 Dec., 2016
Prof. Ranjan Gupta	IUCAA, Pune	17 – 20 May, 2016
Dr. Ranjan Mahajan	SERB, New Delhi	22 – 23 Mar., 2017
Mr. R. D. Srivastava	Lucknow	13 – 17 June, 2016
Dr. Rukmini Jagirdar	Osmania University, Hyderabad	15 – 18 Nov., 2016
Dr. Sachidanand	NPL, New Delhi	22 – 24 June, 2016 25 – 27 Mar., 2017
Dr. Sachindra Naik	PRL, Ahmedabad	15 – 18 Nov., 2016
Prof. Sachin S. Gunthe	IIT, Madras	27 – 29, July, 2016
Mr. Samrat Ghosh	SN Bose, Kolkata	17 – 18 Dec., 2016
Mr. Sanjay	TIFAC, New Delhi	09 – 10 May, 2016
Mr. Sanjay Gupta	Bhopal	16 – 20 May, 2016
Mr. Shailesh Bhagat	TIFR, Mumbai	31 May, 2016
Dr. Shanti P. Devarapalli	Osmania University, Hyderabad	15 – 18 Nov., 2016
Mr. Shashanka Gurumath	VIT University, Vellore	15 – 18 Nov., 2016
Dr. Shashikiran Ganesh	PRL, Ahmedabad	15 – 18 Nov., 2016
Prof. Shyam Lal	PRL, Ahmedabad	03 – 08 Nov., 2016
Mr. S. Chattopadhyay	IUCAA, Pune	22 – 24 April, 2016
Dr. S. Fadnavis	IITM, Pune	19 – 23 Aug., 2016

Dr. S. K. Dhaka	Delhi Univ., Delhi	27 – 29 Dec., 2016
Prof. S. K. Ghosh	NCRA-TIFR, Pune	15 – 18 Nov., 2016
Mr. S. K. K. Pandey	ISRO, Trivandrum	22 – 26 Sept., 2016
Prof. S. Narayanan	SRM Univ., Chennai	07 – 10 June, 2016
Dr. S. K. Varshney	DST, New Delhi	16 – 17 Nov., 2016
Dr. S. P. S. Kushwaha	IIRS, Dehradun	10 – 11 June, 2016
Mr. S. M. Ahmed	Univ. of Hyderabad, Hyderabad	14 – 18 May, 2016
Mr. S. S. Poojary	TIFR, Mumbai	31 May, 2016
Dr. Soumen Mondal	SN Bose, Kolkata	15 – 18 Nov., 2016
Mr. Sunil	Delhi Univ., Delhi	20 – 31 Mar., 2017
Mr. Sunil Sanbome	IITM, Pune	19 – 21 July, 2016 19 Aug. – 01 Sept., 2016
Mr. Suresh Tiwari	IITM, Pune	19 – 24 June, 2016
Dr. Suvendu Rakshit	IIA, Bangalore	15 – 21 May, 2016 15 – 18 Nov., 2016
Prof. S. Venkataramam	PRL, Ahmedabad	03 – 08 Nov., 2016
Dr. T. K. Mandal	NPL, New Delhi	03 – 05 Nov., 2016
Prof. T. P. Prabhu	IIA, Bangalore	27 – 29 Mar., 2017
Prof. T. R. Sheshadri	Delhi University, Delhi	04 – 06 June, 2016
Prof. Umesh C. Joshi	PRL, Ahmedabad	15 – 18 Nov., 2016
Dr. V. K. Varma	GBPUA&T, Pantnagar	12 – 13 Jan., 2017
Ms. V. Karthika	IIST, Thiruvanantpuram	15 – 16 Jan., 2017
Mr. Vineet Kr. Mannaday	GGCU, Bilaspur, Chhatishgadh	15 – 16 Jan., 2017
Dr. Vivek Panwar	Delhi Univ., Delhi	27 – 29 Dec., 2016
Mr. Venktesh	KSKGRL, Allahabad	20 – 24 June, 2016

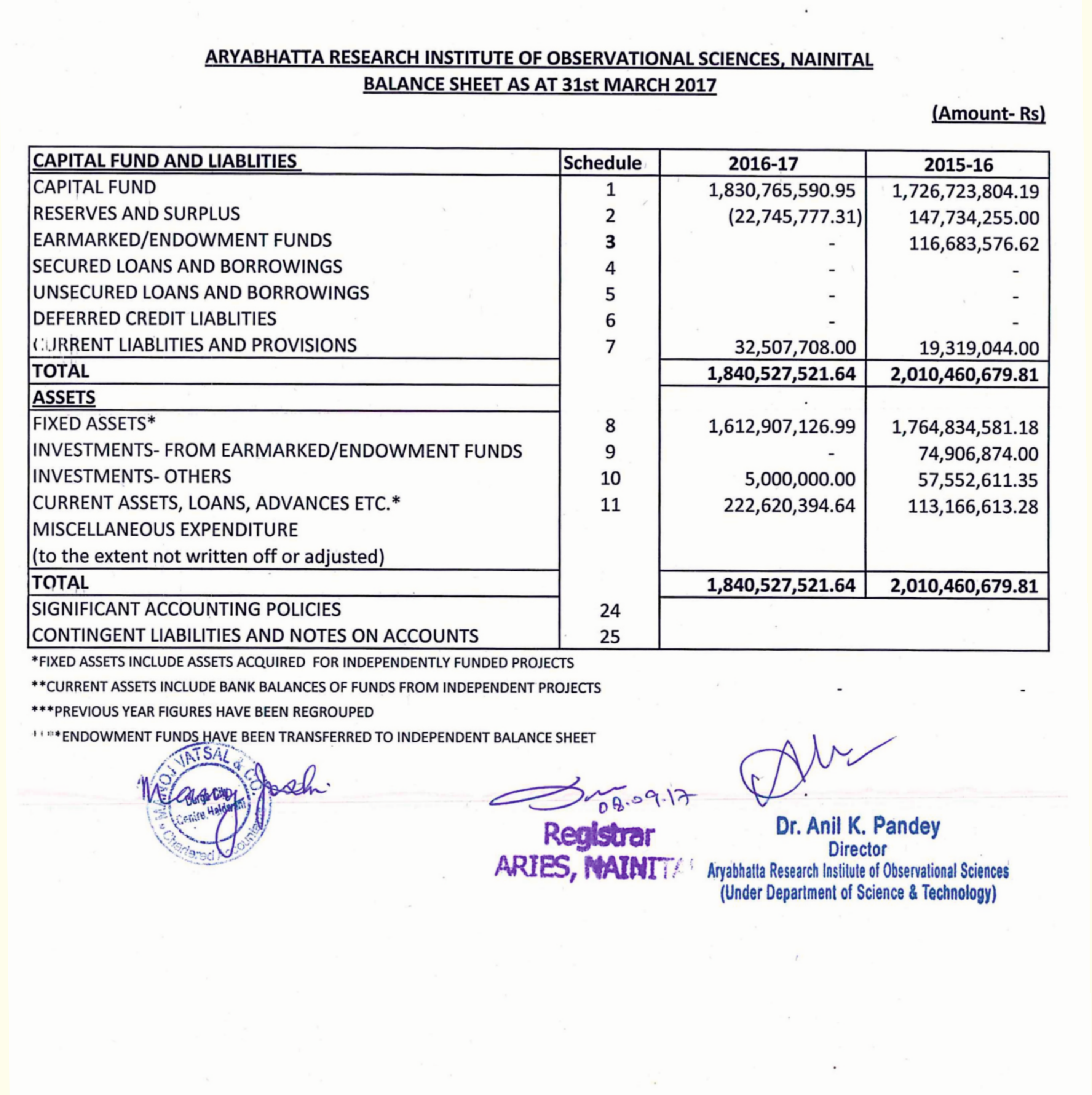
AIMPOL	ARIES Imaging Polarimeter
AGN	Active Galactic Nuclei
AGL	Above Ground Level
AIA	Atmospheric Imaging Assembly
AIRS	Atmospheric Infrared Sounder
AOD	Aerosol Optical Depth
AOD	Active Optics System
APASS	AAVSO Photometric All-Sky Survey
ARF	Aerosol Radiative Forcing
BINA	Belgo-Indian Network for Astronomy and Astrophysics
BP	Blad Patch
BRC	Bright-Rimmed Clouds
CALIPSO	Cloud Aerosol Lidar and Infrared Path finder Satellite Observations
CME	Coronal Mass Ejection
CP	Chemically Peculiar
CV	Cataclysmic Variable
DFOT	Devasthal Fast Optical Telescope
DLC	Differential Light Curves
DOT	Devasthal Optical Telescope
DTAC	Devasthal Time Allotment Committee
EIT	Extreme ultraviolet Imaging Telescope
EUV	Extreme Ultraviolet
FOSC	Faint Object Spectrograph and Camera
FWHM	Full Width at Half Maximum
GLSB	Giant Low Surface Brightness
GMRT	Giant Metrewave Radio Telescope
GRB	Gamma Ray Bursts

GVAX	Ganges Valley Aerosol Experiment
HMI	Helioseismic and Magnetic Imager
IITM	Indian Institute of Tropical Meteorology
ILMT	International Liquid Mirror Telescope
INOV	Intranight Optical Variability
IPHAS	INT Photometric H-Alpha Survey
ISM	Inter Stellar Medium
ISRO	Indian Space Research Organisation
JTAC	Joint Time Allocation Committee
LAT	Large Area Telescope
LBL	Local Boundary Layer
LMC	Large Magellanic Cloud
MERRA	Modern-Era Retrospective analysis for Research and Applications
MHD	Magneto-hydro-dynamics
MKIR	Mauna Kea Infrared
MWR	Multi-wavelength Radiometer
NGC	New General Catalogue
NIR	Near-Infrared
NOAA	National Oceanic and Atmospheric Administration
OCS	Observatory Control System
OPAC	Optical Properties of Aerosol and Clouds
PM	Proper Motion
PSD	Power Spectral Density
QPO	Quasi Periodic Oscillation
RAWEX	Regional Aerosol Warming Experiment
RHESSI	Reuven Ramaty High Energy Solar Spectroscopic
roAP	Rapidly-Pulsating Ap
RQWLQ	Radio-Quiet Weak-Emission-Line Quasars

SAAO	South African Astronomical Observatory
SAC	Scientific Advisory Committee
SAO	Special Astrophysical Observatory
SBDART	Satna Barbara DISTORT Atmospheric Radiative Transfer
SDO	Solar Dynamic Observatory
SDR	Surface Differential Rotations
SFR	Star Formation Rates
SKA	Square Kilometer Array
SMARTS	Small and Moderate Aperture Research Telescope System
SPB	Slowly pulsating B-type star
ST	Stratosphere Troposphere
ST	Sampurnanand Telescope
TANSPEC	TIFR-ARIES Near Infrared Spectrometer
TCS	Telescope Control System
TRACE	Transition Region and Coronal Explorer
UT	Universal Time
UV	Ultraviolet
VZS	von-Zeipel Surfaces
WFI	Wide-Field Imager
WG	Working Group
WFR	Weather Research and Forecasting
XMM	X-ray Multi-Mirror Mission
YSO	Young Stellar Objects

Audit Statements of Account

(2016-2017)



ARYABHATTA RESEARCH INSTITUTE OF OBSERVATIONAL SCIENCES, NAINITAL
BALANCE SHEET AS AT 31st MARCH 2017

(Amount- Rs)

CAPITAL FUND AND LIABLITIES	Schedule	2016-17	2015-16
CAPITAL FUND	1	1,830,765,590.95	1,726,723,804.19
RESERVES AND SURPLUS	2	(22,745,777.31)	147,734,255.00
EARMARKED/ENDOWMENT FUNDS	3	-	116,683,576.62
SECURED LOANS AND BORROWINGS	4	-	-
UNSECURED LOANS AND BORROWINGS	5	-	-
DEFERRED CREDIT LIABLITIES	6	-	-
CURRENT LIABLITIES AND PROVISIONS	7	32,507,708.00	19,319,044.00
TOTAL		**1,840,527,521.64**	**2,010,460,679.81**
ASSETS			
FIXED ASSETS*	8	1,612,907,126.99	1,764,834,581.18
INVESTMENTS- FROM EARMARKED/ENDOWMENT FUNDS	9	-	74,906,874.00
INVESTMENTS- OTHERS	10	5,000,000.00	57,552,611.35
CURRENT ASSETS, LOANS, ADVANCES ETC.*	11	222,620,394.64	113,166,613.28
MISCELLANEOUS EXPENDITURE (to the extent not written off or adjusted)			
TOTAL		**1,840,527,521.64**	**2,010,460,679.81**
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 - -

***PREVIOUS YEAR FIGURES HAVE BEEN REGROUPED

****ENDOWMENT FUNDS HAVE BEEN TRANSFERRED TO INDEPENDENT BALANCE SHEET

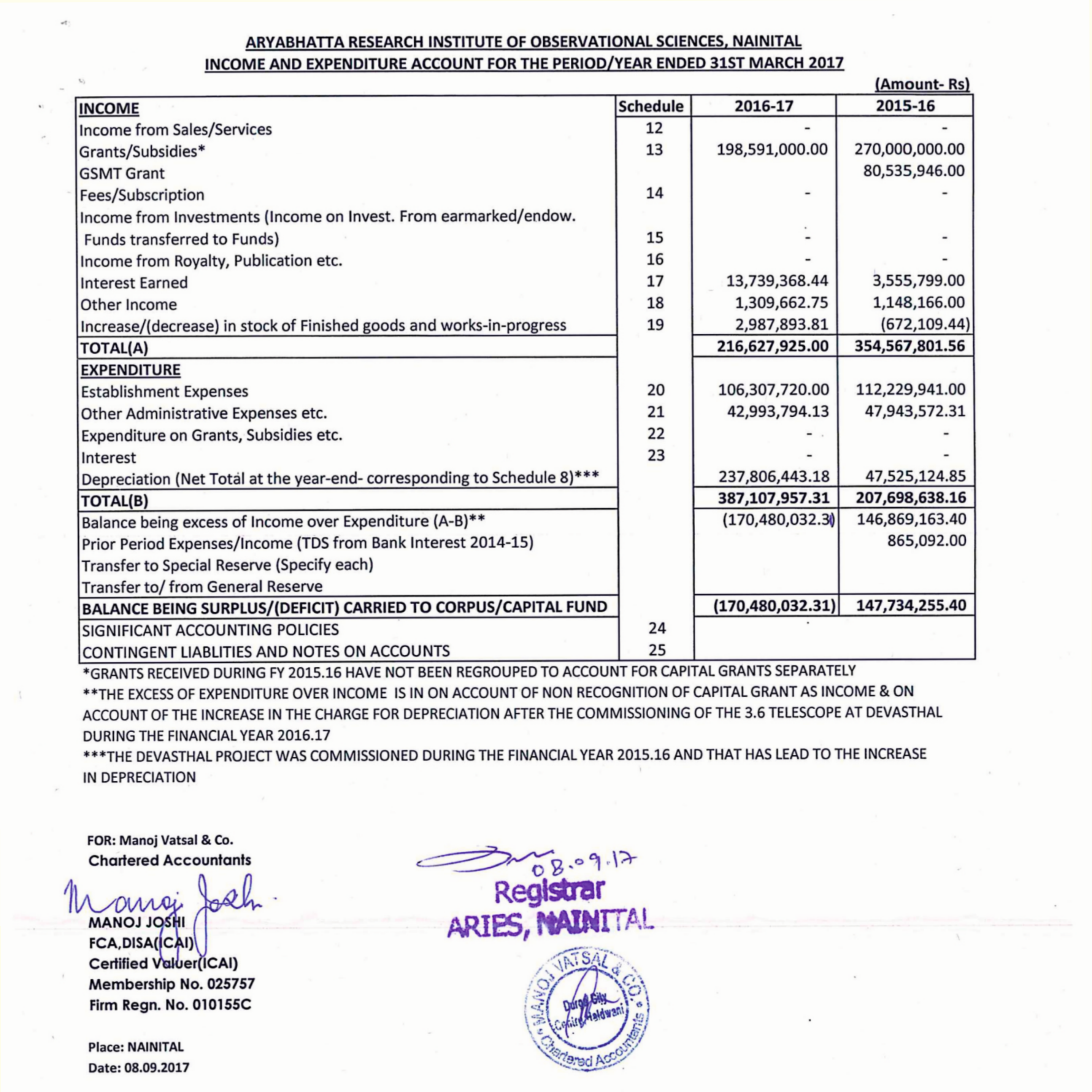
MANOJ VATSAL & CO.
Durga City Centre, Haldwani
Chartered Accountants

Manoj Joshi

08.09.17

Registrar
ARIES, NAINIT

Dr. Anil K. Pandey
Director
Aryabhatta Research Institute of Observational Sciences
(Under Department of Science & Technology)



ARYABHATTA RESEARCH INSTITUTE OF OBSERVATIONAL SCIENCES, NAINITAL
INCOME AND EXPENDITURE ACCOUNT FOR THE PERIOD/YEAR ENDED 31ST MARCH 2017

(Amount- Rs)

INCOME	Schedule	2016-17	2015-16
Income from Sales/Services	12	-	-
Grants/Subsidies*	13	198,591,000.00	270,000,000.00
GSMT Grant			80,535,946.00
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	13,739,368.44	3,555,799.00
Other Income	18	1,309,662.75	1,148,166.00
Increase/(decrease) in stock of Finished goods and works-in-progress	19	2,987,893.81	(672,109.44)
TOTAL(A)		**216,627,925.00**	**354,567,801.56**
EXPENDITURE			
Establishment Expenses	20	106,307,720.00	112,229,941.00
Other Administrative Expenses etc.	21	42,993,794.13	47,943,572.31
Expenditure on Grants, Subsidies etc.	22	-	-
Interest	23	-	-
Depreciation (Net Total at the year-end- corresponding to Schedule 8)***		237,806,443.18	47,525,124.85
TOTAL(B)		**387,107,957.31**	**207,698,638.16**
Balance being excess of Income over Expenditure (A-B)**		(170,480,032.3)	146,869,163.40
Prior Period Expenses/Income (TDS from Bank Interest 2014-15)			865,092.00
Transfer to Special Reserve (Specify each)			
Transfer to/ from General Reserve			
BALANCE BEING SURPLUS/(DEFICIT) CARRIED TO CORPUS/CAPITAL FUND		**(170,480,032.31)**	**147,734,255.40**
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

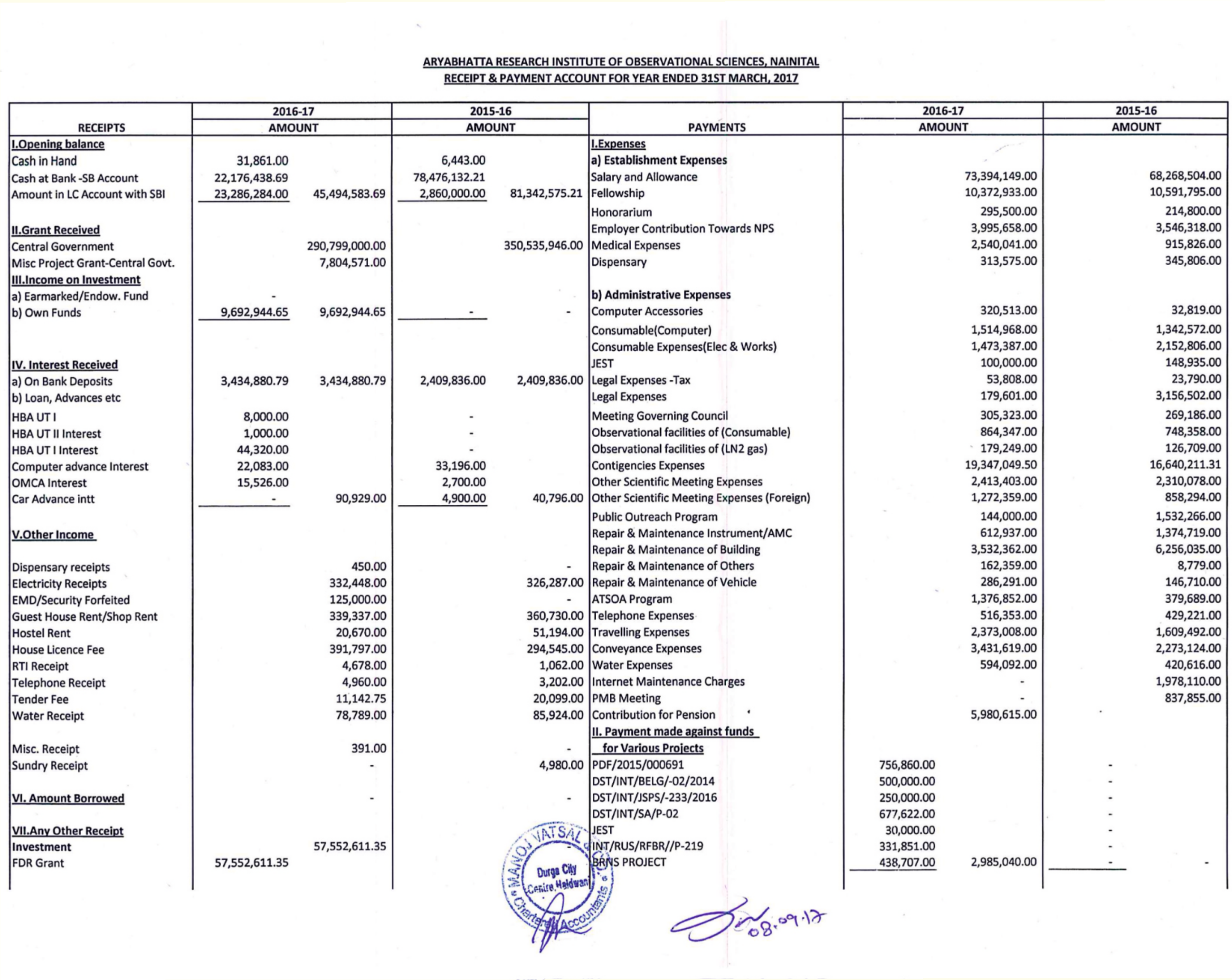
FOR: Manoj Vatsal & Co.
Chartered Accountants

Manoj Joshi

MANOJ JOSHI
FCA,DISA(ICAI)
Certified Valuer(ICAI)
Membership No. 025757
Firm Regn. No. 010155C

Place: NAINITAL
Date: 08.09.2017

08.09.17
Registrar
ARIES, NAINITAL



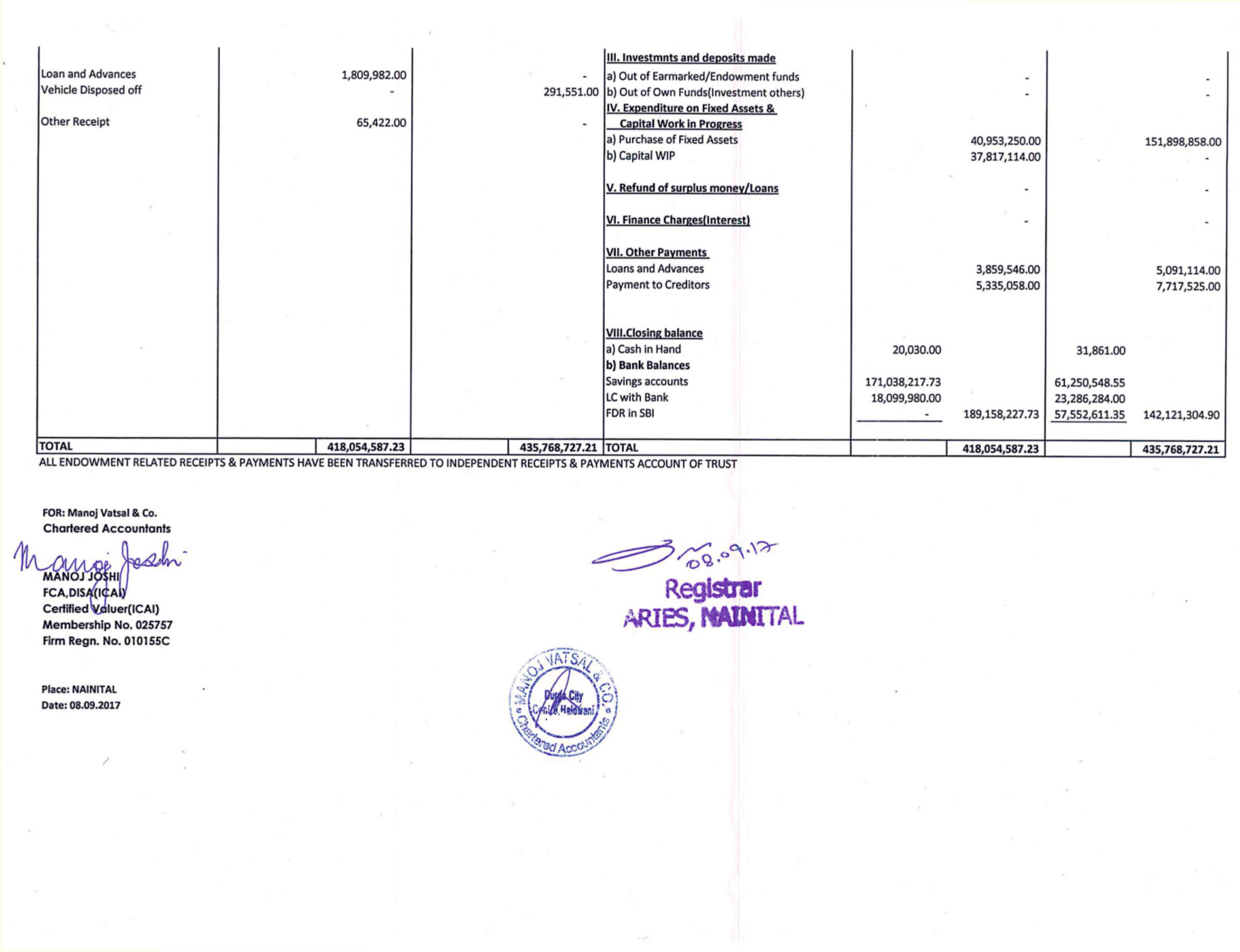
ARYABHATTA RESEARCH INSTITUTE OF OBSERVATIONAL SCIENCES, NAINITAL

RECEIPT & PAYMENT ACCOUNT FOR YEAR ENDED 31ST MARCH, 2017

	2016-17		2015-16			2016-17		2015-16	
RECEIPTS	AMOUNT		AMOUNT		PAYMENTS	AMOUNT		AMOUNT	
I.Opening balance					**I.Expenses**				
Cash in Hand	31,861.00		6,443.00		**a) Establishment Expenses**				
Cash at Bank -SB Account	22,176,438.69		78,476,132.21		Salary and Allowance		73,394,149.00		68,268,504.00
Amount in LC Account with SBI	23,286,284.00	45,494,583.69	2,860,000.00	81,342,575.21	Fellowship		10,372,933.00		10,591,795.00
					Honorarium		295,500.00		214,800.00
II.Grant Received					Employer Contribution Towards NPS		3,995,658.00		3,546,318.00
Central Government		290,799,000.00		350,535,946.00	Medical Expenses		2,540,041.00		915,826.00
Misc Project Grant-Central Govt.		7,804,571.00			Dispensary		313,575.00		345,806.00
III.Income on Investment									
a) Earmarked/Endow. Fund	-				**b) Administrative Expenses**				
b) Own Funds	9,692,944.65	9,692,944.65	-	-	Computer Accessories		320,513.00		32,819.00
					Consumable(Computer)		1,514,968.00		1,342,572.00
					Consumable Expenses(Elec & Works)		1,473,387.00		2,152,806.00
IV. Interest Received					JEST		100,000.00		148,935.00
a) On Bank Deposits	3,434,880.79	3,434,880.79	2,409,836.00	2,409,836.00	Legal Expenses -Tax		53,808.00		23,790.00
b) Loan, Advances etc					Legal Expenses		179,601.00		3,156,502.00
HBA UT I	8,000.00		-		Meeting Governing Council		305,323.00		269,186.00
HBA UT II Interest	1,000.00		-		Observational facilities of (Consumable)		864,347.00		748,358.00
HBA UT I Interest	44,320.00		-		Observational facilities of (LN2 gas)		179,249.00		126,709.00
Computer advance Interest	22,083.00		33,196.00		Contigencies Expenses		19,347,049.50		16,640,211.31
OMCA Interest	15,526.00		2,700.00		Other Scientific Meeting Expenses		2,413,403.00		2,310,078.00
Car Advance intt	-	90,929.00	4,900.00	40,796.00	Other Scientific Meeting Expenses (Foreign)		1,272,359.00		858,294.00
					Public Outreach Program		144,000.00		1,532,266.00
V.Other Income					Repair & Maintenance Instrument/AMC		612,937.00		1,374,719.00
					Repair & Maintenance of Building		3,532,362.00		6,256,035.00
Dispensary receipts		450.00		-	Repair & Maintenance of Others		162,359.00		8,779.00
Electricity Receipts		332,448.00		326,287.00	Repair & Maintenance of Vehicle		286,291.00		146,710.00
EMD/Security Forfeited		125,000.00		-	ATSOA Program		1,376,852.00		379,689.00
Guest House Rent/Shop Rent		339,337.00		360,730.00	Telephone Expenses		516,353.00		429,221.00
Hostel Rent		20,670.00		51,194.00	Travelling Expenses		2,373,008.00		1,609,492.00
House Licence Fee		391,797.00		294,545.00	Conveyance Expenses		3,431,619.00		2,273,124.00
RTI Receipt		4,678.00		1,062.00	Water Expenses		594,092.00		420,616.00
Telephone Receipt		4,960.00		3,202.00	Internet Maintenance Charges		-		1,978,110.00
Tender Fee		11,142.75		20,099.00	PMB Meeting		-		837,855.00
Water Receipt		78,789.00		85,924.00	Contribution for Pension		5,980,615.00		
					II. Payment made against funds				
Misc. Receipt		391.00		-	**for Various Projects**				
Sundry Receipt		-		4,980.00	PDF/2015/000691	756,860.00		-	
					DST/INT/BELG/-02/2014	500,000.00		-	
VI. Amount Borrowed		-		-	DST/INT/JSPS/-233/2016	250,000.00		-	
					DST/INT/SA/P-02	677,622.00		-	
VII.Any Other Receipt					JEST	30,000.00		-	
Investment		57,552,611.35		-	INT/RUS/RFBR//P-219	331,851.00		-	
FDR Grant	57,552,611.35				BRNS PROJECT	438,707.00	2,985,040.00	-	-

MANOJ VATSAL

08.09.17



					III. Investmnts and deposits made				
Loan and Advances		1,809,982.00		-	a) Out of Earmarked/Endowment funds		-		-
Vehicle Disposed off		-		291,551.00	b) Out of Own Funds(Investment others)		-		-
					IV. Expenditure on Fixed Assets & Capital Work in Progress				
Other Receipt		65,422.00		-					
					a) Purchase of Fixed Assets		40,953,250.00		151,898,858.00
					b) Capital WIP		37,817,114.00		-
					V. Refund of surplus money/Loans		-		-
					VI. Finance Charges(Interest)		-		-
					VII. Other Payments				
					Loans and Advances		3,859,546.00		5,091,114.00
					Payment to Creditors		5,335,058.00		7,717,525.00
					VIII.Closing balance				
					a) Cash in Hand	20,030.00		31,861.00	
					b) Bank Balances				
					Savings accounts	171,038,217.73		61,250,548.55	
					LC with Bank	18,099,980.00		23,286,284.00	
					FDR in SBI	-	189,158,227.73	57,552,611.35	142,121,304.90
TOTAL		**418,054,587.23**		**435,768,727.21**	**TOTAL**		**418,054,587.23**		**435,768,727.21**

ALL ENDOWMENT RELATED RECEIPTS & PAYMENTS HAVE BEEN TRANSFERRED TO INDEPENDENT RECEIPTS & PAYMENTS ACCOUNT OF TRUST

FOR: Manoj Vatsal & Co.
Chartered Accountants

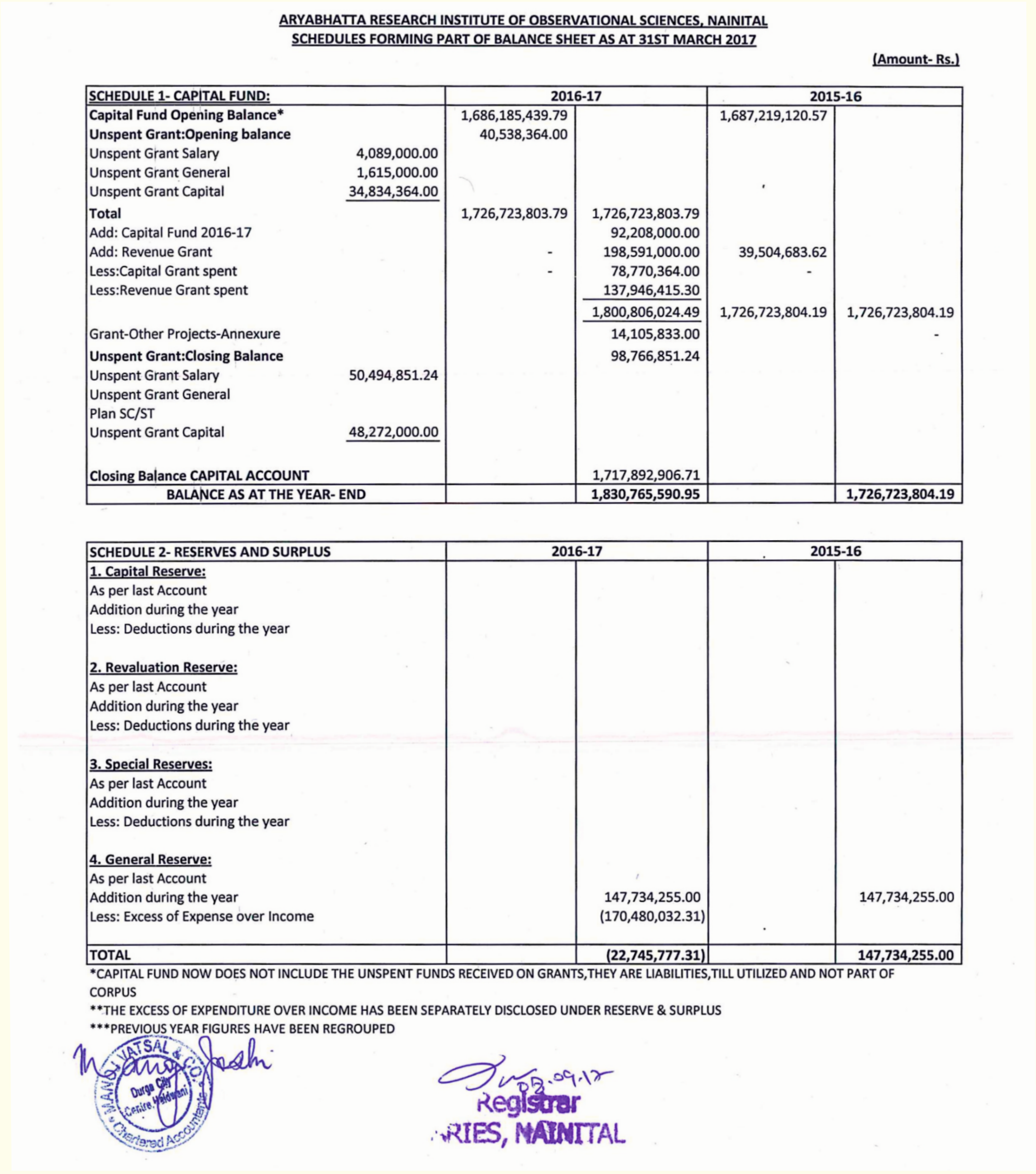
Manoj Joshi

MANOJ JOSHI
FCA,DISA(ICAI)
Certified Valuer(ICAI)
Membership No. 025757
Firm Regn. No. 010155C

Place: NAINITAL
Date: 08.09.2017

08.09.17
Registrar
ARIES, NAINITAL

MANOJ VATSAL & CO.



ARYABHATTA RESEARCH INSTITUTE OF OBSERVATIONAL SCIENCES, NAINITAL
SCHEDULES FORMING PART OF BALANCE SHEET AS AT 31ST MARCH 2017

(Amount- Rs.)

SCHEDULE 1- CAPITAL FUND:		2016-17		2015-16	
Capital Fund Opening Balance*		1,686,185,439.79		1,687,219,120.57	
Unspent Grant:Opening balance		40,538,364.00			
Unspent Grant Salary	4,089,000.00				
Unspent Grant General	1,615,000.00				
Unspent Grant Capital	34,834,364.00				
Total		1,726,723,803.79	1,726,723,803.79		
Add: Capital Fund 2016-17			92,208,000.00		
Add: Revenue Grant		-	198,591,000.00	39,504,683.62	
Less:Capital Grant spent		-	78,770,364.00	-	
Less:Revenue Grant spent			137,946,415.30		
			1,800,806,024.49	1,726,723,804.19	1,726,723,804.19
Grant-Other Projects-Annexure			14,105,833.00		-
Unspent Grant:Closing Balance			98,766,851.24		
Unspent Grant Salary	50,494,851.24				
Unspent Grant General					
Plan SC/ST					
Unspent Grant Capital	48,272,000.00				
Closing Balance CAPITAL ACCOUNT			1,717,892,906.71		
BALANCE AS AT THE YEAR- END			**1,830,765,590.95**		**1,726,723,804.19**

SCHEDULE 2- RESERVES AND SURPLUS	2016-17		2015-16	
1. Capital Reserve:				
As per last Account				
Addition during the year				
Less: Deductions during the year				
2. Revaluation Reserve:				
As per last Account				
Addition during the year				
Less: Deductions during the year				
3. Special Reserves:				
As per last Account				
Addition during the year				
Less: Deductions during the year				
4. General Reserve:				
As per last Account				
Addition during the year		147,734,255.00		147,734,255.00
Less: Excess of Expense over Income		(170,480,032.31)		
TOTAL		**(22,745,777.31)**		**147,734,255.00**

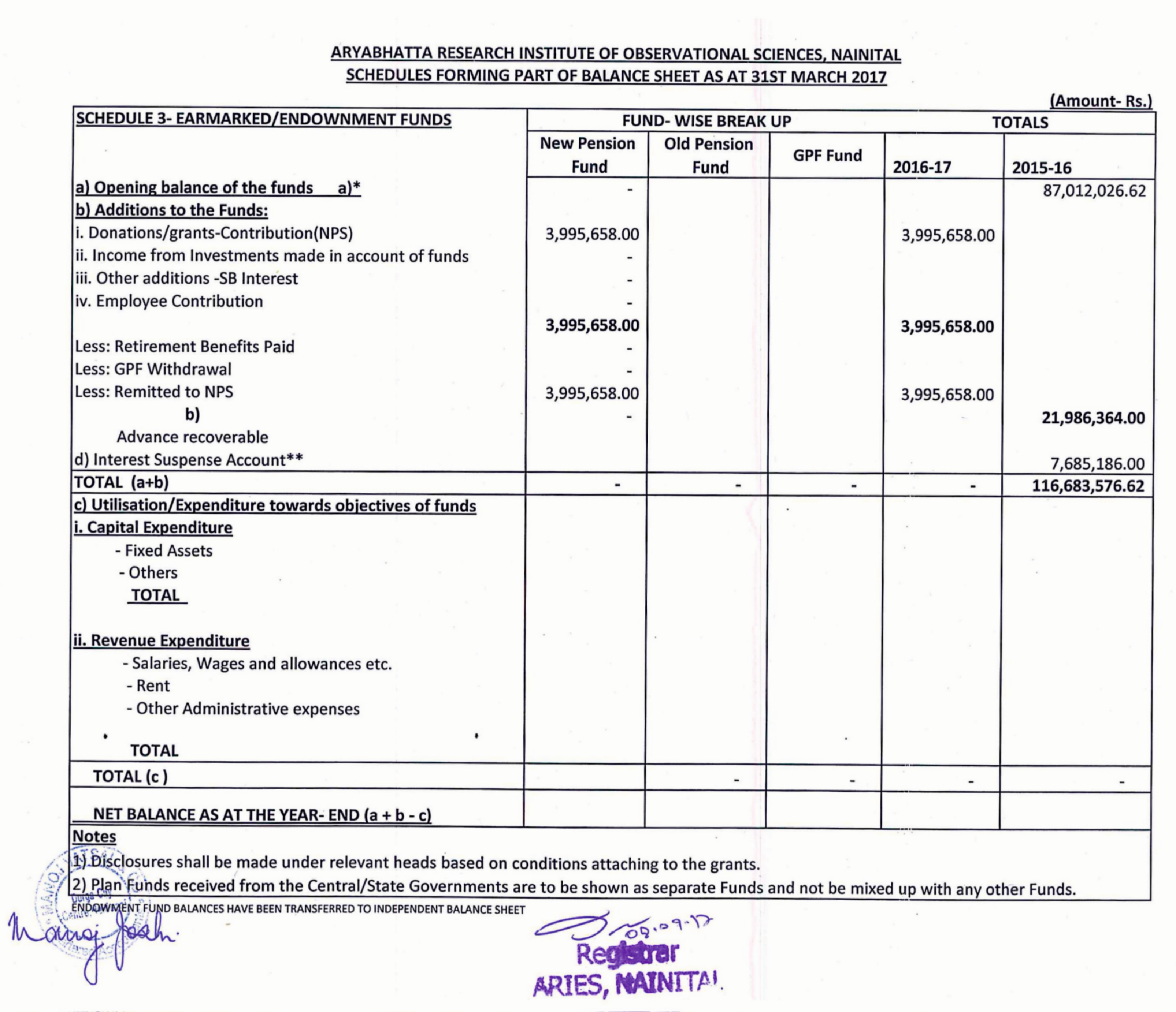
*CAPITAL FUND NOW DOES NOT INCLUDE THE UNSPENT FUNDS RECEIVED ON GRANTS,THEY ARE LIABILITIES,TILL UTILIZED AND NOT PART OF CORPUS

**THE EXCESS OF EXPENDITURE OVER INCOME HAS BEEN SEPARATELY DISCLOSED UNDER RESERVE & SURPLUS

***PREVIOUS YEAR FIGURES HAVE BEEN REGROUPED

MANOJ VATSAL & CO.
Durga City Centre, Haldwani
Chartered Accountants

02.09.17
Registrar
RIES, NAINITAL



ARYABHATTA RESEARCH INSTITUTE OF OBSERVATIONAL SCIENCES, NAINITAL
SCHEDULES FORMING PART OF BALANCE SHEET AS AT 31ST MARCH 2017

(Amount- Rs.)

SCHEDULE 3- EARMARKED/ENDOWNMENT FUNDS	FUND- WISE BREAK UP			TOTALS	
	New Pension Fund	Old Pension Fund	GPF Fund	2016-17	2015-16
a) Opening balance of the funds a)*	-				87,012,026.62
b) Additions to the Funds:					
i. Donations/grants-Contribution(NPS)	3,995,658.00			3,995,658.00	
ii. Income from Investments made in account of funds	-				
iii. Other additions -SB Interest	-				
iv. Employee Contribution	-				
	3,995,658.00			**3,995,658.00**	
Less: Retirement Benefits Paid	-				
Less: GPF Withdrawal	-				
Less: Remitted to NPS	3,995,658.00			3,995,658.00	
b)	-				**21,986,364.00**
Advance recoverable					
d) Interest Suspense Account**					7,685,186.00
TOTAL (a+b)	**-**	**-**	**-**	**-**	**116,683,576.62**
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)					

Notes

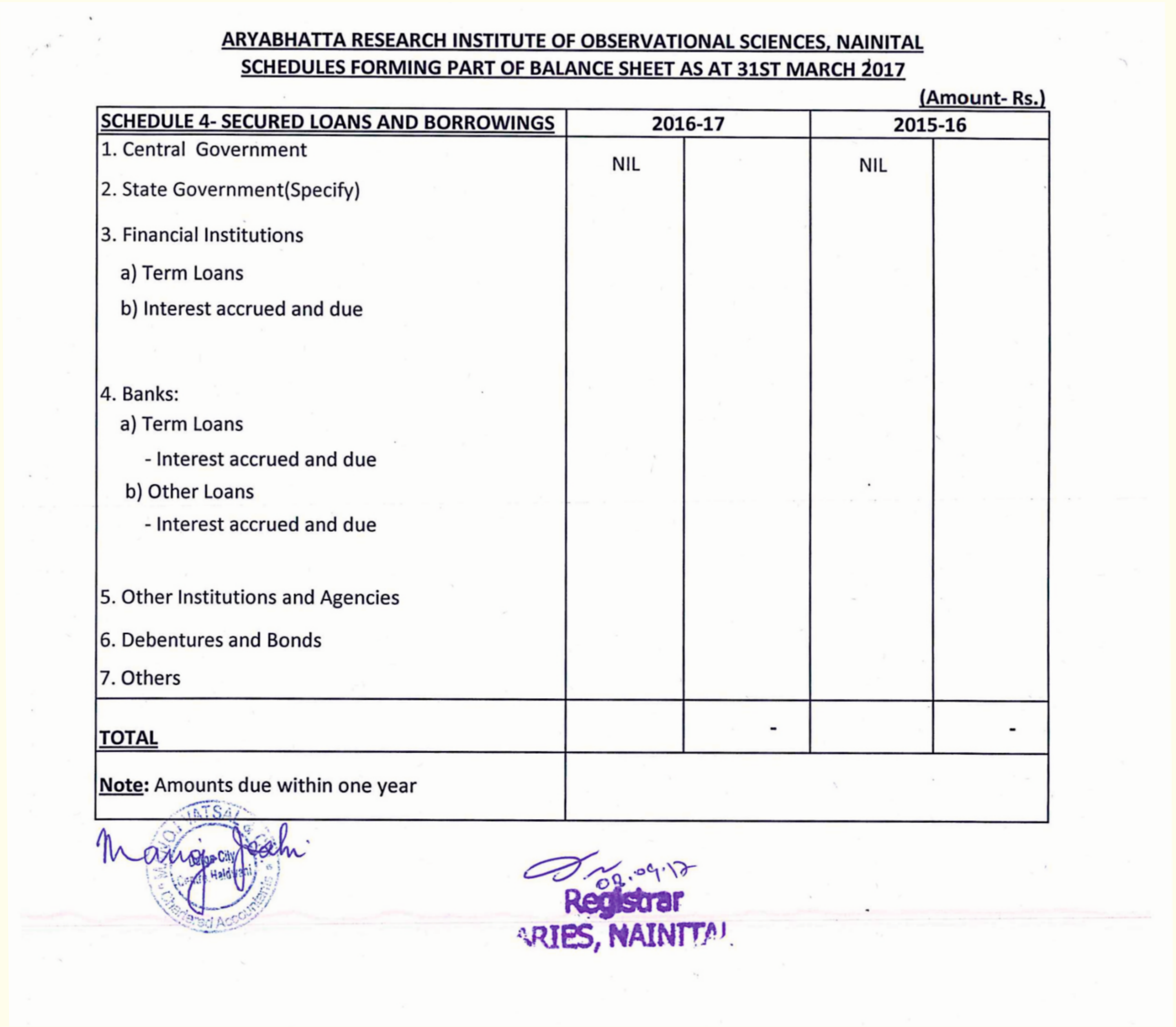
1) Disclosures shall be made under relevant heads based on conditions attaching to the grants.

2) Plan Funds received from the Central/State Governments are to be shown as separate Funds and not be mixed up with any other Funds.

ENDOWMENT FUND BALANCES HAVE BEEN TRANSFERRED TO INDEPENDENT BALANCE SHEET

Manoj Joshi

09.09.17
Registrar
ARIES, NAINITAL



ARYABHATTA RESEARCH INSTITUTE OF OBSERVATIONAL SCIENCES, NAINITAL

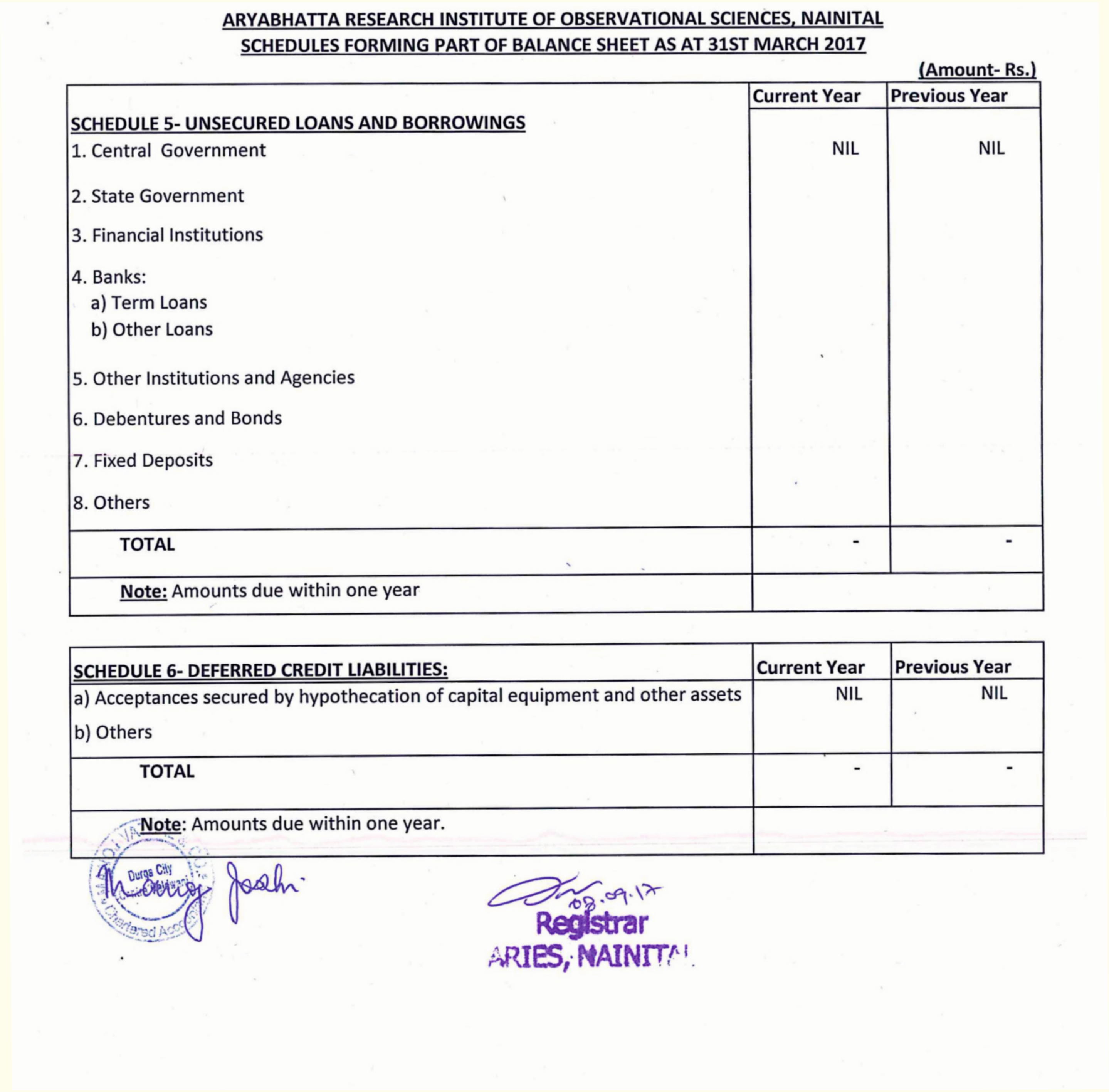
SCHEDULES FORMING PART OF BALANCE SHEET AS AT 31ST MARCH 2017

(Amount- Rs.)

SCHEDULE 4- SECURED LOANS AND BORROWINGS	2016-17		2015-16	
1. Central Government	NIL		NIL	
2. State Government(Specify)				
3. Financial Institutions				
a) Term Loans				
b) Interest accrued and due				
4. Banks:				
a) Term Loans				
- Interest accrued and due				
b) Other Loans				
- Interest accrued and due				
5. Other Institutions and Agencies				
6. Debentures and Bonds				
7. Others				
TOTAL		-		-
Note: Amounts due within one year				

Manoj Joshi

08.09.17
Registrar
ARIES, NAINITAL



ARYABHATTA RESEARCH INSTITUTE OF OBSERVATIONAL SCIENCES, NAINITAL
SCHEDULES FORMING PART OF BALANCE SHEET AS AT 31ST MARCH 2017

(Amount- Rs.)

	Current Year	Previous Year
SCHEDULE 5- UNSECURED LOANS AND BORROWINGS		
1. Central Government	NIL	NIL
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	NIL	NIL
b) Others		
TOTAL	-	-
Note: Amounts due within one year.		

Durga City Chartered Accountants

Manoj Joshi

08.09.17

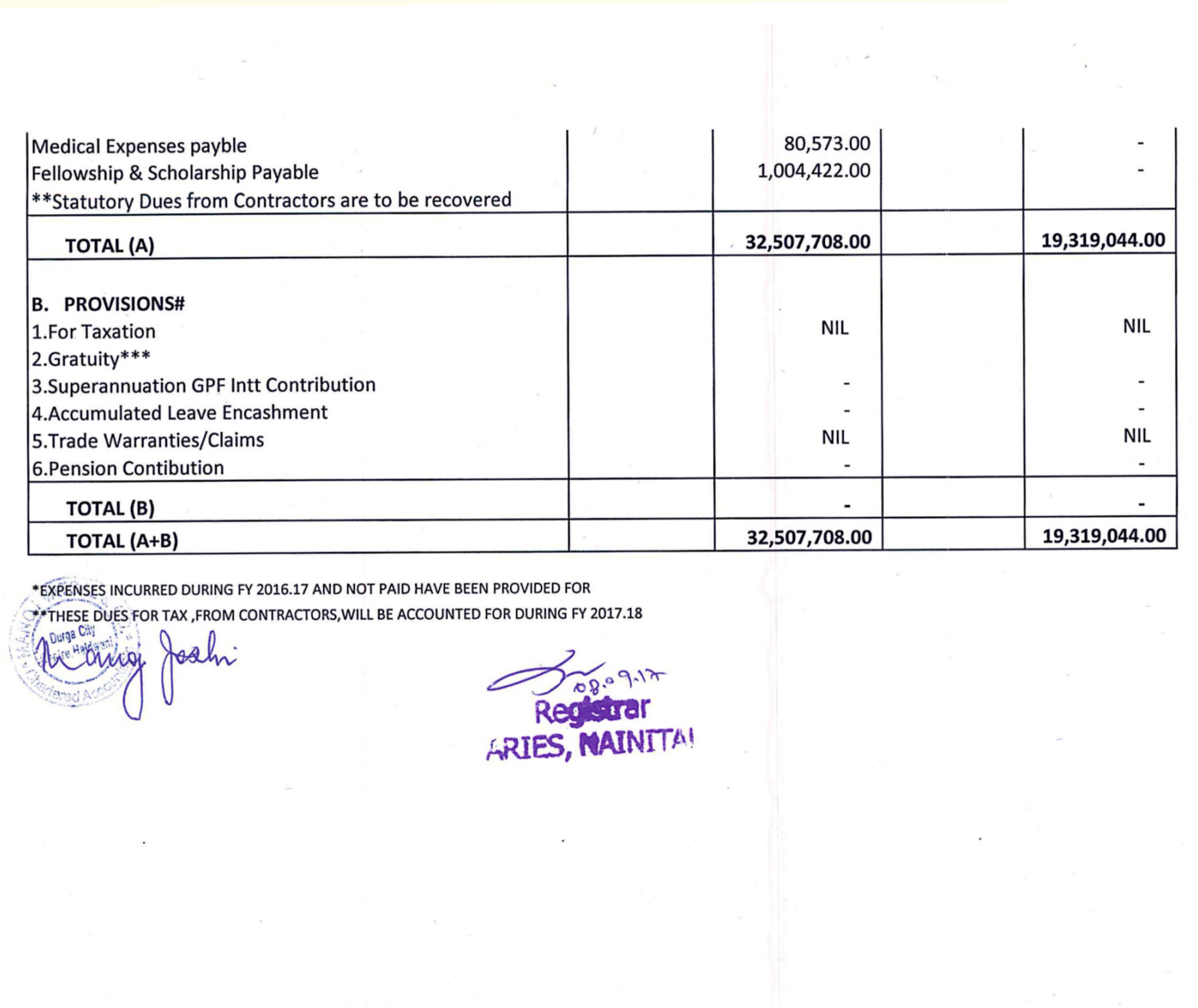
Registrar
ARIES, NAINITAL

ARYABHATTA RESEARCH INSTITUTE OF OBSERVATIONAL SCIENCES, NAINITAL
SCHEDULES FORMING PART OF BALANCE SHEET AS AT 31ST MARCH 2017

(Amount- Rs.)

	2016-17		2015-16	
SCHEDULE 7- CURRENT LIABILITIES AND PROVISIONS				
A. OTHER CURRENT LIABILITIES				
Security and earnest deposits**	5,337,954.00		5,337,954.00	
Performance Security**	3,726,183.00		4,296,294.00	
Retention and performance security deposits**	1,876,809.00		583,366.00	
DDO DST	76,163.00		76,163.00	
Earnest Money A/c**	1,872,878.00		2,912,113.00	
Canteen Security	2,000.00	12,891,987.00	2,000.00	13,207,890.00
JIC PAR Research Project		52,650.00		52,650.00
Money received on account of other projects		10,537,643.00		5,718,112.00
Faulad Construction		20,000.00		20,000.00
Sundry Creditors		1,390,293.00		-
INDO-UK Seminar (DST)		(28,000.00)		(28,000.00)
Women Secientific Scheme (WOS- A)		-		305,573.00
Leave Encashment Payable		14,946.00		14,946.00
GIS Payable		-		(239.00)
TDS Payable		5,355.00		5,355.00
Service- Tax (F.Y. 2015-16)		3,410.00		3,410.00
Mission Butter Fly Payable		(4,100.00)		(4,100.00)
Motor Cy Advance Intt. (UT)		-		23,447.00
OUTSTANDING EXPENSES & CONTRIBUTIONS*				
NPS Payable		64,951.00		-
Outstanding Expenses		838,671.00		-
Salary & Allowance Payable		5,634,907.00		-

08.09.17
Registrar
ARIES, NAINITAL



Medical Expenses payble Fellowship & Scholarship Payable **Statutory Dues from Contractors are to be recovered		80,573.00 1,004,422.00		- -
TOTAL (A)		**32,507,708.00**		**19,319,044.00**
B. PROVISIONS#				
1.For Taxation		NIL		NIL
2.Gratuity***				
3.Superannuation GPF Intt Contribution		-		-
4.Accumulated Leave Encashment		-		-
5.Trade Warranties/Claims		NIL		NIL
6.Pension Contibution		-		-
TOTAL (B)		**-**		**-**
TOTAL (A+B)		**32,507,708.00**		**19,319,044.00**

*EXPENSES INCURRED DURING FY 2016.17 AND NOT PAID HAVE BEEN PROVIDED FOR

**THESE DUES FOR TAX ,FROM CONTRACTORS,WILL BE ACCOUNTED FOR DURING FY 2017.18

Manoj Joshi

08.09.17

Registrar

ARIES, NAINITA

FORM OF FINANCIAL STATEMENTS (NON- PROFIT ORGANISATIONS)
ARYABHATTA RESEARCH INSTITUTE OF OBSERVATIONAL SCIENCES, NAINITAL
SCHEDULES FORMING PART OF BALANCE SHEET AS AT 31ST MARCH 2017

(Amount-Rs)

SCHEDULES 8- FIXED ASSETS DESCRIPTION	GROSS BLOCK					DEPRECIATION					NET BLOCK		
	Cost/valuation As as on 01.04.2016	Additions upto 30.09.2016	Additions after 30.09.2016	Deductions during the	Cost/valuation As on 31.03.2017	As on 01.04.2016	Additions upto 30.09.2016	Additions after 30.09.2016	Other than addition during 2016-17	Total up to 31.03.2017	As on 31.03.2017	As on 31.03.2016	% age
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	29,361,839.60	-	-	-	29,361,839.60	5,205,747.62	-	-	1,207,804.60	6,413,552.22	22,948,287.38	24,156,091.98	5
(ii) Non Residential- Manora Peak	107,627,691.00	-	-	-	107,627,691.00	54,977,211.48	-	-	5,265,047.95	60,242,259.43	47,385,431.57	52,650,479.52	10
(iii) Residential- Devsthal (Guest Hous	1,224,022.00	-	-	-	1,224,022.00	421,302.48	-	-	40,135.98	461,438.46	762,583.54	802,719.52	5
(iv) Non Residential- Devsthal	8,801,426.00	-	-	-	8,801,426.00	4,204,553.06	-	-	459,687.29	4,664,240.35	4,137,185.65	4,596,872.94	10
3. Infrastructure Dev. (Manora Peak)	9,575,013.70	1,026,533.00	3,818,753.00	-	14,420,299.70	4,902,414.18	102,653.30	190,937.65	467,259.95	5,663,265.08	8,757,034.62	4,672,599.53	10
4. Infrastructure Dev. (Devsthal)	49,820,305.90	158,341.00	94,140.00	-	50,072,786.90	8,022,286.29	15,834.10	4,707.00	4,179,801.96	12,222,629.35	37,850,157.55	41,798,019.61	10
5. Road at Devsthal	22,849,164.00	-	-	-	22,849,164.00	9,449,625.02	-	-	1,339,953.90	10,789,578.92	12,059,585.08	13,399,538.98	10
6. Furniture & Fixture	8,881,383.70	373,831.00	69,845.00	-	9,325,059.70	4,240,431.02	37,383.10	3,492.25	464,095.27	4,745,401.64	4,579,658.06	4,640,952.68	10
7. Office Equipment	1,716,513.25	-	33,470.00	-	1,749,983.25	994,423.23	-	1,673.50	72,209.00	1,068,305.73	681,677.52	722,090.02	10
8. Instruments & Equipments:-										-			
(i) Telescope	1,045,247.55	6,409,448.00	-	-	7,454,695.55	814,720.43	961,417.20	-	34,579.07	1,810,716.70	5,643,978.85	230,527.12	15
(ii) Telescope (Solar)	1,367,166.00	-	-	-	1,367,166.00	974,648.10	-	-	58,877.69	1,033,525.79	333,640.22	392,517.90	15
(iii) 1.3 Mt Telescope	77,016,439.00	-	-	-	77,016,439.00	42,838,646.16	-	-	5,126,668.93	47,965,315.09	29,051,123.91	34,177,792.84	15
(iv) 3.60 Mtr Telescope	-	1,263,068,668.00	-	-	1,263,068,668.00	-	189,460,300.20	-	-	189,460,300.20	1,073,608,367.80	-	15
(v) Alumunising Plant (Devsthal)	-	39,523,736.00	-	-	39,523,736.00	-	5,928,560.40	-	-	5,928,560.40	33,595,175.60	-	15
(vi) Public Outreach Telescope	607,295.00	-	-	-	607,295.00	337,834.85	-	-	40,419.02	378,253.87	229,041.13	269,460.15	15
(vii) Schmict Telescope	10,738,623.00	-	-	-	10,738,623.00	7,239,547.25	-	-	524,861.36	7,764,408.61	2,974,214.39	3,499,075.75	15
(viii) Electronic Section	9,055,749.55	-	-	-	9,055,749.55	7,058,524.64	-	-	299,583.74	7,358,108.38	1,697,641.17	1,997,224.91	15
(ix) Work Shop	273,027.45	-	-	-	273,027.45	212,811.71	-	-	9,032.36	221,844.07	51,183.38	60,215.74	15
(x) Aluiminising Anecising	103,357.45	-	-	-	103,357.45	80,562.77	-	-	3,419.20	83,981.97	19,375.48	22,794.68	15
(xi) Optics	27,240.80	-	-	-	27,240.80	21,232.61	-	-	901.23	22,133.84	5,106.96	6,008.19	15
(xii) Instruments	106,173,683.67	198,231.00	1,462,633.00	-	107,834,547.67	47,688,534.08	29,734.65	109,697.48	8,772,772.44	56,600,738.65	51,233,809.02	58,485,149.59	15
(xiii) Modernisation of Instruments	50,365,395.00	1,001,476.00	12,118,450.00	-	63,485,321.00	23,010,693.59	150,221.40	908,883.75	4,103,205.21	28,173,003.95	35,312,317.05	27,354,701.41	15
(xiv) LIDAR	8,760,465.00	-	-	-	8,760,465.00	5,599,330.87	-	-	474,170.12	6,073,500.99	2,686,964.01	3,161,134.13	15
(xv) ADFOSC (Backend Instrument)	3,313,267.00	-	-	-	3,313,267.00	1,606,509.99	-	-	256,013.55	1,862,523.54	1,450,743.46	1,706,757.01	15
(xvi) Solar Section	8,227.00	-	-	-	8,227.00	5,220.76	-	-	450.94	5,671.70	2,555.30	3,006.24	15
(xvii) Projector (Public Outreach)	105,000.00	-	-	-	105,000.00	54,300.14	-	-	7,604.98	61,905.12	43,094.88	50,699.86	15
(xviii) Planetarium (Public Outreach)	3,918,714.00	-	-	-	3,918,714.00	1,512,133.77	-	-	360,987.03	1,873,120.80	2,045,593.20	2,406,580.23	15
(xix) Library Instruments	-	9,500.00	-	-	9,500.00	-	1,425.00	-	-	1,425.00	8,075.00	-	15
(xx) CCTV Cameras	-	-	77,500.00	-	77,500.00	-	-	5,812.50	-	5,812.50	71,687.50	-	15
(xxi) Spectrometer	-	-	1,062,951.00	-	1,062,951.00	-	-	79,721.33	-	79,721.33	983,229.67	-	15
9. Vehicles	2,663,477.10	-	-	-	2,663,477.10	1,704,623.58	-	-	143,828.03	1,848,451.61	815,025.49	958,853.52	15
10. Electric Installation (Manora Peak)	3,563,920.00	251,069.00	2,090,731.00	-	5,905,720.00	1,838,084.31	37,660.35	156,804.83	258,875.35	2,291,424.84	3,614,295.16	1,725,835.69	15
11. Electric Installation (Devsthal)	2,922,165.00	-	-	-	2,922,165.00	1,901,634.06	-	-	153,079.64	2,054,713.70	867,451.30	1,020,530.94	15
12. Computer	33,725,153.40	1,943,102.00	487,314.00	-	36,155,569.40	30,986,526.70	1,165,861.20	146,194.20	1,643,176.02	33,941,758.12	2,213,811.28	2,738,626.70	60
13. Computer Software	1,405,432.00	-	-	-	1,405,432.00	1,372,126.20	-	-	19,983.48	1,392,109.68	13,322.32	33,305.80	60

08.09.17
Registrar
RIES NAINITAL

14. Library Books	43,377,715.50	646,200.00	3,745,565.00	471.00	47,769,009.50	43,377,715.50	646,200.00	1,872,782.50	-	45,896,698.00	1,872,311.50	-	100
TOTAL OF CURRENT YEAR	706,244,548.62	1,314,610,135.00	25,061,352.00	471.00	2,045,915,564.62	312,653,956.45	198,537,250.90	3,480,706.99	35,788,485.29	550,460,399.63	1,495,455,164.99	393,590,592.18	
PREVIOUS YEAR	643,075,901.62		63,460,198.00	291,551.00	706,244,548.62	265,128,831.59		47,525,124.85	-	312,653,956.44	393,590,592.18	377,947,070.05	
B. CAPITAL WORK-IN PROGRSS											117,255,046.00	1,371,243,989.00	
C. PROJECT ASSETS*											196,916.00	-	
TOTAL											1,612,907,126.99	1,764,834,581.18	
(Note to be given as to cost of assets on hire purchase basis included above)													

*PROJECT FIXED ASSETS HAVE BEEN CONSIDERED IN THE ARIES FIXED ASSETS BLOCK OF ASSETS

Manoj Joshi

Durga City Centre Haldwani

08.09.17

Registrar
ARIES, NAINITA

Schedule 8A : Fixed Assets work in progress as on 31.03.2017

Sl.	Description of Assets	Opening balance on April 1, 2016	Addition during year	Assets completed	Balance as on March 31, 2017
1	4.00 Mt International Liquid Mirror Telescope	11,540,943.00	10,429,707.00	-	21,970,650.00
2	Medium Resolution NIR Spectrograph	65,974,948.00	14,481,946.00	-	80,456,894.00
3	TMT/GSMT	1,861,151.00	2,201,934.00	-	4,063,085.00
4	CWIP-Construction Work -Devasthal (CPWD)	-	7,895,000.00	-	7,895,000.00
5	WG-02 (ASTRAD)	-	2,869,417.00	-	2,869,417.00
	TOTAL	79,377,042.00	37,878,004.00	-	117,255,046.00

Manoj Joshi

08.09.17
Registrar
ARIES, NAINITAL

ARYABHATTA RESEARCH INSTITUTE OF OBSERVATIONAL SCIENCES, NAINITAL
SCHEDULES FORMING PART OF BALANCE SHEET AS AT 31ST MARCH 2017

(Amount-Rs)

SCHEDULE 9- INVESTMENTS FROM EARMARKED/ENDOWMENT FUNDS	2016-17	2015-16
Investment in FDR's in Scheduled Banks (GPF A/c)*	-	19,613,571.00
Interest accrued on SBI FDR's (GPF A/c)*	-	4,152,983.00
Investment in UBI FDR's (Old Pension)*	-	48,047,291.00
Interest accrued on UBI FDR's (GPF A/c)*	-	3,093,029.00
TOTAL	**-**	**74,906,874.00**

SCHEDULES 10- INVSTMENTS- OTHERS	2016-17	2015-16
FDR No: 34482716294*	-	57,552,611.35
FDR-ISRO Project	5,000,000.00	-
TOTAL	**5,000,000.00**	**57,552,611.35**

*ALL INVESTMENTS WERE MATURED AND MAINTAINED IN THEIR SAVING BANK ACCOUNTS & THEN REINVESTED(ALONG WITH INTEREST)IN 2017.18

28.09.17
Registrar
ARIES, NAINITAL

ARYABHATTA RESEARCH INSTITUTE OF OBSERVATIONAL SCIENCES, NAINITAL
SCHEDULES FORMING PART OF BALANCE SHEET AS AT 31ST MARCH 2017

(Amount-Rs)

SCHEDULE 11- CURRENT ASSETS, LOANS, ADVANCES ETC	2016-17		2015-16	
A. CURRENT ASSETS:				
1. Inventories:				
a) Stores and Spares	2,648,383.22		1,615,888.51	
b) Stationery Stock	287,374.99		185,187.67	
c) Computer Accessories Stock	3,023,220.51		1,150,057.98	
d) Fuel (POL)	68,033.32	6,027,012.04	87,984.07	3,039,118.23
		6,027,012.04		**3,039,118.23**
2. Sundry Debtors:				
a) Debts Outstanding for a period exceeding six months		-		-
b) Others		-		-
3. Cash balances in hand (including cheques/drafts and imprest)		20,030.00		31,861.00
4. Bank Balances:				
a) With Scheduled Banks:				
-On Deposit Accounts -LC (includes margin money)	18,099,980.00		23,286,284.00	
-On Savings Accounts(As per Annexure I)*	171,038,216.93	189,138,196.93	61,250,548.55	84,536,832.55
		189,158,226.93		**84,568,693.55**
b) With Scheduled Banks Project Wise				
-On Current Accounts		-		-
-On Deposit Accounts		-		-
-On Savings Accounts		8,908,917.00		-
5. Post Office- Savings Accounts		-		-
TOTAL (A)		**204,094,155.97**		**87,607,811.78**

*MATURITY PROCEEDS OF INVESTMENT FDs

BANK BALANCES OF ENDOWMENT FUNDS HAVE BEEN TRANSFERRED TO INDEPENDENT BALANCE SHEET

Manoj Joshi

08.09.17
Registrar
RIES, NAINITAL

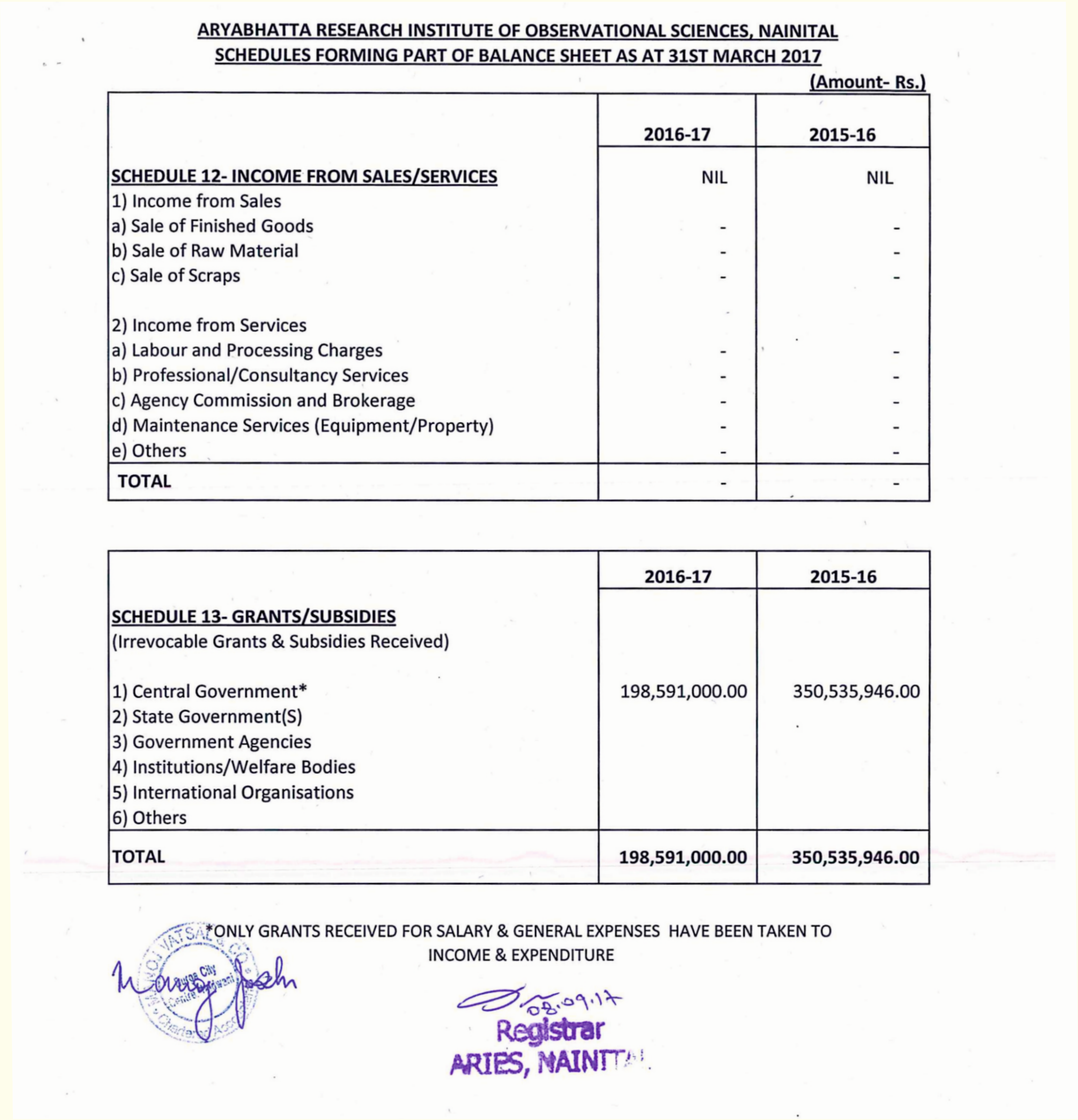
ARYABHATTA RESEARCH INSTITUTE OF OBSERVATIONAL SCIENCES, NAINITAL
SCHEDULES FORMING PART OF BALANCE SHEET AS AT 31ST MARCH 2017

(Amount-Rs)

SCHEDULE 11- CURRENT ASSETS, LOANS, ADVANCES ETC.	2016-17		2015-16	
B. LOANS, ADVANCES AND OTHER ASSETS				
1. Loans: (As per Annexure- 3)				
a) Staff		4,246,622.00		925,823.50
b) Other Entities engaged in activities/objectives similar to that of the Entity		-		-
c) Others		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		2,068,101.00		6,029,463.00
b) Prepayments				-
c) Others		10,842,981.17		18,603,515.00
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)		**18,526,238.67**		**25,558,801.50**
TOTAL (A + B)		**222,620,394.64**		**113,166,613.28**

08.09.17

Registrar
ARIES, NAINITAL



ARYABHATTA RESEARCH INSTITUTE OF OBSERVATIONAL SCIENCES, NAINITAL
SCHEDULES FORMING PART OF BALANCE SHEET AS AT 31ST MARCH 2017

(Amount- Rs.)

	2016-17	2015-16
SCHEDULE 12- INCOME FROM SALES/SERVICES	NIL	NIL
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	-	-

	2016-17	2015-16
SCHEDULE 13- GRANTS/SUBSIDIES		
(Irrevocable Grants & Subsidies Received)		
1) Central Government*	198,591,000.00	350,535,946.00
2) State Government(S)		
3) Government Agencies		
4) Institutions/Welfare Bodies		
5) International Organisations		
6) Others		
TOTAL	**198,591,000.00**	**350,535,946.00**

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

Manoj Joshi

08.09.17

Registrar
ARIES, NAINITAL

ARYABHATTA RESEARCH INSTITUTE OF OBSERVATIONAL SCIENCES, NAINITAL
SCHEDULES FORMING PART OF BALANCE SHEET AS AT 31ST MARCH 2017

(Amount- Rs.)

	2016-17	2015-16
SCHEDULE 14- FEES/SUBSCRIPTIONS		
1) Entrance Fees	NIL	NIL
2) Annual Fees/Subscriptions		
3) Seminar/Program Fees		
4) Consultancy Fees		
5) Others		
TOTAL	-	-
Note- Accounting Policies towards each item are to be disclosed		

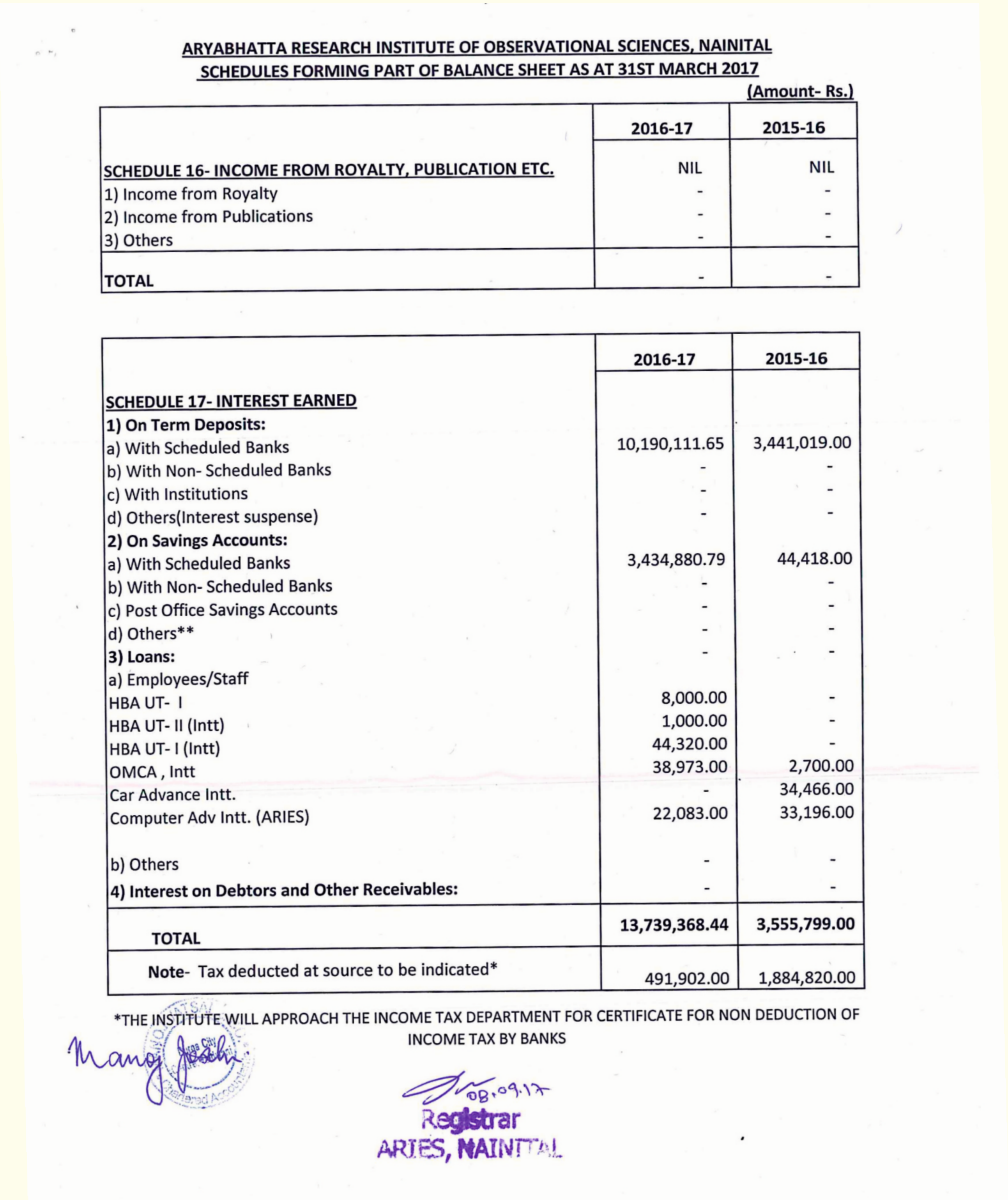
	Investment from Earmarked Fund		Investment- Others	
SCHEDULE 15- INCOME FROM INVESTEMENTS (Income on Invest. From Earmarked/Endowment Funds Transferred to Funds)	2016-17	2015-16	2016-17	2015-16
1) Interest:*	NIL	NIL	NIL	NIL
a) On Govt. Securities				
b) Other Bonds/ Debentures				
c) FDR				
2) Dividends:				
a) On Shares				
b) On Mutual Ffund Securities				
3) Rents				
4) Others				
TOTAL				
TRANSFERRED TO EARMARKED/ENDOWMENT FUNDS				

*THERE IS NIL ACCRUAL OF INCOME SINCE ALL INVESTMENTS WERE MATURED BEFORE 31.03.2017 AND THE INTEREST INCOME RECOGNIZED

Chartered Accountants

08.09.17

Registrar
ARIES, NAINITA



ARYABHATTA RESEARCH INSTITUTE OF OBSERVATIONAL SCIENCES, NAINITAL
SCHEDULES FORMING PART OF BALANCE SHEET AS AT 31ST MARCH 2017

(Amount- Rs.)

	2016-17	2015-16
SCHEDULE 16- INCOME FROM ROYALTY, PUBLICATION ETC.	NIL	NIL
1) Income from Royalty	-	-
2) Income from Publications	-	-
3) Others	-	-
TOTAL	-	-

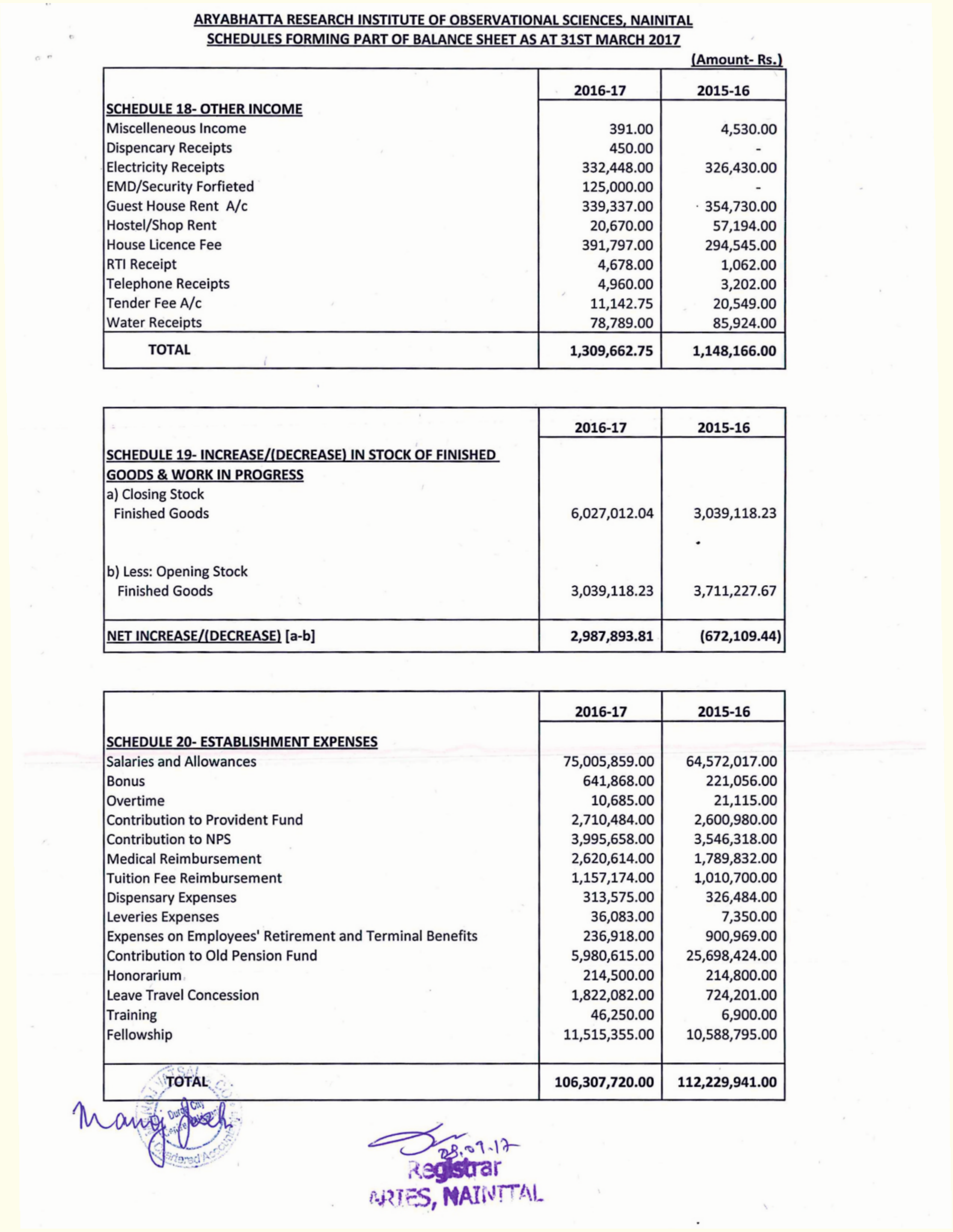
	2016-17	2015-16
SCHEDULE 17- INTEREST EARNED		
1) On Term Deposits:		
a) With Scheduled Banks	10,190,111.65	3,441,019.00
b) With Non- Scheduled Banks	-	-
c) With Institutions	-	-
d) Others(Interest suspense)	-	-
2) On Savings Accounts:		
a) With Scheduled Banks	3,434,880.79	44,418.00
b) With Non- Scheduled Banks	-	-
c) Post Office Savings Accounts	-	-
d) Others**	-	-
3) Loans:	-	-
a) Employees/Staff		
HBA UT- I	8,000.00	-
HBA UT- II (Intt)	1,000.00	-
HBA UT- I (Intt)	44,320.00	-
OMCA , Intt	38,973.00	2,700.00
Car Advance Intt.	-	34,466.00
Computer Adv Intt. (ARIES)	22,083.00	33,196.00
b) Others	-	-
4) Interest on Debtors and Other Receivables:	-	-
TOTAL	**13,739,368.44**	**3,555,799.00**
Note- Tax deducted at source to be indicated*	491,902.00	1,884,820.00

*THE INSTITUTE WILL APPROACH THE INCOME TAX DEPARTMENT FOR CERTIFICATE FOR NON DEDUCTION OF INCOME TAX BY BANKS

Manoj Joshi

08.09.17

Registrar
ARIES, NAINITAL



ARYABHATTA RESEARCH INSTITUTE OF OBSERVATIONAL SCIENCES, NAINITAL
SCHEDULES FORMING PART OF BALANCE SHEET AS AT 31ST MARCH 2017

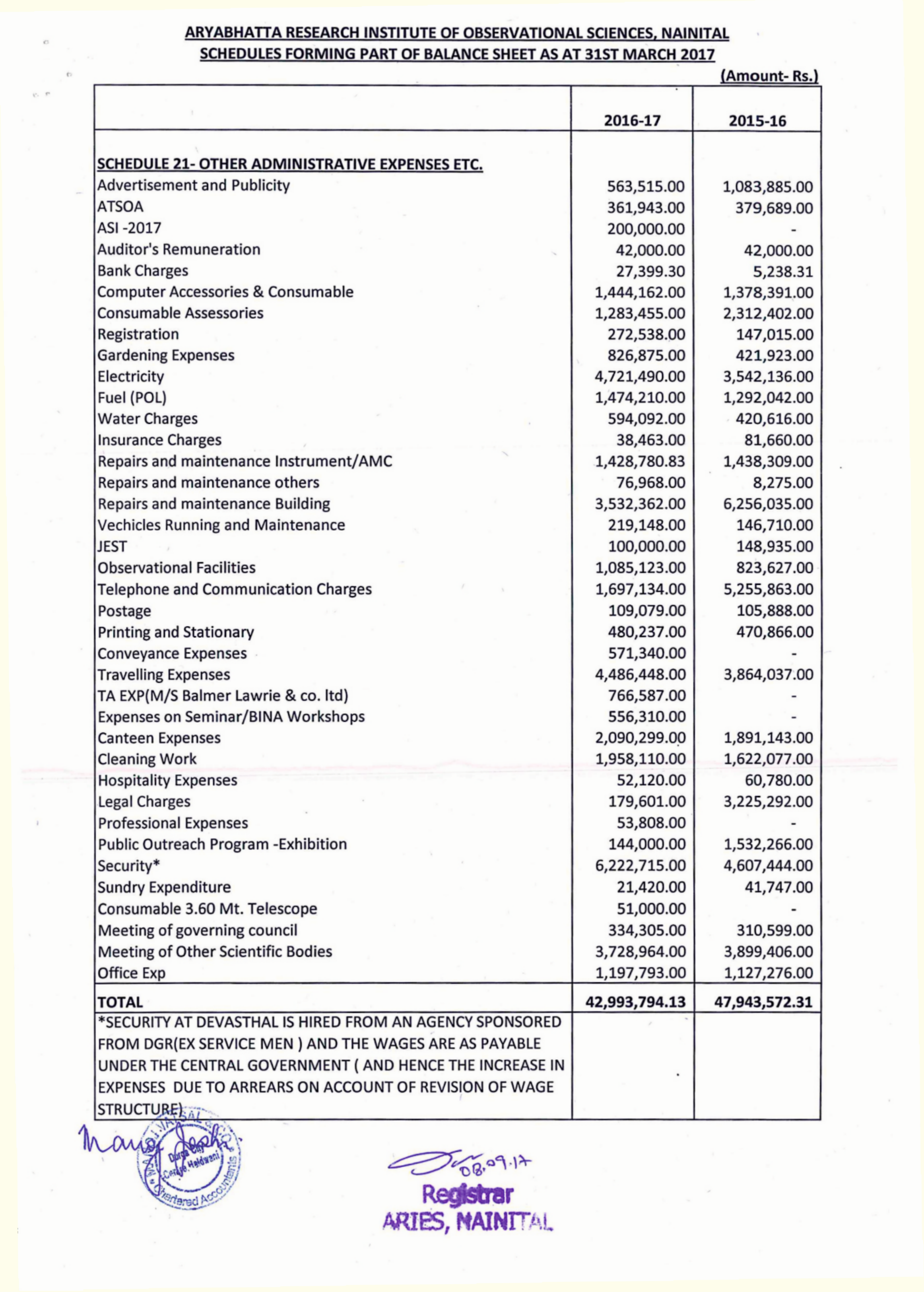
(Amount- Rs.)

	2016-17	2015-16
SCHEDULE 18- OTHER INCOME		
Miscelleneous Income	391.00	4,530.00
Dispencary Receipts	450.00	-
Electricity Receipts	332,448.00	326,430.00
EMD/Security Forfieted	125,000.00	-
Guest House Rent A/c	339,337.00	354,730.00
Hostel/Shop Rent	20,670.00	57,194.00
House Licence Fee	391,797.00	294,545.00
RTI Receipt	4,678.00	1,062.00
Telephone Receipts	4,960.00	3,202.00
Tender Fee A/c	11,142.75	20,549.00
Water Receipts	78,789.00	85,924.00
TOTAL	**1,309,662.75**	**1,148,166.00**

	2016-17	2015-16
SCHEDULE 19- INCREASE/(DECREASE) IN STOCK OF FINISHED GOODS & WORK IN PROGRESS		
a) Closing Stock		
Finished Goods	6,027,012.04	3,039,118.23
b) Less: Opening Stock		
Finished Goods	3,039,118.23	3,711,227.67
NET INCREASE/(DECREASE) [a-b]	**2,987,893.81**	**(672,109.44)**

	2016-17	2015-16
SCHEDULE 20- ESTABLISHMENT EXPENSES		
Salaries and Allowances	75,005,859.00	64,572,017.00
Bonus	641,868.00	221,056.00
Overtime	10,685.00	21,115.00
Contribution to Provident Fund	2,710,484.00	2,600,980.00
Contribution to NPS	3,995,658.00	3,546,318.00
Medical Reimbursement	2,620,614.00	1,789,832.00
Tuition Fee Reimbursement	1,157,174.00	1,010,700.00
Dispensary Expenses	313,575.00	326,484.00
Leveries Expenses	36,083.00	7,350.00
Expenses on Employees' Retirement and Terminal Benefits	236,918.00	900,969.00
Contribution to Old Pension Fund	5,980,615.00	25,698,424.00
Honorarium	214,500.00	214,800.00
Leave Travel Concession	1,822,082.00	724,201.00
Training	46,250.00	6,900.00
Fellowship	11,515,355.00	10,588,795.00
TOTAL	**106,307,720.00**	**112,229,941.00**

28.07.17
Registrar
ARIES, NAINITAL

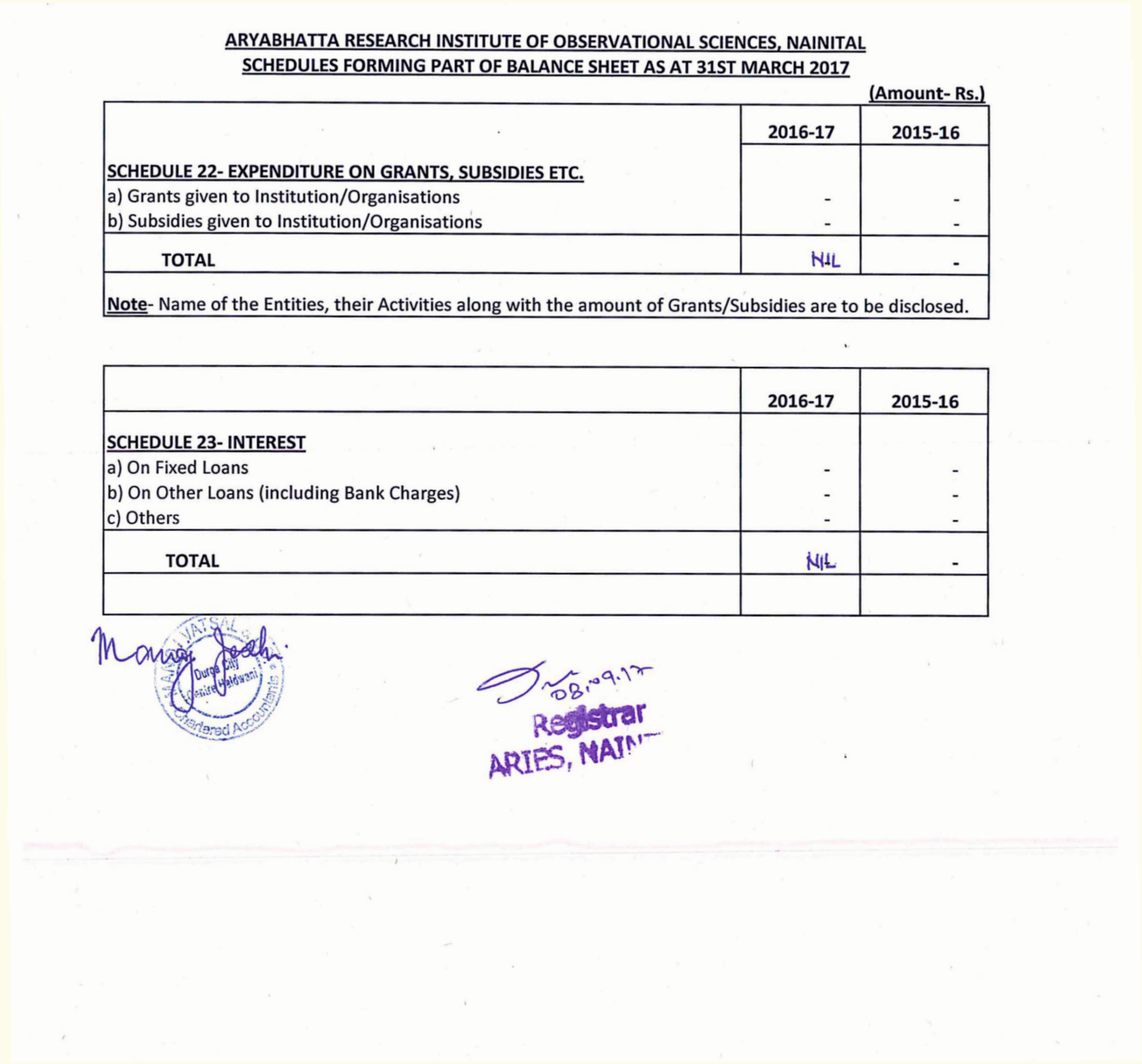


ARYABHATTA RESEARCH INSTITUTE OF OBSERVATIONAL SCIENCES, NAINITAL
SCHEDULES FORMING PART OF BALANCE SHEET AS AT 31ST MARCH 2017

(Amount- Rs.)

	2016-17	2015-16
SCHEDULE 21- OTHER ADMINISTRATIVE EXPENSES ETC.		
Advertisement and Publicity	563,515.00	1,083,885.00
ATSOA	361,943.00	379,689.00
ASI -2017	200,000.00	-
Auditor's Remuneration	42,000.00	42,000.00
Bank Charges	27,399.30	5,238.31
Computer Accessories & Consumable	1,444,162.00	1,378,391.00
Consumable Assessories	1,283,455.00	2,312,402.00
Registration	272,538.00	147,015.00
Gardening Expenses	826,875.00	421,923.00
Electricity	4,721,490.00	3,542,136.00
Fuel (POL)	1,474,210.00	1,292,042.00
Water Charges	594,092.00	420,616.00
Insurance Charges	38,463.00	81,660.00
Repairs and maintenance Instrument/AMC	1,428,780.83	1,438,309.00
Repairs and maintenance others	76,968.00	8,275.00
Repairs and maintenance Building	3,532,362.00	6,256,035.00
Vechicles Running and Maintenance	219,148.00	146,710.00
JEST	100,000.00	148,935.00
Observational Facilities	1,085,123.00	823,627.00
Telephone and Communication Charges	1,697,134.00	5,255,863.00
Postage	109,079.00	105,888.00
Printing and Stationary	480,237.00	470,866.00
Conveyance Expenses	571,340.00	-
Travelling Expenses	4,486,448.00	3,864,037.00
TA EXP(M/S Balmer Lawrie & co. ltd)	766,587.00	-
Expenses on Seminar/BINA Workshops	556,310.00	-
Canteen Expenses	2,090,299.00	1,891,143.00
Cleaning Work	1,958,110.00	1,622,077.00
Hospitality Expenses	52,120.00	60,780.00
Legal Charges	179,601.00	3,225,292.00
Professional Expenses	53,808.00	-
Public Outreach Program -Exhibition	144,000.00	1,532,266.00
Security*	6,222,715.00	4,607,444.00
Sundry Expenditure	21,420.00	41,747.00
Consumable 3.60 Mt. Telescope	51,000.00	-
Meeting of governing council	334,305.00	310,599.00
Meeting of Other Scientific Bodies	3,728,964.00	3,899,406.00
Office Exp	1,197,793.00	1,127,276.00
TOTAL	**42,993,794.13**	**47,943,572.31**
*SECURITY AT DEVASTHAL IS HIRED FROM AN AGENCY SPONSORED FROM DGR(EX SERVICE MEN) AND THE WAGES ARE AS PAYABLE UNDER THE CENTRAL GOVERNMENT (AND HENCE THE INCREASE IN EXPENSES DUE TO ARREARS ON ACCOUNT OF REVISION OF WAGE STRUCTURE)		

08.09.17
Registrar
ARIES, NAINITAL



ARYABHATTA RESEARCH INSTITUTE OF OBSERVATIONAL SCIENCES, NAINITAL
SCHEDULES FORMING PART OF BALANCE SHEET AS AT 31ST MARCH 2017

(Amount- Rs.)

	2016-17	2015-16
SCHEDULE 22- EXPENDITURE ON GRANTS, SUBSIDIES ETC.		
a) Grants given to Institution/Organisations	-	-
b) Subsidies given to Institution/Organisations	-	-
TOTAL	NIL	-
Note- Name of the Entities, their Activities along with the amount of Grants/Subsidies are to be disclosed.		

	2016-17	2015-16
SCHEDULE 23- INTEREST		
a) On Fixed Loans	-	-
b) On Other Loans (including Bank Charges)	-	-
c) Others	-	-
TOTAL	NIL	-

Manoj Joshi

08.09.17
Registrar
ARIES, NAIN

BALANCE SHEET
ARIES EMPLOYEES ENDOWMENT TRUST
FOR THE YEAR ENDED ON 31.03.17

LIABILITIES		AMOUNT(Rs)	ASSETS		AMOUNT(Rs)
CORPUS		108,998,390.62	**BANK ACCOUNT**		131,873,405.26
			GPF-300-SBI	38,425,189.00	
CONTRIBUTION		(18,463,186.80)	SBI-Pension	14,286,317.26	
Employers contribution	7,530,990.00		UBI	79,161,899.00	
Less :PF Withdrawal	(5,889,331.00)				
			ADVANCE TO EMPLOYEES		
Less :Retirement benefits paid	(20,104,845.80)		**RECOVERABLE**		
			Advance to Employees from GPF		882,309.76
			ARIES		
PROVISION		8,691,099.00	ARIES provision	8,691,099.00	2,710,484.00
Superannuation	2,710,484.00		Less Funds transferred	(5,980,615.00)	
Leave encashment	3,105,379.00				
Pension	2,875,236.00				
RESERVES & SURPLUS					
Excess of Income over Expenditure	36,239,896.20	36,239,896.20			
TOTAL		**135,466,199.02**	**TOTAL**		**135,466,199.02**

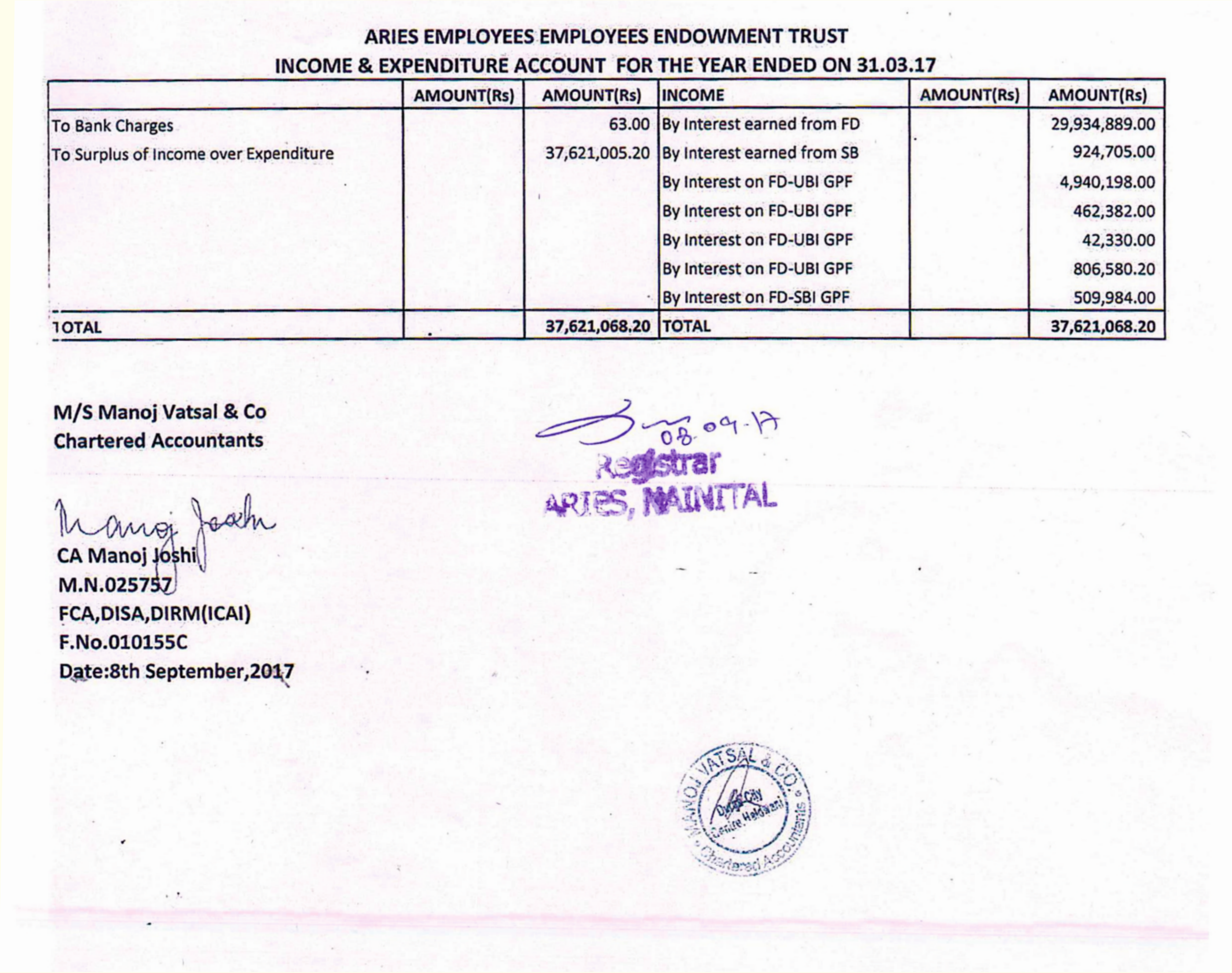
FOR: Manoj Vatsal & Co.
Chartered Accountants

Manoj Joshi
MANOJ JOSHI
FCA,DISA(ICAI)
Certified Valuer(ICAI)
Membership No. 025757
Firm Regn. No. 010155C

Place: NAINITAL
Date: 08.09.2017

08.09.17
Registrar
ARIES, NAINIT

Dr. Anil K. Pandey
Director
Aryabhatta Research Institute of Observational Sciences
(Under Department of Science & Technology)



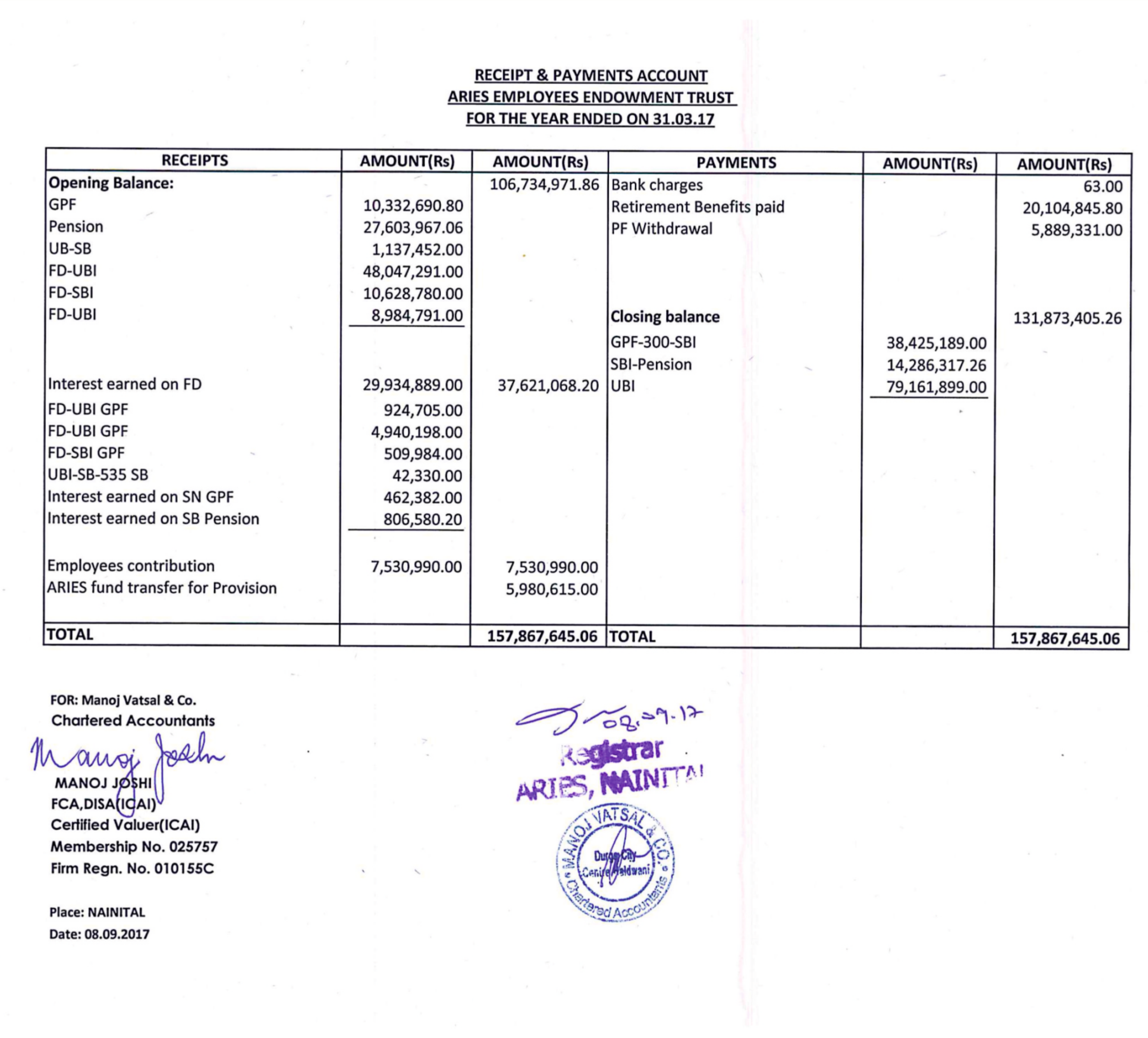
ARIES EMPLOYEES EMPLOYEES ENDOWMENT TRUST
INCOME & EXPENDITURE ACCOUNT FOR THE YEAR ENDED ON 31.03.17

	AMOUNT(Rs)	AMOUNT(Rs)	INCOME	AMOUNT(Rs)	AMOUNT(Rs)
To Bank Charges		63.00	By Interest earned from FD		29,934,889.00
To Surplus of Income over Expenditure		37,621,005.20	By Interest earned from SB		924,705.00
			By Interest on FD-UBI GPF		4,940,198.00
			By Interest on FD-UBI GPF		462,382.00
			By Interest on FD-UBI GPF		42,330.00
			By Interest on FD-UBI GPF		806,580.20
			By Interest on FD-SBI GPF		509,984.00
TOTAL		37,621,068.20	TOTAL		37,621,068.20

M/S Manoj Vatsal & Co
Chartered Accountants

Manoj Joshi
CA Manoj Joshi
M.N.025757
FCA,DISA,DIRM(ICAI)
F.No.010155C
Date:8th September,2017

08.09.17
Registrar
ARIES, NAINITAL



RECEIPT & PAYMENTS ACCOUNT
ARIES EMPLOYEES ENDOWMENT TRUST
FOR THE YEAR ENDED ON 31.03.17

RECEIPTS	AMOUNT(Rs)	AMOUNT(Rs)	PAYMENTS	AMOUNT(Rs)	AMOUNT(Rs)
Opening Balance:		106,734,971.86	Bank charges		63.00
GPF	10,332,690.80		Retirement Benefits paid		20,104,845.80
Pension	27,603,967.06		PF Withdrawal		5,889,331.00
UB-SB	1,137,452.00				
FD-UBI	48,047,291.00				
FD-SBI	10,628,780.00				
FD-UBI	8,984,791.00		**Closing balance**		131,873,405.26
			GPF-300-SBI	38,425,189.00	
			SBI-Pension	14,286,317.26	
Interest earned on FD	29,934,889.00	37,621,068.20	UBI	79,161,899.00	
FD-UBI GPF	924,705.00				
FD-UBI GPF	4,940,198.00				
FD-SBI GPF	509,984.00				
UBI-SB-535 SB	42,330.00				
Interest earned on SN GPF	462,382.00				
Interest earned on SB Pension	806,580.20				
Employees contribution	7,530,990.00	7,530,990.00			
ARIES fund transfer for Provision		5,980,615.00			
TOTAL		**157,867,645.06**	**TOTAL**		**157,867,645.06**

FOR: Manoj Vatsal & Co.
Chartered Accountants
Manoj Joshi
MANOJ JOSHI
FCA,DISA(ICAI)
Certified Valuer(ICAI)
Membership No. 025757
Firm Regn. No. 010155C

Place: NAINITAL
Date: 08.09.2017

08.09.17
Registrar
ARIES, NAINITAL


ILMT
3.6m DOT
1.3m DFOT
26 04 2017