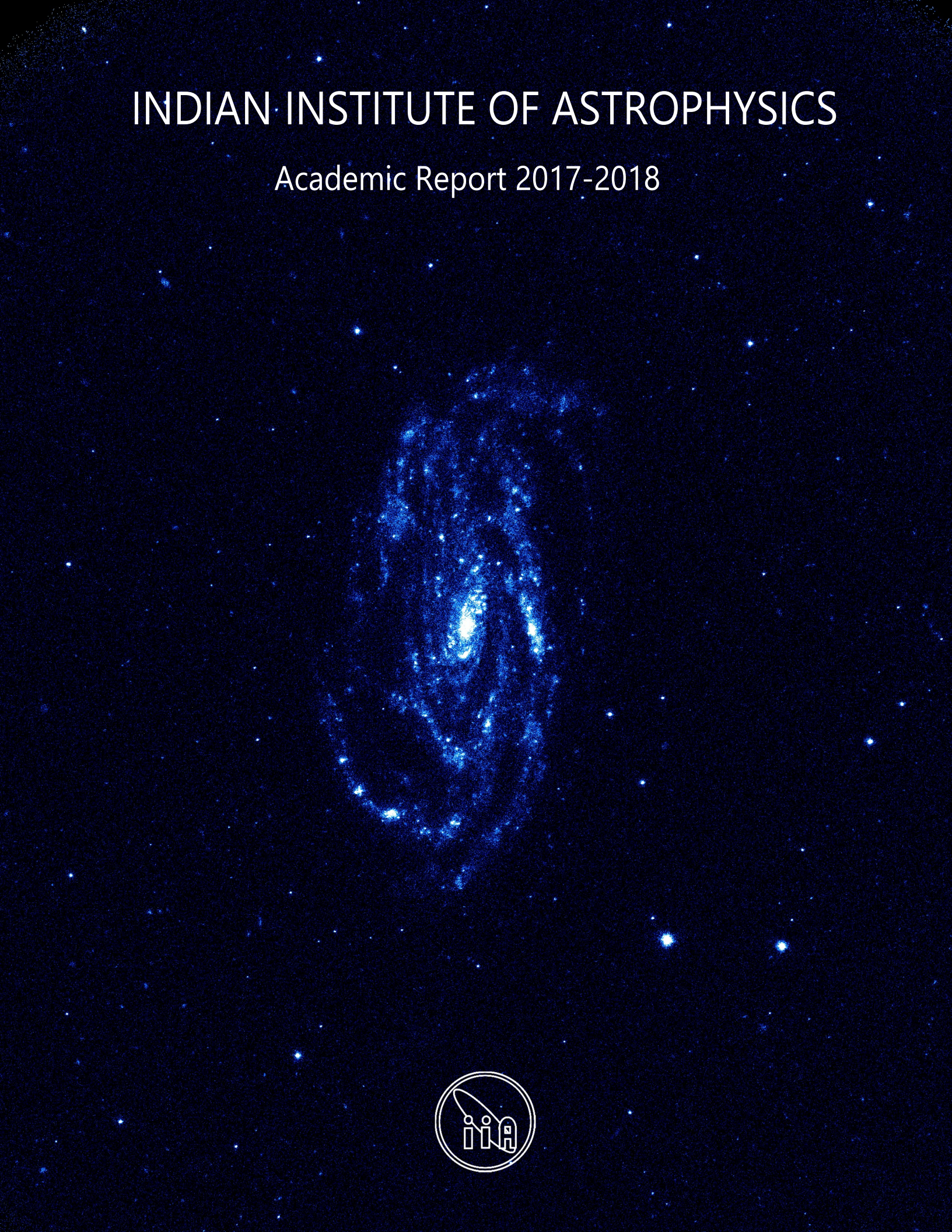
INDIAN INSTITUTE OF ASTROPHYSICS

Academic Report 2017-2018



INDIAN INSTITUTE OF ASTROPHYSICS

ACADEMIC REPORT

2017-2018

Edited by : S. Muneer & G. C. Anupama

Published on behalf of : The Director, Indian Institute of Astrophysics, Sarjapura Road, Bengaluru 560034, INDIA.

Front Cover : NGC 5033 a spiral galaxy observed by UVIT on February 14, 2017 in the near UV band for 2300 seconds. This galaxy at a distance of about 50 million light years from us hosts an active galactic nucleus.
Image Orientation : "North is up and East is to the left"
Image Credit : Kshama S. Kurian & C. S. Stalin

Back Cover : Recently installed Hα telescope at Merak, Ladakh.
Image Credit : Stanzin Tundup & B. Ravindra

Cover Design by : Sanjiv Gorka

Contents

Governing Council (2017–2018)

Professor Ajit K. Kembhavi	Chairman	Emeritus Professor IUCAA, Pune
Professor Ashutosh Sharma	Member (Ex-Officio)	Secretary DST, New-Delhi
Shri J. B. Mohapatra, IRS	Member (Ex-Officio)	Joint Secretary & Financial Adviser DST, New Delhi
Dr P. Sreekumar	Member Secretary	Director IIA, Bengaluru
Professor N. M. Ashok	Member	Visiting faculty PRL, Ahmedabad
Professor Prasad Subramanian	Member	Associate Professor IISER, Pune
Professor Pushpa Khare	Member	Long term visitor IUCAA, Pune
Professor Sibaji Raha	Member	Director (until 2016) Bose Institute, Kolkata
Professor Yashwant Gupta	Member	Dean, GMRT Observatory NCRA, Pune

Honorary Fellows

Professor P. Buford Price
Physics Department, University California, Berkeley, USA

Professor Sir Arnold W. Wolfendale, FRS
Emeritus Professor, Department of Physics, Durham University, UK

Professor D. L. Lambert
Department of Astronomy, University of Texas, Austin, USA

Professor B. V. Sreekantan
National Institute of Advanced Studies (NIAS), Bengaluru 560 012

Dr K. Kasturirangan
Raman Research Institute, Bengaluru 560 080

†Professor S. Chandrasekhar, Nobel Laureate (1995)

†Professor R. M. Walker (2004)

†Professor Hermann Bondi, FRS (2005)

†Professor V. Radhakrishnan (2011)

†Professor M. G. K. Menon, FRS (2016)

† *deceased*

Institute Functionaries

Director
Dr P. Sreekumar

Dean
Professor G. C. Anupama

Chairperson: GC-I: Solar System Studies
Professor R. Ramesh

Chairperson: GC-II: Stellar & Galactic Astronomy
Professor Aruna Goswami

Chairperson: GC-III: Theoretical Astrophysics
Professor Arun Mangalam

Head: System Engineering Group
Mr G. Srinivasulu

Chairperson: Board of Graduate Studies
Professor Aruna Goswami

Senior Administrative Officer
Dr P. Kumaresan

First Appellate Authority
Professor R. Ramesh

Central Public Information Officer
Mr P. K. Mahesh

Vigilance Officer
Professor U. S. Kamath

Chairperson: Internal Complaints Committee against Sexual Harassment
Professor Annapurni Subramaniam

Chairperson: Grievance Cell
Professor Aruna Goswami

Chairperson: Outreach Committee
Dr C. Kathiravan

1
The Year In Review

It gives me immense pleasure to present the highlights of the Institute′s activities during the academic year 2017-18. The Institute made noteworthy contributions in research, development, teaching programmes and in public outreach.

Solar research community actively engaged in their studies on the Sun and solar phenomena using ground- and space-based facilities, theoretical and computational methods. Scientists continue utilizing Kodaikanal Solar Observatory data archive. Using the Calcium II K spectroheliograms, relative intensity and width of the chromospheric network boundary are obtained and they are found to be dependent on the solar cycle. An analysis of the SDO data revealed the overall background field component contributed about 83% towards the Solar Mean Magnetic Field. Interferometeric observations of the solar corona at 53 MHz on a 200 km long baseline is carried out for the first time.

The stellar astronomy group pursued research in exoplanets, novae, supernovae, and chemical abundance analysis of various types of stars. Analyses of photometric and spectroscopic data of a highly reddened, normal type Ia SN 2004ab revealed the extinction within the host galaxy NGC 5054, in the direction of supernova follows the CCM extinction law with smaller value of R_V (the ratio of total-to-selective extinction) ~ 1.41. A comprehensive spectral analysis of the 2006 outburst of RS Ophiuchi revealed the presence of a hot white dwarf source with a roughly constant luminosity. UVIT data revealed UV variability in eighteen RR Lyrae stars, and detection of new variables in the central region of the Horizontal Branch population of the globular cluster NGC 1851. Photometric studies on the globular cluster NGC 6934 revealed new variables. Analyses of the low resolution NIR H and K band spectra of DY per and DY Per suspect stars indicated that they could be related to the RCB/HdC class of stars.

Black hole astrophysics, phenomena in active galaxies, magnetic fields in galaxies and cosmology are some of the topics pursued by the Cosmology and extragalactic astronomy group. UV studies of galaxies and galaxy clusters revealed direct measure of star formation rates, often modulated by merger events and AGN activity. The post-merger galaxy NGC 7252 was observed with the UVIT and the star formation rates show a dependence on the distance from the center of the galaxy.

The theoretical astrophysical group is engaged in relativistic astrophysics, magnetic fields, quantum chemistry, galactic

gas dynamics and radiative transfer theory for the Sun and exoplanets. The possibility of accreting primordial black holes as the source of heating for the collapsing gas in the context of the direct collapse black hole scenario for the formation of super-massive black holes (SMBHs) at high redshifts, z $\sim$ 67 was explored.

Observing facilities of the Institute are optimally utilized by the scientists and astronomers. We get significant number of observing proposals from universities and other research institutions. A new vacuum coating plant is installed at IAO, Hanle for aluminizing the mirrors. A new H-alpha telescope is installed and commissioned at Merak, Ladakh. The telescope is being used for observations of the solar chromosphere. A spectropolarimeter is commissioned at Kodaikanal Solar Observatory for studies on the solar active regions in Ca II (854.2 nm) and Hα (656.28 nm). Considering the cost-effectiveness and affordable launch opportunities, development of a CubeSat programme is being explored.

Considerable progress was made on some of the large projects undertaken by the Institute. India–TMT, led by IIA, made significant progress on its assigned work packages. Manufacturing of actuators for mirror segment integration and testing is completed and facility for segment polishing is nearing completion. India–TMT conducted a successful TMT wide partnership meeting in November 2017 at Infosys campus, Mysuru sponsored by National Science Foundation, USA. An analytical model was developed to estimate the polarization effects, such as instrumental polarization (IP), crosstalk (CT), and depolarization, due to the optics of the Thirty Meter Telescope. IIA team played a lead role in preparing the white paper on a next generation TMT instrument for spectroscopic observations by TMT. The Institute received sanction order for the procurement of 7.6 ha forest land for the establishment of the National Large Solar telescope in Merak, Ladakh. The laboratory model of the complex Visible Emission Line Coronagraph (VELC) payload on Aditya-L1 mission is integrated and work on the Qualification Model is in progress. The work towards generating a detailed project report for a 10-m class National Large Optical-Infrared telescope (NLOT) is in progress. Significant progress was made in this period on prototyping the 7-segment test case design with near-closure on phasing and alignment strategies and realization of indigenous sensors for active control.

The construction of Raman Science Center at Leh is completed. A large Optics Fabrication Facility for segmented mirrors polishing is nearing completion at our Hoskote campus. Augmentation of India TMT Coordination Centre office extension works, construction of environment friendly accommodation to the staff members at Hanle are some of the other civil works taken up by the Institute this year.

The computing facilities of the Institute are further upgraded and updated with new hardware and software. An eight-node HPC cluster is installed for the parallel computing community. The Library continues to make progress with acquisition of new books, online subscription of many journals and databases. The Institute made concerted efforts to archive historical books and documents. IIA archives continue to get many visitors.

Graduate Studies programme of the Institute has 88 students. During the academic year, seven students were awarded PhD Degree and seven others submitted their PhD thesis on a wide range of topics. Three students completed their MTech Degree under the IIA–University of Calcutta integrated

MTech–PhD programme. The Institute has a variety of programmes for human resource development such as research and engineer trainee programme, internship programme, visits of students and staff from other institutions, projects as part of academic course work etc.

The Institute signed an MoU with Space Physical Laboratory (SPL), Vikram Sarabhai Space Centre (VSSC), Thiruvananthapuram for collaboration in the measurements of Carbon dioxide and Water vapour.

The Institute took various steps for the implementation of the Official Language and continued efforts to make equitable work environment by safeguarding the interests of SCs, STs, physically-challenged and women.

Figure 1.1: Cabinet Minister Dr Harsh Vardhan examining the IIA archives.

Dr Harsh Vardhan, Hon′ble Minister for Science and Technology, Govt of India, visited the CREST Campus on 20 February 2018 and the Koramangala campus on 18 March 2018. During his visit to CREST, the Hon′ble Minister interacted with the scientists and engineers, witnessed the remote operation of the 2-m HCT, visited the M.G.K. Menon Laboratory and the construction site of the India–TMT Optics Fabrication Facility and also planted a sapling in front of the upcoming building. During his visit to the Koramangala campus, he visited the IIA Library and Archives, the Optics Division, India–TMT Laboratory and interacted with the students and staff of IIA.

I am happy with the progress made in many areas in particular, academic research and capacity building, essential pillars on which research institutions flourish. The cooperative spirit across science and engineering teams, with support from the administrative staff, has been pivotal in achieving this. As I complete my 5-year term as Director in June 2018, I am confident that IIA will continue to provide key leadership and shoulder major responsibilities in astronomy research in the years ahead.

P. Sreekumar
Director

2 Research

2.1 The Sun and the Solar System

Temporal and Latitudinal Variations of the Length-Scales and Relative Intensities of the Chromospheric Network

The Calcium K spectroheliograms of the Sun from Kodaikanal have a data span of about 100 years and covers over 9 solar cycles. The Ca line is a strong chromospheric line dominated by chromospheric network and plages which are good indicators of solar activity. Length-scales and relative intensities of the chromospheric network have been obtained in the solar latitudes from 50 degree N to 50 degree S from the spectroheliograms. The length-scale was obtained from the half-width of the two-dimensional autocorrelation of the latitude strip which gives a measure of the width of the network boundary. As reported earlier for the transition region extreme ultraviolet (EUV) network, relative intensity and width of the chromospheric network boundary are found to be dependent on the solar cycle. A varying phase difference has been noticed in the quantities in different solar latitudes. A cross-correlation analysis of the quantities from other latitudes with ±30 degree latitude revealed an interesting phase difference pattern indicating flux transfer. Evidence of equatorward flux transfer has been observed. The average equatorward flux transfer was estimated to be 5.8 m/s. The possible reasons of the drift could be meridional circulation, torsional oscillations, or the bright point migration. Cross-correlation of intensity and length-scale from the same latitude showed increasing phase difference with increasing latitude. Cross correlation of the quantities are also obtained across the equator to see the possible phase lags in the two hemispheres. Signatures of lags are seen in the length scales of southern hemisphere near the equatorial latitudes, but no such lags in the intensity are observed. The results have important implications on the flux transfer over the solar surface and hence on the solar activity and dynamo.
(MNRAS, 2018 (in press))

(K. P. Raju)

On the Different Contributions to the Solar Mean Magnetic Field

In this study the data from Solar Dynamics Observatory (SDO) was analysed towards the goal of estimating contribution from various magnetic features on the surface of the Sun to the observed Solar Mean

Magnetic Field (SMMF). Surface features such as plages, networks and sunspots were identified using SDO/*AIA* full disk intensity images at 1600 Å and 4500 Å. The region of the disk outside these features is identified as background region. Once various features are identified, the corresponding weighted mean LOS field was calculated from the co-temporal SDO/*HMI* LOS magnetograms. From this analysis it is found that the background field component contributed about 83% towards the SMMF whereas, the contribution of the mean plages and the network field was about 14%. Based on these findings it is concluded that the origin of the observed SMMF lies in the polarity imbalance of a large scale magnetic field on the visible surface of the Sun.

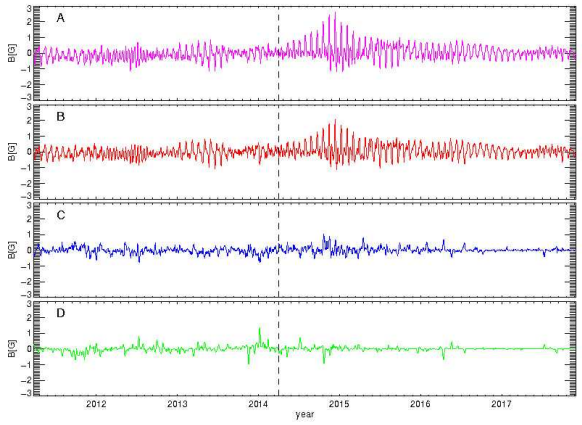


Figure 2.1: Plots of SMMF (panel A), the weighted mean fields of background (panel B), plages, enhanced networks and active networks (panel C) and sunspots (panel D). The dotted vertical line corresponds to the time of solar maximum of cycle 24 which was during April, 2014.

(ApJ, Under Review)

(S. Bose and K. Nagaraju)

Coronal magnetic field measurements using forbidden emission lines

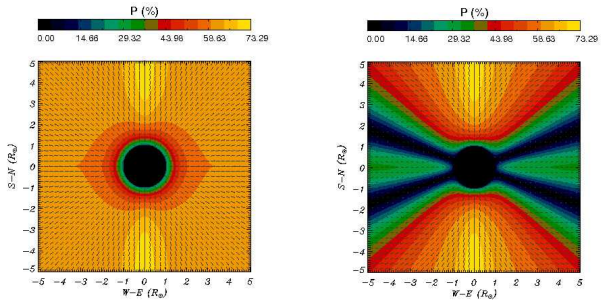


Figure 2.2: Maps of degree of linear polarization P and polarization angle PA for a latitude dependent density distribution model representing sunspot minimum. *Left:* Radial Field. *Right:* Dipolar Field. Notice the Van Vleck effect (symmetric black regions) in the case of dipolar field.

The polarization measurement of coronal forbidden emission lines is the most promising method of determining the direction of magnetic fields in the corona. A classical theory for the forbidden lines is presented in Megha et al. (ApJ, 2017, 841, 129) for the case of arbitrary strength magnetic fields. The authors of the present work have applied that theoretical formalism to study the effect of density distributions, magnetic field configurations, and velocity fields on the Stokes profiles of the [Fe XIII] 10747 Å coronal forbidden line. Fig. 2.2 shows the map of degree of linear polarization P and position angle PA for a radial field (left panel) and for a dipolar field (right panel) using a latitude dependent density distribution model. Notice that P is asymmetric and reaches a maximum of 73.29% in the polar regions for a radial field. In the case of dipolar field, notice the Van Vleck effect which represents vanishing P (symmetric black regions in the map). This occurs when the field direction is 54.7 degrees with respect to the local radius vector (which corresponds to a latitude = 19.5 degrees.)

(IAU Symposium, 2018, No. 340, Long-Term Datasets for the Understanding of Solar and Stellar Magnetic Cycles, eds. Dipankar Banerjee, Jie Jiang, Kanya Kusano, & Sami Solanki (Cambridge University Press), Accepted)

(Megha, A., Sampoorna, M., Nagendra, K. N., and Sankarasubramanian, K.)

Flares before and after Coronal Mass Ejections

Flare characteristics such as the flare occurrence number density and the distribution of peak flux as well as duration of flares occurring on either side of a coronal mass ejection (CME) onset time are studied. While the flares are rather evenly distributed statistically on either side of the CME onset time, the flare peak flux and duration tend to decrease depending upon their occurrence either before or after the CME onset. This is consistent with the earlier findings that flares emit higher energy before a CME whereas the energy is less in flares occurring after a CME.
(RAA, 2018 Vol. 18 No. 3, 34)

(G. S. Suryanarayana)

CME productivity associated with Solar Flare peak X-ray emission flux

It is often noticed that the occurrence rate of Coronal Mass Ejections (CMEs) increases with increase in flare duration where peak flux too increase. However, there is no complete association between the duration and peak flux. Distinct characteristics have been reported for active regions (ARs) where flares and CMEs occur in contrast to ARs where flares alone occur. It is observed that peak flux of flares is higher when associated with CMEs compared to peak flux of flares with which CMEs are not associated. In other words, it is likely that flare duration and peak flux are independently affected by distinct active region dynamics. Hence, the authors examine the relative ability of flare duration and peak flux in enhancing the CME productivity. They report that CME productivity is distinctly higher in association with the enhancement of flare peak flux in comparison to corresponding enhancement of flare duration.
(AdSpR, 2018, 61, 2482–2489)

(G. S. Suryanarayana; K. M. Balakrishna)*

Prominence eruption initiated by helical kink-instability of an embedded flux rope

The authors study the triggering mechanism of a limb-prominence eruption and the associated coronal mass ejection near AR 12342 using SDO and LASCO/SOHO observations. The prominence is seen with an embedded flux thread (FT) at one end and bifurcates from the middle to a different footpoint location. The morphological evolution of the FT is similar to an unstable flux rope (FR), which we regard as prominence embedded FR. The FR twist exceeds the critical value. In addition, the morphology of the prominence plasma in 304 Å images marks the helical nature of the magnetic skeleton with a total of 2.96 turns along arc length (See Fig. 2.3). The potential field extrapolation model indicates that the critical height of the background magnetic field gradient falls within the inner corona (105 Mm) consistent with the extent of coronal plasma loops. These results suggest that the helical kink instability in the embedded FR caused the slow rise of the prominence to a height of the torus instability domain. Moreover, the differential emission measure analysis unveils heating of the prominence plasma to

coronal temperatures during eruption, suggesting a reconnection-related heating underneath the upward rising embedded FR. The prominence starts with a slow rise motion of 10 km/s, followed by fast and slow acceleration phases having an average acceleration of 28.9 m/s^2, 2.4 m/s^2 in C2, C3 field of view respectively. As predicted by previous numerical simulations, the observed synchronous kinematic profiles of the CME leading edge and the core supports the involved FR instability in the prominence initiation.

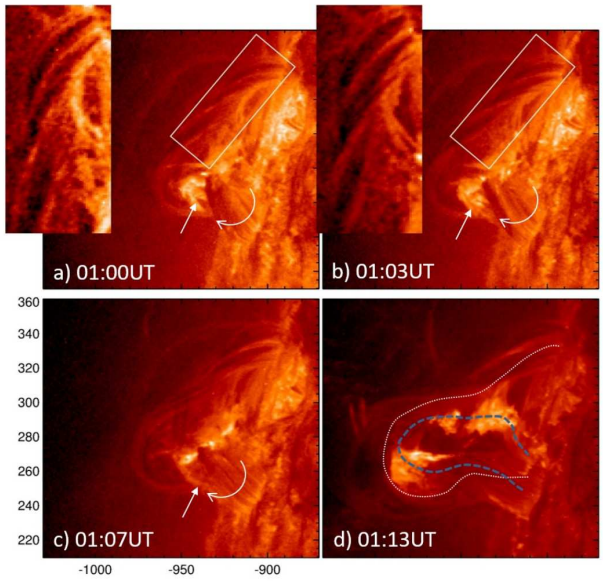


Figure 2.3: Signatures of magnetic twist evolution during slow rise motion. In a) and b) rectangular region is zoomed in the inset to show the right-helical threads in the prominence. Arrows point to writhed section of the prominence and curved arrows indicate rolling motion (clockwise from above) of field lines resulting from conversion of writhe to twist during slow upward rise motion. In panel d), traces of prominence and magnetic flux rope are indicated with dotted, dashed curves.

(ApJ, 2017, 850, 38)

(P. Vemareddy, N. Gopalswamy and B. Ravindra)*

2.2 Stellar and Galactic Astrophysics

Short-Term Hα Line Variations in Classical Be Stars: 59 Cyg and OT Gem

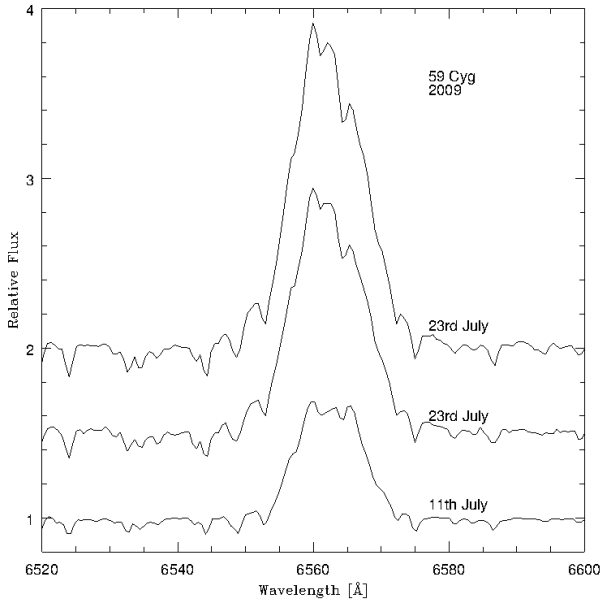


Figure 2.4: Time series of OT Gem Hα line from February to May 2009; (Spectra are offset and labelled with the observation date, the oldest appears at the top and most recent at the bottom. Note that although the spectra are displayed evenly spaced, they are not evenly distributed in time.

The authors present optical spectroscopic study of two classical Be stars, 59 Cyg and OT Gem obtained over a period of few months in 2009 using the 1.0-m telescope at the VBO. They detected a rare triple-peak Hα emission phase in 59 Cyg and a rapid decrease in the emission strength of Hα in OT Gem, which are used to understand their circumstellar disks. They find that 59 Cyg

is likely to be rapid rotator, rotating at a fractional critical rotation of ~ 0.80. The radius of the Hα emission region for 59 Cyg is estimated to be $Rd/R \sim 10.0$, assuming a Keplerian disk, suggesting that it has a large disk. The authors classify stars which have shown triple-peaks into two groups and find that the triple-peak emission in 59 Cyg is similar to ζ Tau. OT Gem is found to have a fractional critical rotation of ~ 0.30, suggesting that it is either a slow rotator or viewed in low inclination. In OT Gem, a large reduction in the radius of the Hα emission region is observed from -6.9 to -1.7 in a period of three months, along with the reduction in the emission strength. Observations suggest that the disk is lost from outside to inside during this disk loss phase in OT Gem.
(JAA, 2017, 38, 6)

*(*Paul, K. T.; *Shruthi, S. B.; Subramaniam, Annapurni)*

Are DY Persei Stars Cooler Cousins of R Coronae Borealis Stars?

In this work, the authors present for the first time, the study of low resolution H- and K-band spectra of 7 DY Per type and suspect stars, as well as DY Persei itself. They also observed H- and K-band spectra of 3 R Coronae Borealis (RCB) stars, one hydrogen-deficient carbon (HdC) star, and 14 cool carbon stars, including normal giants as comparisons. High $^{12}C/^{13}C$ and low $^{16}O/^{18}O$ ratios are characteristic features of majority RCBs and HdCs. $^{16}O/^{18}O$ ratios of the program stars are estimated from the relative strengths of the $^{12}C^{16}O$ and $^{12}C^{18}O$ molecular bands observed in K-band. Preliminary analysis suggests that a quartet of the DY Per suspects, along with DY Persei itself, seem to show isotopic ratio strength consistent with that of RCB/HdC stars, whereas two of them do not show significant ^{13}C and ^{18}O in their atmospheres. Present analysis provides further indications that DY Per type stars could be related to the RCB/HdC class of stars.
(ApJ, 2018, 854, 140)

*(Bhowmick, Anirban; Pandey, Gajendra; *Joshi, Vishal; *Ashok, N. M.)*

Chemical analysis of three barium stars: HD 51959, HD 88035, HD 121447

The authors present elemental abundance results from high resolution spectral analysis of three nitrogen-enhanced barium stars. Their analysis is based on spectra obtained with the FEROS attached to 1.52-m telescope at ESO, Chile. The spectral resolution is R$\sim$48000 and the spectral coverage spans from 3500–9000 Å. This is the first ever abundance analyses results for the objects HD 51959 and HD 88035. Although a few studies are available in literature on the object HD 121447, the results are significantly different from each other. The authors therefore carried out a detailed chemical composition study for this object based on a high resolution spectrum with high S/N ratio, for a better understanding of the origin of the abundance patterns observed in this star. Stellar atmospheric parameters, the effective temperature, surface gravity, microturbulence and metallicity of the stars are determined from the LTE analysis using model atmospheres. The metallicity of HD 51959 and HD 88035 are found to be near-solar; they exhibit enhanced abundances of neutron-capture elements. HD 121447 is found to be moderately metal-poor with [Fe/H] $= -0.65$. While carbon is near-solar in the other two objects, HD 121447 shows carbon enhancement at a level, [C/Fe] $= 0.82$. Neutron-capture

elements are highly enhanced with [X/Fe]>2 (X: Ba, La, Pr, Nd, Sm) in this object. The α- and iron-peak elements show abundances very similar to field giants with the same metallicity. From kinematic analysis all the three objects are found to be members of thin disk population with a high probability of 0.99, 0.99 and 0.92 for HD 51959, HD 88035 and HD 121447 respectively.
(MNRAS, 2018, 476, 3086)

(Drisya Karinkuzhi, Aruna Goswami, Navin Sridhar, T. Masseron*, Meenakshi P.)*

Chemical analysis of a Carbon-enhanced very metal-poor star: CD-27 14351

The first time abundance analysis of a very metal-poor carbon-enhanced star CD−27 14351 is presented based on a high resolution (R $\sim$ 48 000) FEROS spectrum. The abundance analysis performed using Local Thermodynamic Equilibrium (LTE) model atmospheres shows that the object is a cool star with stellar atmospheric parameters, effective temperature T_{eff} = 4335 K, surface gravity log g = 0.5, microturbulence ξ = 2.42 km s^{-1}, and, metallicity [Fe/H] = −2.6. The star exhibits high carbon and nitrogen abundances with [C/Fe] = 2.89 and [N/Fe] = 1.89. Overabundances of neutron-capture elements are evident in Ba, La, Ce, and Nd with estimated [X/Fe] > 1, the largest enhancement being seen in Ce with [Ce/Fe] = 2.63. While the first peak s-process elements Sr and Y are found to be enhanced with respect to Fe, ([Sr/Fe] = 1.73 and [Y/Fe] = 1.91) the third peak s-process element Pb could not be detected in the spectrum at the given resolution. Europium, primarily a r-process element also shows an enhancement with [Eu/Fe] = 1.65. With [Ba/Eu] = 0.12 the object CD−27 14351 satisfies the classification criterion for CEMP-r/s star. The elemental abundance distributions observed in this star is discussed in light of chemical abundances observed in other CEMP stars from literature.
(ApJ, 2017, 834, 61)

(Drisya Karinkuzhi, Aruna Goswami, and Thomas Masseron)*

Abundance Analyses of the New R Coronae Borealis Stars: ASAS-RCB-8 and ASAS-RCB-10

Abundance analyses of the two newly discovered R Coronae Borealis (RCB) stars ASAS-RCB-8 and ASAS-RCB-10 were conducted using high-resolution optical spectra and model atmospheres. Their chemical compositions place the pair among the majority class of RCBs. ASAS-RCB-10 is one of the most N-poor majority RCBs with an above average O abundance. Relative to ASAS-RCB-10, ASAS-RCB-8 is H poor by 1.6 dex, O-poor by 0.7 dex but N-rich by 0.8 dex suggesting a higher contamination by CNO-cycled material.
(PASP, 2017, 129, 980)

*(Hema, B. P.; Pandey, Gajendra; *Kamath, Devika; Kameswara Rao, N.; *Lambert, David; *Woolf, Vincent M.)*

Non-local Thermodynamic Equilibrium Abundance Analyses of the Extreme Helium Stars V652 Her and HD 144941

Optical high-resolution spectra of V652 Her and HD 144941, the two extreme helium stars with exceptionally low C/He ratios, have been subjected to a non-LTE abundance analysis using the tools TLUSTY and SYNSPEC. Defining atmospheric parameters were obtained from a grid of non-LTE atmospheres and a variety of spectroscopic

indicators including He I and He II line profiles, and the ionization equilibrium of ion pairs such as C II/C III and N II/N III. The various indicators provide a consistent set of atmospheric parameters: T_{eff} = 25,000 ± 300 K, log g = 3.10 ± 0.12 (cgs), and ξ = 13 ± 2 km s^{-1} are provided for V652 Her, and T_{eff} = 22,000 ± 600 K, log g = 3.45 ± 0.15 (cgs), and ξ = 10 km s^{-1} are provided for HD 144941. In contrast to the non-LTE analyses, the LTE analyses–LTE atmospheres and an LTE line analysis–with the available indicators do not provide a consistent set of atmospheric parameters. The principal non-LTE effect on the elemental abundances is on the neon abundance. It is generally considered that these extreme helium stars with their very low C/He ratio result from the merger of two helium white dwarfs. Indeed, the derived composition of V652 Her is in excellent agreement with predictions by Zhang & Jeffery, who model the slow merger of helium white dwarfs; a slow merger results in the merged star having the composition of the accreted white dwarf. In the case of HD 144941, which appears to have evolved from metal-poor stars, a slow merger is incompatible with the observed composition but variations of the merger rate may account for the observed composition. More detailed theoretical studies of the merger of a pair of helium white dwarfs are to be encouraged.
(ApJ, 2017, 847, 127)

*(Pandey, Gajendra; *Lambert, David L.)*

The variable star population in the globular cluster NGC 6934

The authors carried out V and I CCD time series photometry of the globular cluster NGC 6934 and estimated the distance and metallicity through Fourier decomposition of RR Lyrae light curves. They report $[Fe/H]_{UVES}$ of −1.48 and d = 16.03 ± 0.42 kpc and $[Fe/H]_{UVES}$ of −1.43 and d = 15.91 ± 0.39 from the calibration of RRab and RRc respectively. They found 12 new variables, 4 RRab, 3 SX Phe, 2 W Vir and 3 semi-regular variables. Independent distance estimate is made using SX Phe stars and discussed along with the earlier estimates. The horizontal branch structure in the CMD of the NGC 6934 in the context of location occupied by RRab and RRc is discussed.
(RMxAA, 2018, 54, 15)

(M. A. Yepez, A. Arellano Ferro*, S. Muneer, Sunetra Giridhar)*

Period changes in the RR Lyrae stars of NGC 6171

Based upon the photometric data compiled since 1935 and the authors′ recent observations till 2017, O-C diagrams were built for 22 RR Lyrae stars in the globular cluster NGC 6171, leading to the discovery of secular period changes in four variables for which period change rate β has been calculated. However, the authors find that 82% of the sample stars have stable periods over the last 82 years. For the stable period stars the whole database has been employed to refine their periods. Among the period changing stars, three (V10, V12 and V16) have decreasing periods and period changes that are larger than those expected from stellar evolution. Notwithstanding these individual cases with significant period change rate, the global average of the measured period changes in the cluster is essentially zero, in consonance with theoretical predictions for the clusters with reddish horizontal branches. The hitherto unpublished observations now brought into public domain are employed to calculate a set of times of maximum light which is used in the present analysis.
(Accepted in AN)

(A. Arellano Ferro, P. Rosenzweig*, A. Luna*, D. Deras*, S. Muneer, Sunetra Giridhar)*

The Horizontal Branch population of NGC 1851 as revealed by the Ultra-violet Imaging Telescope (UVIT)

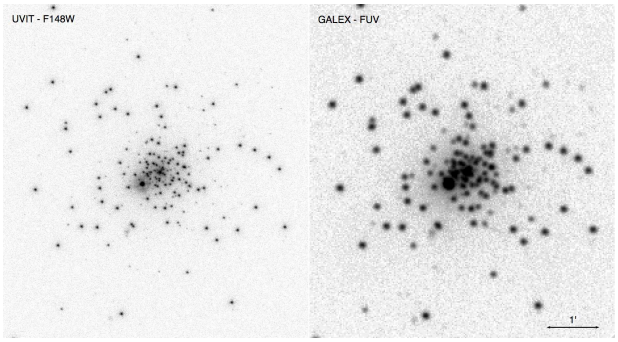


Figure 2.5: Comparison of FUV images for NGC 1851 taken with UVIT and GALEX (left and right panels, respectively). The UVIT image was constructed from a total integration time of 6982.13 sec in the F148W filter. North is up and east is to the left.

The authors present UV photometry of the globular cluster NGC 1851 using images acquired with the Ultra-violet Imaging Telescope (UVIT) onboard the ASTROSAT satellite. PSF-fitting photometric data derived from images in two far-UV (FUV) filters and one near-UV (NUV) filter are used to construct color-magnitude diagrams (CMD), in combination with HST and ground-based optical photometry. In the FUV, only the bluest part of the cluster horizontal branch (HB) is detected; while in the NUV, the full extent of the HB is detected, including the red HB, blue HB and a small number of RR Lyrae stars. UV variability was detected in 18 RR Lyrae stars, and 3 new variables were also detected in the central region. The UV/optical CMDs are then compared with isochrones of different age and metallicity (generated using Padova and BaSTI models) and synthetic HB (using helium enhanced Y^2 models). The almost complete sample of the HB stars tend to show a marginal difference in spatial/azimuthal distribution among the blue and red HB stars. This study thus show-cases the capability of UVIT, with its excellent resolution and large field of view, to study the hot stellar population in Galactic globular clusters.
(The Astronomical Journal, 2017, 154, 233)

*(Subramaniam, A.; Sahu, S.; *Postma, J. E.; *Côté, P.; *Hutchings, J. B.; *Darukhanawalla, N.; *Chung, C.; Tandon, S. N.; Kameswara Rao, N.; George, K.; *Ghosh, S. K.; *Girish, V.; Mohan, R.; Murthy, J.; Pati, A. K.; Sankarasubramanian, K.; Stalin, C. S.; *Choudhury, S.)*

V2676 Oph: Estimating physical parameters of a moderately fast nova

Using their previously reported observations, the authors of the present work derive some physical parameters of the moderately fast nova V2676 Oph 2012 #1. The best-fit Cloudy model of the nebular spectrum obtained on 2015 May 8 shows a hot white dwarf source with $T_{BB} \approx 1.0\times10^5$ K having a luminosity of 1.0×10^{38} erg/s. Abundance analysis shows that the ejecta are significantly enhanced relative to solar, He/H=2.14, O/H=2.37, S/H=6.62 and Ar/H=3.25. The ejecta mass is estimated to be 1.42×10^{-5} $M_\odot$. The nova showed a pronounced dust formation phase after 90 d from discovery. The $J-H$ and $H-K$ colors were very large as compared to other molecule- and dust-forming novae in recent years. The dust temperature and mass at two epochs have been estimated from spectral energy distribution fits to infrared

photometry.
(Acta Astronomica, 2018, 68, 79)

(A. Raj, M. Pavana, U. S. Kamath, G. C. Anupama and F. M. Walter)*

Photoionization modelling of the optical spectra of RS Ophiuchi 2006 outburst

A detailed analyses of the optical spectral evolution of the 2006 outburst of RS Ophiuchi beginning one day after discovery to over a year indicated it to be similar to that in previous outbursts. The early-phase spectra were dominated by hydrogen and helium (I and II) lines. Coronal and nebular lines appeared in the later phases. Emission line widths were found to narrow with time, which was interpreted as a shock expanding into the red giant wind. Using the photoionization code CLOUDY, spectra at nine epochs spanning 14 months after the outburst peak, thus covering a broad range of ionization and excitation levels in the ejecta, were modelled. The best-fitting model parameters indicated the presence of a hot white dwarf source with a roughly constant luminosity of 1.26×10^{37} erg s^{-1}. During the first three months, the abundances (by number) of He, N, O, Ne, Ar, Fe, Ca, S and Ni were found to be above solar abundances; the abundances of these elements decreased in the later phase. A photoionization model of the quiescent spectrum indicated the presence of a low-luminosity accretion disc. The helium abundance was found to be subsolar at quiescence.
(MNRAS, 2018, 474, 4211)

(A. Mondal, G. C. Anupama, U. S. Kamath, R. K. Das*, G. Selvakumar, S. Mondal*)*

Optical behaviour of a Type Iax supernova SN 2014dt

Optical photometric (up to ∼410 d since B_{max}) and spectroscopic (up to ∼157 d since B_{max}) evolution of a Type Iax supernova (SN) 2014dt located in M61 were studied. SN 2014dt is one of the brightest and closest (D ∼ 20 Mpc) discovered Type Iax SN. It best matches the light-curve evolution of SN 2005hk and reaches a peak magnitude of $M_B \sim -18.13 \pm 0.04$ mag with $\Delta m_{15} \sim 1.35 \pm 0.06$ mag. The early spectra of SN 2014dt are similar to other Type Iax SNe, whereas the nebular spectrum at 157 d is dominated by narrow emission features with less blending as compared to SNe 2008ge and 2012Z. The ejecta velocities are between 5000 and 1000 km s^{-1}, which also confirms the low-energy budget of Type Iax SN 2014dt compared to normal Type Ia SNe. Using the peak bolometric luminosity of SN 2005hk, a ^{56}Ni mass of ∼0.14 $M_\odot$ is estimated. The striking similarity between SN 2014dt and SN 2005hk implies that a comparable amount of ^{56}Ni would have been synthesized in the explosion of SN 2014dt.
(MNRAS, 2018, 474, 2551)

(Singh, Mridweeka; Misra, Kuntal*; Sahu, D. K.; Dastidar, Raya*; Gangopadhyay, Anjasha*; Bose, Subhash*; Srivastav, Shubham; Anupama, G. C.; *Chakradhari, N. K.; Kumar, Brajesh; Kumar, Brijesh*; Pandey, S. B.)*

Highly reddened Type Ia supernova SN 2004ab: another case of anomalous extinction

Optical photometric and spectroscopic analyses of SN 2004ab are presented. SN 2004ab is a highly reddened normal type Ia SN with $E(B-V)_{\rm total} = 1.70$ mag. The intrinsic decline rate parameter of SN 2004ab is $\Delta m_{15}(B)_{\rm true} = 1.27$. The Si II λ6355 velocity gradient is estimated as $\dot{v} = 90$ km s^{-1} d^{-1} indicating that SN 2004ab is a

member of HVG subgroup. The pseudo-EWs of Si II λ5972 and λ6355 absorption lines suggest that SN 2004ab is a broad line (BL) type. The line strength ratio $\mathcal{R}$(Si II) is 0.37, higher than those of other BLs having similar $\Delta m_{15}(B)$. Using CCM model, the ratio of total-to-selective extinction for host galaxy NGC 5054, in the direction of SN 2004ab, is derived as $R_V = 1.41$, which is much lower than that of Milky Way. The derived extinction is also consistent with power law extinction model $A_\lambda/A_V = (\lambda/\lambda_V)^p$ with $p \sim -2.2$. SN 2004ab peaked at an absolute magnitude of $M_B^{\rm max} = -19.31 \pm 0.25$ mag. Peak bolometric luminosity of $\log L_{\rm bol}^{\rm max} = 43.10 \pm 0.07$ erg s^{-1} suggests that 0.53 ± 0.08 M$_\odot$ of ^{56}Ni was synthesized in this explosion. Though, SN 2004ab is a highly reddened supernova, its absolute luminosity, after correcting for extinction using non-standard extinction law, is similar to a normal SN Ia and follows the empirical *Luminosity decline rate relation*.

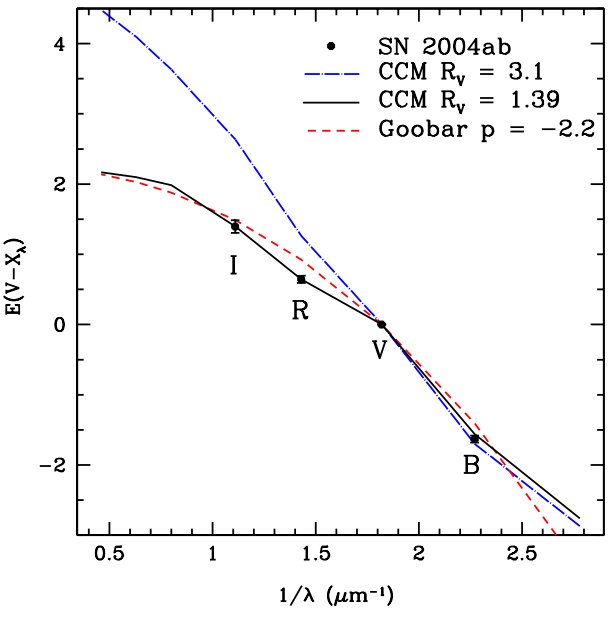


Figure 2.6: Colour excesses $E(V - X_\lambda)$, where $X_\lambda = BVRI$ measurement for SN 2004ab. CCM extinction model $A_\lambda/A_V = a_\lambda + (b_\lambda/R_V)$ with $R_V = 3.1$, $R_V = 1.39$ and power law extinction model $A_\lambda/A_V = (\lambda/\lambda_V)^p$ with $p = -2.2$ are also displayed.

(MNRAS, 2018, 474, 2502)

(N. K. Chakradhari, D. K. Sahu, G. C. Anupama, T. P. Prabhu)*

SN 2015bp: adding to the growing population of transitional Type Ia supernovae

Photometric and spectroscopic observations of type Ia supernova 2015bp are presented, spanning ~ -6 to $\sim +141$ days since B-band maximum. Also presented are unpublished HCT spectra of type Ia iPTF13ebh between -11 to $+34$ days since B-band maximum. SN 2015bp shows rapidly declining light curves with $\Delta m_{15}(B) = 1.72 \pm 0.04$. The I-band light curve shows a clear secondary maximum and peaks before the B-band maximum, placing SN 2015bp in the transitional category of SNe Ia. The spectral evolution of SN 2015bp resembles other transitional SNe Ia rather than 1991bg-like events. The C II λ6580 feature is detected in both SN 2015bp and iPTF13ebh, though it is present till the epoch of B-band maximum in the case of SN 2015bp. The velocity gradients of Si II λ6355 place SN 2015bp and iPTF13ebh in the FAINT subclass, whereas pseudo-equivalent widths of Si II features place them in the Cool (CL) subclass of SNe Ia. The bolometric light curve of SN 2015bp indicates that ~ 0.2 M$_\odot$ of ^{56}Ni was synthesized in the explosion, with a total ejected mass of ~ 0.9 M$_\odot$, suggesting a sub-Chandrasekhar mass white dwarf progenitor.
(MNRAS, 2017, 466, 2436)

(Shubham Srivastav, G. C. Anupama, D. K. Sahu, C. D. Ravikumar)*

Unveiling Vela: time variability of interstellar lines in the direction of the Vela supernova remnant - II. Na D and Ca II

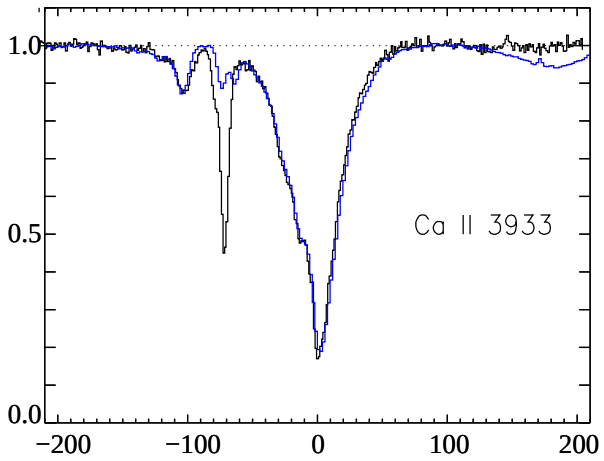


Figure 2.7: Profiles of Ca II K in the sight line towards HD 75129 obtained with SALT (blue line) on 2017 May 29 is superposed on the 1996 profile obtained by Cha & Sembach (2000) (black line). The component at $-67\,\mathrm{km\ s^{-1}}$ has weakened considerably by 2017.

In a survey conducted between 2011 and 2012 using the 2.3-meter Vainu Bappu Telescope (VBT) and its fibre-fed coude echelle spectrometer at a spectral resolution very similar to that of Cha and Sembach's survey of interstellar Na I D line profiles in the direction of the Vela supernova remnant (SNR), a few lines of sight showed dramatic changes in low-velocity absorption components with respect to profiles from 1993 to 1994 reported by Cha & Sembach. Three stars – HD 63578, HD 68217 and HD 76161 – showed large decrease in strength over the 1993-2012 interval. HD 68217 and HD 76161 are associated with the Vela SNR whereas HD 63578 is associated with γ^2 Velorum wind bubble. The authors of the present work present high spectral resolution observations of Ca II K lines obtained with the Southern African Large Telescope towards these three stars along with simultaneous observations of Na I D lines. These new spectra confirm that the Na D interstellar absorption weakened drastically between 1993-1994 and 2011-2012 but show for the first time that the Ca II K line is unchanged between 1993-1994 and 2015. This remarkable contrast between the behaviour of Na D and Ca II K absorption lines is a puzzle concerning gas presumably affected by the outflow from the SNR and the wind from γ^2 Velorum.
(MNRAS, 2017, 467, 1186)

*(N. Kameswara Rao, *David L. Lambert, *Arumalla B. S. Reddy, *Ranjan Gupta, S. Muneer, and *Harinder P. Singh)*

2.3 Cosmology and Extragalactic Astronomy

Dissecting star-formation in the "Atoms-for-Peace" galaxy: Ultra-Violet Imaging Telescope observations of the post-merger galaxy NGC 7252

The tidal tails of post-merger galaxies exhibit ongoing star formation far from their disks. The study of such systems can be useful for our understanding of gas condensation in diverse environments. The ongoing star formation in the tidal tails of post-merger galaxies can be directly studied from ultraviolet (UV) imaging observations. The post merger galaxy NGC 7252 ("Atoms-for-Peace") galaxy) is observed with the Astrosat UV imaging telescope (UVIT) in broadband NUV and FUV filters to isolate the star forming regions in the tidal tails and study the spatial variation in star formation rates. Based on ultraviolet

imaging observations, the authors discuss star-forming regions of ages < 200 Myr in the tidal tails. Star formation rates are measured in these regions and in the main body of the galaxy. The integrated star formation rate of NGC 7252 (i.e., that in the galaxy and tidal tails combined) without correcting for extinction is found to be 0.81 ± 0.01 $M_\odot$/yr. It is shown that the integrated star formation rate can change by an order of magnitude if the extinction correction used in star formation rates derived from other proxies are taken into consideration. The star formation rates in the associated tidal dwarf galaxies (NGC 7252E, SFR=0.02 $M_\odot$/yr and NGC 7252NW, SFR=0.03 $M_\odot$/yr) are typical of dwarf galaxies in the local Universe. The star formation rates show a dependence on the distance from the centre of the galaxy. This can be due to the different initial conditions responsible for the triggering of star formation in the gas reservoir that was expelled during the recent merger in NGC7252.

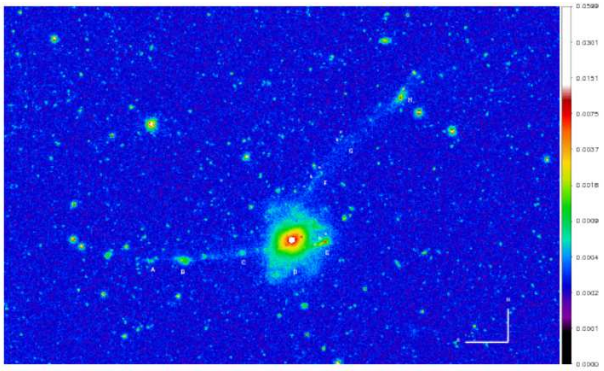


Figure 2.8: NUV image of the galaxy NGC 7252 observed with UVIT on board AstroSat. The low surface brightness features in the tidal tails are evident. The colour scaling in counts/sec is shown on the right.

(A&A, 2018 in press)

*(George, K.; Joseph, P.; *Côté, P.; *Ghosh, S. K.; *Hutchings, J. B.; Mohan, R.; *Postma, J.; Sankarasubramanian, K.; Sreekumar, P.; Stalin, C. S.; Subramaniam, A.; and Tandon, S. N.)*

Star clusters in the Magellanic Clouds - II. Age-dating, classification, and spatio-temporal distribution of the SMC clusters

The authors estimate the age and reddening parameters of already identified star clusters of the Small Magellanic Cloud (SMC) in a consistent way using available photometric data, classify them based on their mass and strength, and study their spatio-temporal distribution. They have used a semi-automated quantitative method, developed in the first paper of this series, to estimate the cluster parameters using the V and I band photometric data from the Optical Gravitational Lensing Experiment (OGLE) III survey. The authors estimated parameters of 179 star clusters and classified them into 4 groups, where, 17 are newly parameterized. An on-line catalog of parameters as well as cleaned and isochrone-fitted Color Magnitude Diagrams (CMDs) of 179 clusters are presented. The authors compiled age information of 468 clusters by combining previous studies with their catalog to study spatio-temporal distribution. Most of the clusters located in the southern part of the SMC are in the age range 600 Myr – 1.25 Gyr, whereas, the clusters younger than 100 Myr are mostly found in the northern SMC, with the central SMC showing continuous cluster formation. The peak of the cluster age distribution is identified at 125 ± 25 My, due to the most recent LMC-SMC interaction. 90 % of the studied sample are found to have mass < 1700 $M_\odot$, suggesting that the SMC is dominated by low mass clusters.

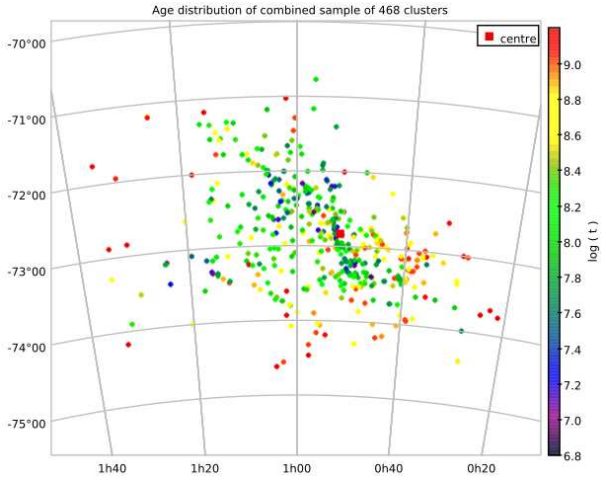


Figure 2.9: Spatial distribution of the compiled sample of 468 star clusters in the SMC as a function of age.

(A&A, 2018 in press)

*(Nayak, P. K.; Subramaniam, A.; *Choudhury, S.; Indu, G.; Sagar, Ram)*

Why are classical bulges more common in S0 galaxies than in spiral galaxies?

The authors of the present work try to understand why the classical bulge fraction observed in S0 galaxies is significantly higher than that in spiral galaxies using a comparative study of the bulge and global properties of a sample of spiral and S0 galaxies in a fixed environment. Their sample is flux limited and contains 262 spiral and 155 S0 galaxies drawn from the Sloan Digital Sky Survey (SDSS).
(MNRAS, submitted)

(Preetish Mishra, Yogesh Wadadekar* and Sudhanshu Barway)*

A SALT Spectral Study of S0s Hosting Pseudobulges

A SALT-RSS spectroscopic study of a sample of S0 galaxies established as pseudobulge hosts. The spectra of various regions of each galaxy are extracted using standard long-slit spectroscopic reduction procedures and modeled to derive detailed star formation histories. The authors find that these objects which are all classified as pseudobulge hosts are not alike.

(Kaustubh Vaghmare, Sudhanshu Barway, Ajit Kembhavi*, Yogesh Wadadekar* and Petri Vaisanen*)*

A (likely) X-ray jet from NGC 6217 observed by XMM-Newton

NGC 6217 is a nearby spiral galaxy with a starburst region near its centre. Evidence for a low-luminosity Active Galactic Nucleus (AGN) in its core has also been found in optical spectra. Intriguingly, X-ray observations by ROSAT revealed three knots aligned with the galaxy centre, resembling a jet structure. This work presents a study of XMM-Newton observations made to assess the hypothesis of a jet emitted from the centre of NGC 6217. The XMM data confirm the knots found with ROSAT and our spectral analysis shows that they have similar spectral properties with a hard photon index $\Gamma \sim 1.7$. The core of NGC 6217 is well fitted by a model with an AGN and a starburst component, where the AGN contributes at most 46 per cent of the total flux. The candidate jet has an apparent length ~ 15 kpc and a luminosity of $\sim 5 \times 10^{38}$ erg s^{-1}. It stands out by being hosted by a spiral galaxy, since jets are more widely associated with ellipticals. To explain the jet launching mechanism the authors consider the hypothesis of an advection dominated accretion flow with a low accretion rate. The candidate jet emitted from NGC 6217 is intriguing since it represents a challenge to the current knowledge of the connection between AGN, jets and host galaxies.

(Monthly Notices of the Royal Astronomical Society , 2017, Vol 472, P 2280–2288)

(S. Falocco , J. Larsson*, S. Nandi)*

Outlying Hα emitters in SDSS IV MaNGA

The authors have carried out a systematic search for outlying Hα emitters in the entire data release 14 of the SDSS IV Mapping Nearby Galaxies at APO (MaNGA) survey. They have discovered 41 such outlying Hα emitters by visually identifying Hα emitting regions with no underlying optical continuum emission in imaging from the SDSS.

(Omkar Bait, Yogesh Wadadekar* and Sudhanshu Barway)*

ASASSN-16fp (SN 2016coi): A transitional supernova between Type Ic and broad-lined Ic

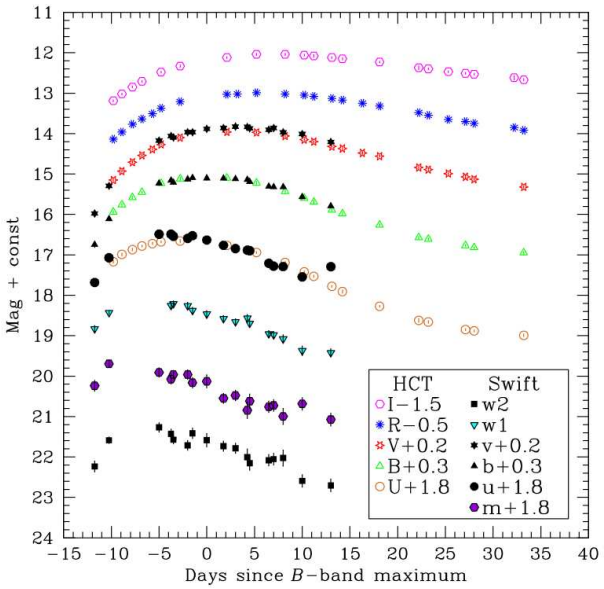


Figure 2.10: The $UBVRI$ and *Swift* UVOT light curves of ASASSN-16fp.

The authors present results based on a well sampled optical ($UBVRI$, taken with HCT) and ultraviolet (*Swift*/UVOT) imaging, and low-resolution optical spectroscopic follow-up observations (using HCT) of the nearby Type Ic supernova (SN) ASASSN-16fp (SN 2016coi). The SN was monitored during the photospheric phase (−10 to +33 days with respect to the B-band maximum light). The rise to maximum light and early post-maximum decline of the light curves are slow. The peak absolute magnitude ($M_V = -17.7 \pm 0.2$ mag) of ASASSN-16fp is comparable with broad-lined Ic SN 2002ap, SN 2012ap and transitional Ic SN 2004aw but considerably fainter than the GRB/XRF associated supernovae (e.g. SN 1998bw, 2006aj). Similar to the light curve, the spectral evolution is also slow. ASASSN-16fp shows distinct photospheric phase spectral lines along with the C II features. The expansion velocity of the ejecta near maximum light reached ∼16000 km s^{-1} and settled to ∼8000 km s^{-1}, ∼1 month post-maximum. Analytical modelling of the quasi-bolometric light curve of ASASSN-16fp suggests that ∼0.1 M$_\odot$ ^{56}Ni mass was synthesized in the explosion, with a kinetic energy of $6.9^{+1.5}_{-1.3} \times 10^{51}$ erg and total ejected mass of $\sim 4.5 \pm 0.3$ M$_\odot$.
(MNRAS, 2018, 473, 3776-3788)

(B. Kumar, A. Singh, S. Srivastav, D. K. Sahu and G. C. Anupama)

Short-timescale γ-ray variability in CTA 102

The flat-spectrum radio quasar CTA 102 experienced a prolonged state of enhanced activity across the entire observed electromagnetic spectrum during 2016-2017, most pronounced during a major outburst between 2016 December and 2017 May. Fermi-LAT observed a flux of $2.2 \pm 0.2 \times 10^5$

photons cm^{-2} s^{-1} at energies above 100 MeV on 2017 April 19 during a single orbit. The authors report here the detection of significant (4.7σ) flux variations down to timescales of $\sim$ 5 minutes during this orbit. The measured variability timescale is much shorter than the light-travel time across the central black hole ($\sim$ 70 minutes) indicating a very compact emission region within the jet, similar to that seen in IC 310, Mrk 501, or PKS 1222+21 from MAGIC observations. This short-timescale variability is unexpected since the γ-ray spectrum shows no sign of attenuation due to pair creation in interactions with photons from the broad emission line region, and therefore must be assumed to originate far from the black hole. The observed fast variability could either indicate the dissipation of magnetic islands or protons in a collimated beam from the base of the jet encountering the turbulent plasma at the end of the magnetic nozzle.
(ApJL, 2018, 854, 26)

(A. Shukla, K. Mannheim*, S. R. Patel*, J. Roy*, V. Chitnis*, D. Dorner*, A. R. Rao*, G. C. Anupama, C. Wendel*)*

A misaligned double-double radio galaxy hosted by a binary black-hole

Double-double radio galaxies (DDRGs) can be characterized by a second pair of lobes driven by the same central active galactic nuclei (AGN). For these episodic sources the outflow of new jet mostly follow the same direction of the previous jets. A change in the direction of the new restarted jets is not common phenomenon for DDRGs. There are few examples of DDRGs with the signature of transmute of jet axes. In this study, the authors identified one DDRG, J1328+2752, which shows not only restarted jet activity with a axis reorientation but also generates double-peaked emissions line from the central AGN. The misalignment angle for this source is $\sim$ 30 degree. In the optical spectra the average velocity off-set of the two components is $\sim$ 235 km/s. The split in emission lines are the possible outcome of a bound pair of SMBH, moving with their own characteristic velocity.

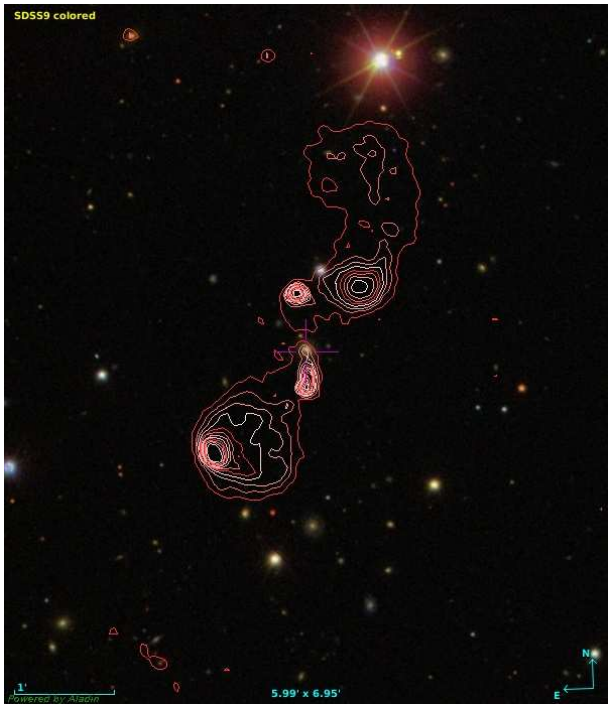


Figure 2.11: A 610 MHz GMRT image of J1328+2752.

(Monthly Notices of the Royal Astronomical Society: Letters, Volume 467, p.L56-L60)

(S. Nandi, M. Jamrozy, R. Roy*, J. Larsson*, D. J. Saikia*, M. Baes* and M. Singh*)*

Static structure of chameleon dark matter as an explanation of dwarf spheroidal galaxy cores

The authors of the present work propose a novel mechanism which explains cored dark matter density profile in recently observed dark matter rich dwarf spheroidal galaxies.

In this scenario, dark matter particle mass decreases gradually as function of distance towards the center of a dwarf galaxy due to its interaction with a chameleon scalar. At closer distance towards galactic center, the strength of attractive scalar fifth force becomes much stronger than gravity and is balanced by the Fermi pressure of dark matter cloud, thus an equilibrium static configuration of dark matter halo is obtained. Like the case of soliton star or fermion Q-star, the stability of the dark matter halo is obtained as the scalar achieves a static profile and reaches an asymptotic value away from the galactic center. For simple scalar-dark matter interaction and quadratic scalar self interaction potential, it is shown that dark matter behaves exactly like cold dark matter (CDM) beyond few kpc away from galactic center but at closer distance it becomes lighter and fermi pressure cannot be ignored anymore. Using Thomas-Fermi approximation, the authors numerically solve the radial static profile of the scalar field, fermion mass and dark matter energy density as a function of distance.
(Phys. Rev., 2017, D 95, 083008)

(P. Chanda, S. Das)*

On dark matter - dark radiation interaction and cosmic reionization

An intriguing possibility for the dark sector of our universe is that the dark matter particle could interact with a dark radiation component. If the non-gravitational interactions of the dark matter and dark radiation species with Standard Model particles are highly suppressed, then astrophysics and cosmology could be our only windows into probing the dynamics of such a dark sector. It is well known that such dark sectors would lead to suppression of small scale structure, which would be constrained by measurements of the Lyman-α forest. In this work the authors consider the cosmological signatures of such dark sectors on the reionization history of our universe. Working within the recently proposed "ETHOS" (effective theory of structure formation) framework, they show that if such a dark sector exists in our universe, the suppression of low mass dark matter halos would also reduce the total number of ionizing photons, thus affecting the reionization history of our universe. The authors place constraints on the interaction strengths within such dark sectors by using the measured value of the optical depth from the Planck satellite, as well as from demanding a successful reionization history. They compare and contrast such scenarios with warm dark matter scenarios which also suppress structure formation on small scales. In a model where dark matter interacts with a sterile neutrino, a bound is found on the ETHOS parameter $a_4 \lesssim 1.2\times10^6$ Mpc^{-1}. For warm dark matter models, the authors constrain the mass $m_{WDM} \gtrsim 0.7$ keV, which is comparable to bounds obtained from Lyman-α measurements. Future 21-cm experiments will measure the global history of reionization and the neutral hydrogen power spectrum, which could either lead to stronger constraints or discovery of secret dark sector interactions.

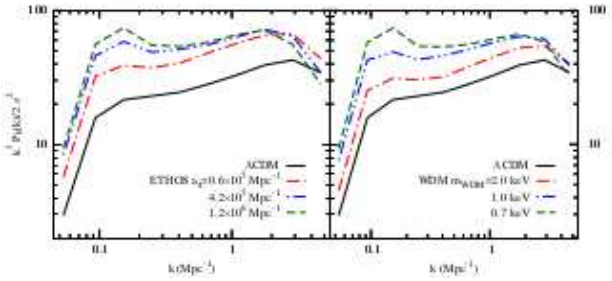


Figure 2.12: The figures above show the brightness temperature power spectrum of HI field as a function of k at $z = 8$ for the three different benchmark interacting DM-DR and WDM models. Models with fewer low mass halos have fewer, but more intense ionizing source. The localization of ionized bubbles leads to larger HI regions which is reflected in the increased brightness power spectra on large scales $(1 - 10Mpc)$ which can in principle be probed by LOFAR and future 21 cm experiments.

(Submitetd to JCAP)

(S. Das, R. Mondal, V. Rentala*, S. Suresh)*

The effects of the small-scale behaviour of dark matter power spectrum on CMB spectral distortion

After numerous astronomical and experimental searches, the precise particle nature of dark matter is still unknown. The standard Weakly Interacting Massive Particle (WIMP) dark matter, despite successfully explaining the large-scale features of the universe, has long-standing small-scale issues. The spectral distortion in the Cosmic Microwave Background (CMB) caused by Silk damping in the pre-recombination era allows one to access information on a range of small scales $0.3\,Mpc^{-1} < k < 104\,Mpc^{-1}$, whose dynamics can be precisely described using linear theory. In this work, the authors investigate the possibility of using the Silk damping induced CMB spectral distortion as a probe of the small-scale power. They consider four suggested alternative dark matter candidates – Warm Dark Matter (WDM), Late Forming Dark Matter, Ultra Light Axion dark matter and Charged Decaying Dark Matter; the matter power in all these models deviate significantly from the ΛCDM model at small scales. The spectral distortion of CMB is computed for these alternative models and compare the results with the ΛCDM model. It is shown that the main impact of alternative models is to alter the sub-horizon evolution of the Newtonian potential which affects the late-time behaviour of spectral distortion of CMB. The y-parameter diminishes by a few percent as compared to the ΛCDM model for a range of parameters of these models. The authors also briefly discuss the detectability of this deviation in light of the upcoming CMB experiment PIXIE, which might have the sensitivity to detect this signal from the pre-recombination phase.
(JCAP, 2017, 1707, no.07, 012)

(Abir Sarkar, Shiv Sethi*, Subinoy das)*

On Minkowski Functionals of CMB polarization

CMB polarization data is usually analyzed using E and B modes because they are scalars quantities under rotations along the lines of sight and have distinct physical origins. The authors explore the possibility of using the Stokes parameters Q and U for complementary analysis and consistency checks in the context of searches for non-Gaussianity. They show that the Minkowski Functionals (MFs) of Q, U are invariant under local rotations along the lines of sight even though Q, U are spin-2 variables, for full sky analysis. The invariance does not hold for incomplete sky. For local type primordial

non-Gaussianity, when compared the non-Gaussian deviations of MFs for Q, U to what is obtained for E mode or temperature fluctuations, it is found that the amplitude is about an order of magnitude lower and the shapes of the deviations are different. This finding can be useful in distinguishing local type non-Gaussianity from other origins of non-Gaussianity in the observed data. Lastly, the authors analyze the sensitivity of the amplitudes of the MFs for Q, U and the number density of singularities of the total polarization intensity to the tensor-to-scalar ratio, r, and find that all of them decrease as r increases.
(Phys. Lett., 2017, B771, 67-73)

(Pravabati Chingangbam, Vidhya Ganesan, K. P. Yogendran, Changbom Park*)*

Minkowski Tensors in Two Dimensions - Probing the Morphology and Isotropy of the Matter and Galaxy Density Fields

The authors apply the Minkowski Tensor statistics to two dimensional slices of the three dimensional matter density field. The Minkowski Tensors are a set of functions that are sensitive to directionally dependent signals in the data, and furthermore can be used to quantify the mean shape of density fields. The study begins by reviewing the definition of Minkowski Tensors and introducing a method of calculating them from a discretely sampled field. Focusing on the statistic $W_2^{1,1}$ – a 2 × 2 matrix – its value is calculated for both the entire excursion set and for individual connected regions and holes within the set. To study the morphology of structures within the excursion set, the eigenvalues λ_1, λ_2 are calculated for the matrix $W_2^{1,1}$ of each distinct connected region and hole and measure their mean shape using the ratio $\beta \equiv \langle\ \lambda_2/\lambda_1\ \rangle$. The authors compare both $W_2^{1,1}$ and β for a Gaussian field and a smoothed density field generated from the latest Horizon Run 4 cosmological simulation, to study the effect of gravitational collapse on these functions. The global statistic $W_2^{1,1}$ is essentially independent of gravitational collapse, as the process maintains statistical isotropy. However, β is modified significantly, with overdensities becoming relatively more circular compared to underdensities at low redshifts. When applying the statistics to a redshift-space distorted density field, the matrix $W_2^{1,1}$ is no longer proportional to the identity matrix and measurements of its diagonal elements can be used to probe the large-scale velocity field.
(Astrophys. J., 2018, 858, no.2, 87)

(S. Appleby, P. Chingangbam, C. Park*, S. E. Hong*, J. Kim* and V. Ganesan)*

Tensor Minkowski Functionals: first application to the CMB

Tensor Minkowski Functionals (TMFs) are tensor generalizations of the usual Minkowski Functionals which are scalar quantities. The authors introduce them here for use in cosmological analysis. They focus on one of the TMFs, namely $W_2^{1,1}$. The ratio of the eigenvalues of the average of $W_2^{1,1}$ over all structures, α, encodes the net orientation of the structures; and the average of the ratios of the eigenvalues of $W_2^{1,1}$ for each structure, β, encodes the net intrinsic anisotropy of the structures. A code has been developed that computes $W_2^{1,1}$ for structures on two dimensions. α and β are computed for simulated Gaussian and isotropic CMB temperature and E mode fields. α=1 is recovered; as expected from statistical isotropy. It is also noticed that LCDM predicts a characteristic shape of β for temperature and E mode as a function of the threshold. Then α and β are computed using data from the PLANCK

mission and compared with results from simulations. The authors find very good agreement of both β and α for all PLANCK temperature data sets with LCDM expectations. E mode data show good agreement for β but α for all data sets deviate from LCDM higher than 3-σ. These deviations most likely originate from the noise field and beam characteristics of the detector rather than the true E mode signal, and needs to be probed further.
(JCAP, 2017, 1706, no.06, 023)

(Vidhya Ganesan and Pravabati Chingangbam)

Tensor Minkowski Functionals for random fields

The authors of the present work generalize the translation invariant tensor-valued Minkowski Functionals which are defined on two-dimensional flat space to the unit sphere. They apply them to level sets of random fields. The contours enclosing boundaries of level sets of random fields give a spatial distribution of random smooth closed curves. Analytic expressions are obtained for the ensemble expectation values for the matrix elements of the tensor-valued Minkowski Functionals for isotropic Gaussian and Rayleigh fields. The authors elucidate the way in which the elements of the tensor Minkowski Functionals encode information about the nature and statistical isotropy (or departure from isotropy) of the field. They then implement their method to compute the tensor-valued Minkowski Functionals numerically and demonstrate how they encode statistical anisotropy and departure from Gaussianity by applying the method to maps of the Galactic foreground emissions from the PLANCK data.
(JCAP, 2017, 1712, no.12, 023)

(P. Chingangbam, K. P. Yogendran, Joby P. K., V. Ganesan, S. Appleby*, C. Park*)*

2.4 Theoretical Physics & Astrophysics

Can Pop III stars survive to the present day?

A number of recent simulations of primordial star forming clouds have shown that the protostellar disk is susceptible to fragmentation giving birth to multiple primordial protostars. Some of these protostars are then ejected from the disk with velocities exceeding their escape velocity. This raises the question whether some of these ejected protostars can enter the main sequence and survive until the present epoch. An answer to this question lies in unravelling the complex interplay between the dynamical interaction of the fragments with the ambient gas and the accretion phenomena. To this effect, the authors developed a semi-analytical model where they began by using the typical orbital parameters of these protostars and the properties of the clusters, as determined from numerical simulations of protostellar collapse. Next, these parameters are used as inputs into a simple semi-analytical model of Bondi-Hoyle accretion to explore the maximum mass range of Pop III protostars that could have avoided core collapse and survived to the present day. The results indicate that Pop III protostars which initially form with $M \leq 0.65\,M_{\odot}$ and velocities larger than the escape velocity may survive to the present day. This implies that such low mass protostars that escape the cloud of formation are poorly bound in the halo of formation. In view of the preserved ordering by binding energy in mergers, the authors therefore expect that these stars are more likely to be found in the halo or loosely bound struc-

tures like low-mass satellites.
(MNRAS, Under review)

(Jayanta Dutta, Sharanya Sur, Athena Stacy*, Jasjeet S. Bagla*)*

Faraday rotation signatures of fluctuation dynamos in young galaxies

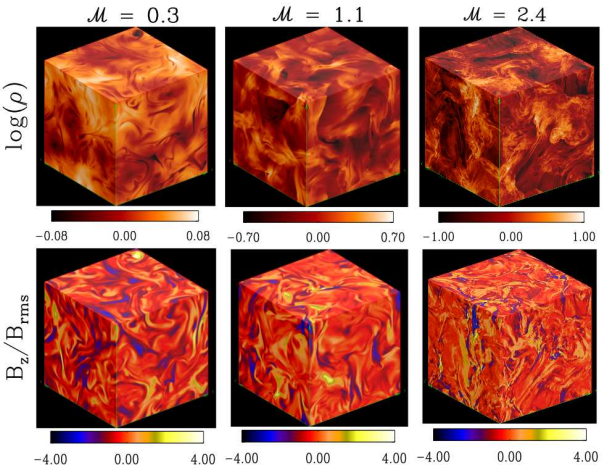


Figure 2.13: Shown column-wise : 3D volume renderings of the density (upper row) and $B_z/B_{\rm rms}$ (lower row) in the saturated phase for Mach numbers $\mathcal{M} = 0.3$ (left), 1.1 (middle) and 2.4 (right), respectively.

Observations of Faraday rotation through high-redshift galaxies ($z \sim 1$) has revealed that they host coherent magnetic fields that are of comparable strengths to those observed in nearby galaxies. These fields could be generated by Fluctuation dynamos. Using idealized numerical simulations of such dynamos in forced compressible turbulence up to rms Mach number of 2.4, the authors probed the resulting rotation measure (RM) and the degree of coherence of the magnetic field. These simulations were conducted with the `FLASH`* code. By shooting lines-of-sight (LOS) through the simulation volumes, the authors obtained values of the normalized standard deviation of RM, $\bar{\sigma}_{\rm RM} = 0.45 - 0.55$ at dynamo saturation independent of the Mach number of the flow. Remarkably, such values of $\bar{\sigma}_{\rm RM}$ lead to a random RM $\sim 16 - 48$ rad m^{-2} in the galactic context consistent with the observations. It is also shown that the dominant contribution to the RM in subsonic and transonic cases comes from the general sea of volume filling fields, rather than from the rarer structures. However, in the supersonic case, strong field regions as well as moderately overdense regions contribute significantly. Present results can thus account for the observed RMs in young galaxies.
(MNRAS Letters, 2018, Vol. 475, L72 - L76)

(Sharanya Sur, Pallavi Bhat, Kandaswamy Subramanian*)*

Role of primordial black holes in the direct collapse scenario of supermassive black hole formation at high redshifts

In this work, the authors explore the possibility of accreting primordial black holes as the source of heating for the collapsing gas in the context of the direct collapse black hole scenario for the formation of super-massive black holes (SMBHs) at high redshifts, $z \sim 6 - 7$. One of the essential requirements for the direct collapse model to work is to maintain the temperature of the in-falling gas at $\approx 10^4$ K. It is shown that even under the existing abundance limits, the primordial black holes of masses $\gtrsim 10^{-2} M_\odot$, can heat the collapsing gas to an extent that the H_2 formation is inhibited. The collapsing gas can maintain its temperature at 10^4 K till the gas reaches a critical density $n_c \approx 10^3$ cm^{-3}, at which the roto-vibrational states of H_2 approaches local thermodynamic equilibrium and H_2 cooling becomes

*http://flash.uchicago.edu/site/flashcode/

inefficient. In the absence of H_2 cooling, the temperature of the collapsing gas stays at H_2 K even as it collapses further. Scenarios of subsequent angular momentum removal and the route to find collapse through either a supermassive star or a supermassive disk are discussed.
(Journal of Astrophysics and Astronomy, 2018, Vol. 39, Page 9P)

(Pandey, Kanhaiya L.; Mangalam, A.)

Description of C_2 dissociation using a naive treatment of dynamical correlation in the presence of quasidegeneracy of varying degree

Generation of even qualitatively correct results of potential energy surfaces (PESs) of the ground and two lowest-lying excited singlet states of Carbon dimer is a non-trivial task due to the strong geometry-dependent closeness of these potential energy curves leading to real and avoided crossings. The state-specific multi-reference perturbation theory (SSMRPT) based on improved virtial orbital scheme is applied to obtain the above mentioned states. It is shown that the IVO-SSMRPT method is capable of providing a correct representation of the surfaces including the locations of the crossing points between the states.
(Moecular Physics, 2017, 115, 2789)

(Suvonil Sihna Roy, Shovan Mannan*, Rajat K. Chaudhuri and Sudip Chattopadhyay*)*

A confinement induced spectroscopic study of noble gas atoms using equation of motion architecture: Encapsulation within fullerene's voids

Relativistic study of spectroscopic properties of the endohedral fullerenes $Ng@C_{60}^{q}$ (where Ng=He, Ne and q=0, ±1, ±2 are the charges) associated with the fullerene molecule, has been done using the equation of motion coupled cluster (EOM-CC) methodology. Specific properties estimated are the transition energies, dipole oscillator strengths and the transition probabilities for the low lying excitations which have been compared with those for the isolated atom to depict the confinement effect of the host molecule on the encapsulated atom. This is accomplished by introducing an effective potential to the atomic Hamiltonian induced by the fullerene moiety and its charge. The EOM-CC results have been compared with those estimated with random phase approximation (RPA), to understand the effect of electron correlation under such confinements. Systematic and interesting behavior of the properties are highlighted indicating the effect of fullerene cage potential on the redistribution of electron density of the guest atom.
(Journal of Chemical Physics, 2017, 147, 034111)

(Supriya K Chaudhuri, Rajat K Chaudhuri, Prasanta K Mukherje* and Sudip Chattopadhyay*)*

A simplified ab initio treatment of diradicaloid structures produced from stretching and breaking chemical bonds

The present investigation reports on the prospect of using state specific multireference perturbation theory (SSMRPT) with an improved virtual orbital complete active space configuration interaction (IVO-CASCI) reference function (IVO-SSMRPT) to generate potential energy surfaces (PESs) for molecular systems [such as CH_4, C_2H_6, C_2H_4, H_2O_2, LiH, and KN] by stretching and breaking of suitable bonds with modest basis sets. The authors have also revisited the dissociation energy profile of triplet

ketene which exhibits a step-like structure in the observed rate. The application of the method has also been made to the ionization energies of H_2O. Although the perturbative corrections are obtained by the diagonalization of the effective Hamiltonian, in IVO-SSMRPT, only one physically relevant solution is achievable. It is parameter free and does not require any threshold to avoid the intruder problem. It is strictly size-extensive and size-consistent provided that local orbitals are used. The PESs obtained with the present approach are smooth all along the reaction path. Obtained estimates are in close agreement with the available reference data indicating that IVO-SSMRPT is a robust paradigm for the accurate computation of ground, excited and ionized states as it captures the mutual inter-play of different flavors of correlation effects in a balanced and accurate way.
(Physical Chemistry Chemical Physics (PCCP), 2017, 19, 22282)

(Suvonil Sinha Ray, Anirban Ghosh*, Anindita Shit*, Rajat K Chaudhuri and Sudip Chattopadhyay*)*

Combined complete active space configuration interaction and perturbation theory applied to conformational energy prototypes: Rotation and inversion barriers

A second-order multireference perturbation theory, termed as IVO-SSMRPT which allows the use of CASCI reference wave functions with improved virtual orbitals (IVO) for capturing static correlation and state-specific parameterization of the state-universal electronic wave function in an attempt to account for dynamic correlation has been utilized in an investigation of the torsional properties of ethylene, silaethylene, hydrogen peroxide, hydrazine, and oxalyl chloride. The authors also calculate the barrier to inversion of ammonia. IVO-SSMRPT is robust and useful to scan energy surfaces as it avoids the intruder-state problem, a troubling aspect of various established MRPT methods, without exploiting level-shifting or increasing the size of the active space. It is found that IVO-SSMRPT with the use of a relatively small active space and basis set can be compared with recent reference estimates which are reproduced within the expected precision indicating the method is useful for the study of rotation and inversion barriers of challenging molecules.
(Computational and Theoretical Chemistry, 2017, 1120, 56)

(Suvonil Sinha Ray, Uttam Sinha Mahapatra*, Rajat K Chaudhuri and Sudip Chattopadhyay*)*

2.5 Experimental Astrophysics & Instrumentation

The zenithal 4-m International Liquid Mirror Telescope: a unique facility for supernova studies

The 4-m International Liquid Mirror Telescope (ILMT) will soon become operational at the newly developed Devasthal observatory near Nainital (Uttarakhand, India). Coupled with a 4k × 4k pixels CCD detector and TDI optical corrector, it will reach approximately 22.8, 22.3, and 21.4 mag in the g', r', and i' spectral bands, respectively, in a single scan. The limiting magnitudes can be further improved by co-adding the consecutive night images in particular filters. The uniqueness to observe the same sky region by looking towards the zenith direction

every night makes the ILMT a unique instrument to detect new supernovae (SNe) by applying the image subtraction technique. High cadence (∼24 h) observations will help to construct dense sampling multi-band SNe light curves. The importance of the ILMT facility in the context of SNe studies are discussed. Considering the various plausible cosmological parameters and observational constraints, detailed calculations of the expected SNe rate that can be detected with the ILMT in different spectral bands are performed.
(Monthly Notices of the Royal Astronomical Society, 2018, Vol. 476 Page 2075)

*(Kumar, Brajesh; Pandey, Kanhaiya L.; *Pandey, S. B.; *Hickson, P.; *Borra, E. F.; Anupama, G. C.; *Surdej, J.)*

Supernovae study: Context of the 4-m International Liquid Mirror Telescope

The upcoming 4-m International Liquid Mirror Telescope (ILMT) facility will perform deep imaging (in single scan $g' \sim 22$ mag) of a narrow strip of sky each clear night in the Time Delayed Integration mode. A cadence of one day observation will provide unique opportunities to discover different types of supernovae (SNe) along with many other types of variable sources. The authors present the approach to discover SNe with the 4-m ILMT and discuss the follow-up strategy in the context of other existing observational facilities. The advantages of liquid mirror telescope observations over the traditional glass mirror telescopes are also discussed.
(Bulletin de la Societe Royale des Sciences de Liege, 2018, Vol. 87, Page 80K)

*(Kumar, Brajesh; *Pandey, Shashi Bhushan; Pandey, Kanhaiya Lal; Anapuma, Gadiyara Chakrapani; *Surdej, Jean)*

Analysis of polarization introduced due to the telescope optics of the Thirty Meter Telescope

An analytical model was developed to estimate the polarization effects, such as instrumental polarization (IP), crosstalk (CT), and depolarization, due to the optics of the Thirty Meter Telescope. These were estimated for the unvignetted field-of-view of the telescope and at the wavelengths of interest. The model estimated an IP of 1.26% and a CT of 44% at the Nasmyth focus of the telescope at the wavelength of 0.6 μm, at field angle zero, with the telescope pointing towards zenith. Mueller matrices were estimated for the primary, secondary, and Nasmyth mirrors. It was found that some of the Mueller matrix elements of the primary and secondary mirrors show a fourfold azimuthal antisymmetry, which indicates that the polarization at the Cassegrain focus is negligible. At the inclined Nasmyth mirror, there is no azimuthal antisymmetry in the matrix elements, and this results in nonzero values for IP and CT, which would negatively impact the polarization measurements at the telescope focus. The averaged Mueller matrix was estimated at the Nasmyth focus at different instrument ports and various zenith angles of the telescope. The variation in the Mueller matrix elements for different coatings was also estimated. This analysis will help in achieving precise requirements for future instruments with polarimetric capability, and also indicate the polarimetric science that can be undertaken with the TMT.
(JATIS, 2018, 4a8003)

(Ramya M Anche, A. K. Sen, G. C. Anupama*, K. Sankarasubramanian and Warren Skidmore*)*

CubeSat based UV spectrograph for studying atmospheres of planets orbiting M-dwarfs

UV photons play a crucial role in energetic processing of organic molecules in Interstellar medium and planetary atmospheres. Computational models and laboratory based experiments have shown that UV photons play a key role in the chemical evolution of atmosphere of planets around M-dwarfs. Therefore observation of such objects in UV-vis window is crucial for determining pathways leading to abiogenesis of organic molecules in those regions. CubeSats are excellent choice for space based UV observation since it is cost-effective and there are plenty of affordable launch opportunities. CubeSats based payloads can make significant observations at the relatively under-explored regions of the UV spectrum. The authors have designed a UV spectrograph to which can be fit on CubeSat platform. The telescope design is two mirrors spherical optics system which reflects light onto a modified Czerny-Turner spectrograph with reflection grating. The grating focuses the light onto a UV sensitive CCD. Primary scientific objective is to look for M-Dwarf UV flares and this UV activity will have a strong impact on the habitability of any possible planet around the star. UV light may have played a key role in the origin of life on Earth and characterizing the UV environment on M-dwarf planets is important for understanding the potential habitability. Various aspects of design and development of CubeSat based UV spectrograph for exoplanetary missions are presented.
(SPIE Astronomical Telescopes + Instrumentation, 10–15 June 2018 in Austin Texas, USA)

(B. G. Nair, Joice Mathew, Mayuresh Sarpotdar, K. Nirmal, S. Ambili, A. G. Sreejith, Margarita Safonova and Jayant Murthy)

3 Publications

3.1 In Journals

[1] *Abbott, B. P., et al. (including Anupama, G. C., Pavana, M.), 2017, The Astrophysical Journal Letters. Vol. 848, No. 2, L12.
Multi-messenger Observations of a Binary Neutron Star Merger

[2] *Abe, M., Prasannaa, V. S., *Das, B. P., 2018, Physical Review A, Vol. 97, 032515.
Application of the finite-field coupled-cluster method to calculate molecular properties relevant to electron electric-dipole-moment searches

[3] *Adegoke, O., Rakshit, Suvendu., *Mukhopadhyay, B., 2017, Monthly Notices of the Royal Astronomical Society, Vol. 466, Issue 4, pp. 3951–3960.
Spectral and time series analyses of the Seyfert 1 AGN: Zw 229.015

[4] *Agarwal, A., et al. (including Mangalam, A.), 2017, Monthly Notices of the Royal Astronomical Society, Vol. 469, Issue 1, p. 813–840.
Core shift effect in blazars

[5] Anche, Ramya M, *Sen, A. K., Anupama, G. C., Sankarasubramanian, K., *Skidmore, W., 2018., Journal of Astronomical Telescopes, Instruments, and Systems Vol. 4, Issue 1, 018003.
Analysis of polarization introduced due to the telescope optics of the Thirty Meter Telescope

[6] Anshu Kumari., Ramesh, R., Kathiravan, C., *Gopalswamy, N., 2017, The Astrophysical Journal, Vol. 843, Issue 1, 10.
New Evidence for a Coronal Mass Ejection-driven High Frequency Type II Burst near the Sun

[7] *Aoki, Wako., et al. (including Parthasarathy, M.), 2017, Publications of the Astronomical Society of Japan, Vol. 69, Issue 2, 21.
High-resolution spectroscopy of the extremely iron-poor post-AGB star CC Lyr

[8] *Arellano Ferro, A., *Bramich, D. M., Giridhar, S., 2017, Revista Mexicana de Astronomica y Astrofisica, Vol. 53, No. 1, pp. 121–131.
CCD time-series photometry of variable stars in globular clusters and the metallicity dependence of the horizontal

* *Collaborators from other Institutions*

branch luminosity

[9] *Arun, K., *Gudennavar, S. B., Sivaram, C., 2017, Advances in Space Research, Vol. 60, Issue 1, pp. 166–186.
Dark matter, dark energy, and alternate models: A review

[10] *Arun, K., *Gudennavar, S. B., Prasad, A., Sivaram, C., Advances in Space Research, Vol. 61, Issue 1, pp. 567–570.
Alternate models to dark energy

[11] *Bhattacharya, D., et al. (including Sreekumar, P., Stalin, C. S.), 2017, Monthly Notices of the Royal Astronomical Society, Vol. 471, Issue 4, pp. 5008–5017.
Unusual long-term low-activity states of EGRET blazars in the Fermi era

[12] Bhowmick, A., Pandey, G., *Joshi, V., *Ashok, N. M., 2018, The Astrophysical Journal, Vol. 854, No. 2, 140.
Are DY Persei Stars Cooler Cousins of R Coronae Borealis Stars?

[13] *Biswas, S., et al. (including Das, Subinoy., Das, Mousumi.), 2017, Journal of Cosmology and Astroparticle Physics, Vol. 2017, Issue 11, 3.
Constraints on dark matter models from the observation of Triangulum-II with the Fermi Large Area Telescope

[14] Brajesh Kumar., Singh, A., Srivastav, S., Sahu, D. K., Anupama, G. C., 2018, Monthly Notices of the Royal Astronomical Society, Vol. 473, No. 3, pp. 3776–3788.
ASASSN-16fp (SN 2016coi): a transitional supernova between Type Ic and broad-lined Ic

[15] *Brosch, N., et al. (including Murthy, J.), 2017, Contributions of the Astronomical Observatory Skalnaté Pleso, Vol. 47, No. 2, pp. 200–207.
Ultraviolet astronomy with small space telescopes

[16] *Chakradhari, N. K., Sahu, D. K., Anupama, G. C., Prabhu, T. P., 2018, Monthly Notices of the Royal Astronomical Society, Vol. 474, No. 2, pp. 2502–2513.
Highly reddened Type Ia supernova SN 2004ab: another case of anomalous extinction

[17] Chanda, Prolay Krishna., Das, Subinoy., 2017, Physical Review D, Vol. 95, Issue 8, 083008.
Static structure of chameleon dark matter as an explanation of dwarf spheroidal galaxy cores

[18] *Chaudhuri, S. K., Chaudhuri, R. K., *Mukherjee, P. K., *Chattopadhyay., 2017, Journal of Chemical Physics, Vol. 147, No. 3, 034111.
A confinement induced spectroscopic study of noble gas atoms using equation of motion architecture: Encapsulation within fullerene's voids

[19] Chatterjee, Subhamoy., Hegde, M., Banerjee, D., Ravindra, B., 2017, The Astrophysical Journal, Vol. 849, Issue 1, 44.
Long-term Study of the Solar Filaments from the Synoptic Maps as Derived from Hα Spectroheliograms of the Kodaikanal Observatory

[20] Chatterjee, Subhamoy., Mandal, Sudip., Banerjee, D., 2017, The Astrophysical Journal, Vol. 841, Issue 2, 70.
Variation of Supergranule Parameters with Solar Cycles: Results from Century-long Kodaikanal Digitized Ca II *K Data*

[21] *Corasaniti, P. S., *Agarwal, S., *Marsh, D. J. E., Das, Subinoy., 2017, Physical Review D, Vol. 95, Issue 8, 083512.
Constraints on dark matter scenarios from measurements of the galaxy luminosity function at high redshifts

[22] *Davies, R. L., et al. (including Shastri, P.), 2017, Monthly Notices of the Royal Astronomical Society, Vol. 470, Issue 4, pp. 4974–4988.
Dissecting galaxies: separating star formation, shock excitation and AGN activity in the central region of NGC 613

[23] Dipanweeta Bhattacharyya., Mangalam, A., 2018, Journal of Astrophysics and Astronomy, Vol. 39, No. 1, 4.
$M_\bullet - \sigma$ relation in spherical systems

[24] *Dumka, U. C., et al. (including Sagar, R.), 2017, Science of The Total Environment, Vol. 605–606, pp. 124–138.
First results from light scattering enhancement factor over central Indian Himalayas during GVAX campaign

[25] *Felipe, T., et al. (including Rajaguru, S. P.), 2017, Astronomy & Astrophysics, Vol. 608, A97.
Signatures of the impact of flare-ejected plasma on the photosphere of a sunspot light bridge

[26] *Göker Ü. D., Singh, J., *Nutku, F., Priyal, M., 2017, Serbian Astronomical Journal, vol. 195, pp. 59–70.
Temporal Variations of Different Solar Activity Indices Through the Solar Cycles 21–23

[27] *Guo, Zhen et al. (including Subramaniam, A.), 2018, The Astrophysical Journal, Vol. 852, Issue 1, 56.
Star-Disk Interactions in Multiband Photometric Monitoring of the Classical T Tauri Star GI Tau

[28] *Gupta, A., et al. (including Mangalam, A.), 2017, Monthly Notices of the Royal Astronomical Society, Vol. 472, Issue 1, pp. 788–798.
A peculiar multiwavelength flare in the blazar 3C 454.3

[29] *Gurumath, S. R., Hiremath, K. M., *Ramasubramanian, V., 2017, Journal of Astrophysics and Astronomy, Vol. 38, Issue 2, 19.
Metallicity of Sun-like G-stars that have Exoplanets

[30] *Hallakoun, N., et al. (including Sridharan, R.), 2017, Monthly Notices of the Royal Astronomical Society, Vol. 469, Issue 3, pp. 3213–3224.
Once in a blue moon: detection of 'bluing' during debris transits in the white dwarf WD 1145+017

[31] *Hampton, E., et al. (including Shastri, P.), 2017, Monthly Notices of the Royal Astronomical Society, Vol. 470, Issue 3, pp. 3395–3416.
Using an artificial neural network to classify multicomponent emission lines with integral field spectroscopy from SAMI and S7

[32] Hasan, S. S., Banerjee, D., Ravindra, B., Sankarasubramanian, K., Rangarajan, K. E., 2017, Current Science, Vol. 113, No. 4, pp. 696–700.
National Large Solar Telescope

[33] Hazra, G., *Choudhuri, A. R., 2017, Monthly Notices of the Royal Astronomical Society, Vol. 472, Issue 3, pp. 2728–2741.
A theoretical model of the variation of

the meridional circulation with the solar cycle

[34] Hema, B. P., Pandey, G., *Kamath, D., Kameswara Rao, N., *Lambert, D., *Woolf, V. M., 2017, Publications of the Astronomical Society of the Pacific, Vol. 129, Issue 980, 104202.
Abundance Analyses of the New R Coronae Borealis Stars: ASAS-RCB-8 and ASAS-RCB-10

[35] *Jensen, J. J., et al. (including Rakshit, Suvendu.), 2017. Monthly Notices of the Royal Astronomical Society, Vol. 470, Issue 3, pp. 3071–3094.
PAH features within few hundred parsecs of active galactic nuclei

[36] Kameswara Rao, N., et al. (including Muneer, S.), 2017, Monthly Notices of the Royal Astronomical Society, Vol. 467, Issue 1, pp. 1186–1192.
Unveiling Vela: time variability of interstellar lines in the direction of the Vela supernova remnant - II. Na D and Ca II

[37] Kameswara Rao, N., Sutaria, F., Murthy, J., Krishna, S., Mohan, R., *Ray, A., 2018, Astronomy & Astrophysics, Vol. 609, L1.
Planetary nebulae with UVIT: Far ultra-violet halo around the Bow Tie nebula (NGC 40)

[38] *Karthikeyan, B., *Shanmugapriya, G., *Rajamanickam, N., Bagare, S. P., 2018, Research Notes of the American Astronomical Society, Vol. 2, No. 1, 21.
Examining Barium Deuteride Molecules in Sunspots

[39] *Kasliwal, M. M., et al. (including Anupama, G. C.), 2017, Science, Vol. 358, Issue 6370, pp. 1559–1565.
Illuminating gravitational waves: A concordant picture of photons from a neutron star merger

[40] *Kasliwal, M. M., et al. (including Parthasarathy, M.), 2017, The Astrophysical Journal, Vol. 839, No. 2, 88.
SPIRITS: Uncovering Unusual Infrared Transients with Spitzer

[41] *Kharb, P., Subramanian, S., *Vaddi, S., Das, M., *Paragi, Z., 2017, The Astrophysical Journal, Vol. 846, Issue 1, 12.
Double-peaked Emission Lines Due to a Radio Outflow in KISSR 1219

[42] *Kishore, P.; Kathiravan, C.; Ramesh, R.; Ebenezer, E., 2017, Journal of Astrophysics and Astronomy, Vol. 38, Issue 2, 24.
Coronal Magnetic Field Lines and Electrons Associated with Type III-V Radio Bursts in a Solar Flare

[43] Kshama, S. K., *Paliya, V. S., Stalin, C. S., 2017, Monthly Notices of the Royal Astronomical Society, Vol. 466, Issue 3, pp. 2679–2689.
Intra-night optical variability characteristics of different classes of narrow-line Seyfert 1 galaxies

[44] *Kumar, P., et al. (including Stalin, C. S.), 2017, Monthly Notices of the Royal Astronomical Society, Vol. 471, Issue 1, pp. 606–616.
Multi-epoch intranight optical monitoring of eight radio-quiet BL Lac candidates

[45] Kumari, A., Ramesh, R., Kathiravan, C., *Wang, T. J., 2017, Solar Physics, Vol. 292, Issue 11, 161.
Strength of the Solar Coronal Magnetic Field – A Comparison of Independent

Estimates Using Contemporaneous Radio and White-Light Observations

[46] Kumari, A., Ramesh, R., Kathiravan, C., *Wang, T. J., 2017, Solar Physics, Vol. 292, Issue 12, 177.
Addendum to: Strength of the Solar Coronal Magnetic Field – A Comparison of Independent Estimates Using Contemporaneous Radio and White-Light Observations

[47] Lalitha, S., *Schmitt, J. H. M. M., *Singh, K. P., 2017, Astronomy & Astrophysics, Vol. 602, A26.
Structure and variability in the corona of the ultrafast rotator LO Pegasi

[48] *Mahanta, U., Goswami, A., *Duorah, H. L., *Duorah, K., 2017, Journal of Astrophysics and Astronomy, Vol. 38, Issue 4, 63.
Contribution of Proton Capture Reactions to the Ascertained Abundance of Fluorine in the Evolved Stars of Globular Cluster M4, M22, 47 Tuc and NGC 6397

[49] *Mahanta, U., Goswami, A., *Duorah, H. L., *Duorah, K., 2017, Research in Astronomy and Astrophysics, Vol. 17, Issue 8, 080.
p-capture reaction cycles in rotating massive stars and their impact on elemental abundances in globular cluster stars: A case study of O, Na and Al

[50] *Malkov, O., et al. (including Murthy, J.), 2018, Open Astronomy, Vol. 27, No. 1, pp. 62–69.
Interstellar extinction from photometric surveys: application to four high-latitude areas

[51] Mandal, Sudip., *Krishna Prasad, S., Banerjee, D., 2018, The Astrophysical Journal, Vol. 853, No. 2, 134.
A Statistical Study on the Frequency-dependent Damping of the Slow-mode Waves in Polar Plumes and Interplumes

[52] Mandal, Sudip., Chatterjee, Subhamoy., Banerjee, D., 2017, The Astrophysical Journal, Vol. 844, Issue 1, 24.
Association of Supergranule Mean Scales with Solar Cycle Strengths and Total Solar Irradiance

[53] Mandal, Sudip., Hegde, Manjunath., Samanta, Tanmoy., Hazra, G., Banerjee, D., Ravindra, B., 2017, Astronomy & Astrophysics, Vol. 601, A106.
Kodaikanal digitized white-light data archive (1921–2011): Analysis of various solar cycle features

[54] Mandal, Sudip., *Karak, B. B., Banerjee, D., 2017, The Astrophysical Journal, Vol. 851, Issue 1, 70.
Latitude Distribution of Sunspots: Analysis Using Sunspot Data and a Dynamo Model

[55] Mangalam, A., *Prasad, A., 2018, Advances in Space Research, Vol. 61, Issue 2, pp. 738–748.
Topological and statistical properties of nonlinear force-free fields

[56] *Mathew, B., *Manoj, P., Bhatt, B. C., Sahu, D. K., *Maheswar, G., Muneer, S., 2017, The Astronomical Journal, Vol. 153, Issue 5, 225.
The Curious Case of PDS 11: A Nearby, >10 Myr Old, Classical T Tauri Binary System

[57] Megha, A., Sampoorna, M., Nagendra, K. N., Sankarasubramanian, K., 2017, The Astrophysical Journal, Vol. 841, Issue 2, 129.
Hanle-Zeeman Scattering Matrix for Magnetic Dipole Transitions

[58] *Messina, S., Parihar, P. S., *Distefano, E., 2017, Monthly Notices of the Royal Astronomical Society, Vol. 468, Issue 1, pp. 931–945.
Impact of photometric variability on age and mass determination in young stellar objects: the case of the Orion Nebula Cluster

[59] *Mondal, A., Anupama, G. C., Kamath, U. S., *Das, R., Selvakumar, G., *Mondal, S., 2018, Monthly Notices of the Royal Astronomical Society, Vol. 474, No. 3, pp. 4211–4224.
Optical spectroscopy of the recurrent nova RS Ophiuchi – from the outburst of 2006 to quiescence

[60] Mugundhan, V., Ramesh, R., Kathiravan, C., Gireesh, G. V. S., Kumari, A., Hariharan, K., Barve, Indrajit V., 2018, The Astrophysical Journal Letters, Vol. 855, No. 1, L8.
The First Low-frequency Radio Observations of the Solar Corona on ≈200 km Long Interferometer Baseline

[61] Mugundhan, V., Hariharan, K., Ramesh, R., 2017, Solar Physics, Vol. 292, Issue 11, 155.
Solar Type IIIb Radio Bursts as Tracers for Electron Density Fluctuations in the Corona

[62] Mugundhan, V., Ramesh, R., Kathiravan., C., Gireesh, G. V. S., *Aathira Hegde., 2018, Solar Physics, Vol. 293, No. 3, 41.
Spectropolarimetric Observations of Solar Noise Storms at Low Frequencies

[63] Murthy, J., et al. (including Sutaria, F.), 2017, Astronomy and Computing, Vol. 20, pp. 120–127.
JUDE: An Ultraviolet Imaging Telescope pipeline

[64] Muthumariappan, C., 2017, Monthly Notices of the Royal Astronomical Society, Vol. 470, Issue 1, pp. 626–638.
Three-dimensional Monte Carlo dust radiative transfer study of the H-poor planetary nebula IRAS 18333-2357 located in M22

[65] *Narayan, Sathya., Murthy, J., *Karuppath, N., 2017, Monthly Notices of the Royal Astronomical Society, Vol. 466, Issue 3, pp. 3199–3205.
Dust scattering from the Taurus Molecular Cloud

[66] *Omar, A., *Kumar, B., Maheswar, G., Sagar, R., 2017, Current Science, Vol. 113, No. 4, pp. 682–685.
Scientific capabilities and advantages of the 3.6 meter optical telescope at Devasthal, Uttarakhand

[67] *Paliya, V. S., et al. (including Rakshit, Suvendu., Mandal, Amit Kumar., Stalin, C. S.), 2018, The Astrophysical Journal Letters, Vol. 853, Issue 1, L2.
Gamma-Ray-emitting Narrow-line Seyfert 1 Galaxies in the Sloan Digital Sky Survey

[68] *Paliya, V. S., Stalin, C. S., *Ajello, M. *Kaur, A., 2017, The Astrophysical Journal, Vol. 844, Issue 1, 32.
Intra-night Optical Variability Monitoring of Fermi Blazars: First Results from 1.3-m J. C. Bhattacharya Telescope

[69] Pandey, Kanhaiya L., Mangalam, A., 2018, Journal of Astrophysics and Astronomy, Vol. 39, No. 1, 9.
Role of primordial black holes in the direct collapse scenario of supermassive black hole formation at high redshifts

[70] Pandey, G., *Lambert, D. L., 2017, The Astrophysical Journal, Vol. 847, Issue

2, 127.
Non-local Thermodynamic Equilibrium Abundance Analyses of the Extreme Helium Stars V652 Her and HD 144941

[71] *Pandey, K. K., Hiremath, K. M., *Yellaiah, G., 2017, Astrophysics and Space Science, Vol. 362, Issue 6, 106.
Latitude character and evolution of Gnevyshev gap

[72] Panini, S. S., et al. (including Sreekumar, P.), 2018, Journal of Astronomical Telescopes, Instruments, and Systems, Vol. 4, Issue 1, 011002.
Multilayer mirror-based soft x-ray polarimeter for astronomical observations

[73] Pant, V., *Tiwari, A., *Yuan, D., Banerjee, D., 2017, The Astrophysical Journal Letters, Vol. 847, Issue 1, L5.
First Imaging Observation of Standing Slow Wave in Coronal Fan Loops

[74] Parthasarathy, M., 2018, Information Bulletin on Variable Stars, Vol. 63, Issue 6201, 6233.
Spectroscopy of bright Algol-type semi-detached close binary system HU Tauri (HR 1471)

[75] *Paul, K. T., Subramaniam, A., *Mathew, B., *Shruthi, S. B., 2017, New Astronomy, Vol. 56, pp. 28–49.
NIR properties of Be stars in star clusters in the Magellanic Clouds

[76] Prasad, B. R., et al. (including Banerjee, D., Singh, J., Nagabhushana, S., Kumar, A., Kamath, P. U., Kathiravan, S., Suresh Narra, Venkata., Rajkumar, N., Natarajan, V., Juneja, M., Somu, P., Pant, V.), 2017, Current Science, Vol. 113, No. 4, pp. 613–615.
Visible Emission Line Coronagraph on Aditya-L1

[77] Prasanna Deshmukh., Parihar, P. S., *Balasubramaniam, K. A., *Mishra, D. S., Mahesh, P. K., 2017, Journal of Astronomical Instrumentation, Vol. 6, No. 3, 1750006.
Dynamic Loading Assembly for Testing Actuators of Segmented Mirror Telescope

[78] Prasanna Deshmukh., et al. (including Parihar, P. S.), 2018, Journal of Astronomical Telescopes, Instruments, and Systems, Vol. 4, No.1, 014005.
Design, development, and validation of a segment support actuator for the prototype segmented mirror telescope

[79] Prasannaa, V. S., *Abe, M., *Bannur, V. M., Das, B. P., 2017, Physical Review A, Vol. 95, Issue 4, 042513.
Theoretical analysis of effective electric fields in mercury monohalides

[80] Pravabati, C., *Yogendran, K. P., Joby, P. K., Vidhya, G., *Appleby, S., *Park, C., 2017, Journal of Cosmology and Astroparticle Physics, Issue 12, 023.
Tensor Minkowski Functionals for random fields on the sphere

[81] Pravabati, C., Vidhya, G., *Yogendran, K. P., *Park, C., 2017, Physics Letters B, Vol. 771, pp. 67–73.
On Minkowski Functionals of CMB polarization

[82] Priyal, M., Singh, J., Ravindra, B., *Rathina, S. K., 2017, Solar Physics, Vol. 292, Issue 7, 85.
Long-term variations in the intensity of Plages and Networks as Observed in Kodaikanal Ca-K Digitized Data

[83] Priyanka Rani., Stalin, C. S., 2018, Journal of Astrophysics and Astronomy, Vol. 39, No. 1, 15.

Measurement of coronal properties of Seyfert galaxies from NuSTAR's hard X-ray spectrum

[84] Priyanka Rani., Stalin, C. S.; Rakshit, Suvendu., 2017, Monthly Notices of the Royal Astronomical Society, Vol. 466, Issue 3, pp. 3309–3322.
X-ray flux variability of active galactic nuclei observed using NuSTAR

[85] *Rahna, P. T., et al. (including Murthy, J., Sutaria, F.), 2017, Monthly Notices of the Royal Astronomical Society, Vol. 471, Issue 3, pp. 3028–3035.
Investigating the in-flight performance of the UVIT payload on AstroSat

[86] Raj, A., Pavana, M., Kamath, U. S., Anupama, G. C., *Walter, F. M., 2018, Acta Astronomica, Vol. 68, No. 1, pp. 79–88.
V2676 Oph: estimating physical parameters of a moderately fast nova

[87] Rakshit, Suvendu., Stalin, C. S., 2017, The Astrophysical Journal, Vol. 842, Issue 2, 96.
Optical Variability of Narrow-line and Broad-line Seyfert 1 Galaxies

[88] Rakshit, Suvendu., Stalin, C. S., *Chand, H., *Zhang, Xue-Guang., 2017, The Astrophysical Journal Supplement Series, Vol. 229, Issue 2, 39.
A Catalog of Narrow Line Seyfert 1 Galaxies from the Sloan Digital Sky Survey Data Release 12

[89] *Ray, S. S., *Manna, S., Chaudhuri, R. K., *Chattopadhyay, S., 2017, Molecular Physics, Vol. 115, No. 21–22, pp. 2789–2806.
Description of C_2 dissociation using a naive treatment of dynamical correlation in the presence of quasidegeneracy of varying degree

[90] Reddy, B. E., *Ramaprakash, A. N., 2017, Current Science, Vol. 113, No. 4, pp. 631–638.
India's participation in the Thirty Meter Telescope International Observatory project

[91] Rubinur, K., Mousumi Das., *Kharb, P., 2018, Journal of Astrophysics and Astronomy, Vol. 39, No. 1, 8.
Searching for dual active galactic nuclei

[92] Sajal Kumar Dhara., et al. (including Ravindra, B., Banyal, R. K.), 2017., Solar Physics, Vol. 292, Issue 10, 145.
Trigger of Successive Filament Eruptions Observed by SDO and STEREO

[93] Sampoorna, M., Nagendra, K. N., 2017, The Astrophysical Journal, Vol. 838, Issue 2, 95.
Importance of Cross-redistribution in Scattering Polarization of Spectral Lines: The Cases of $^3P-^3S$ Triplets of Mg I *and Ca* I

[94] Sampoorna, M., Nagendra, K. N., *Stenflo, J. O., 2017, The Astrophysical Journal, Vol. 844, Issue 2, 97.
Polarized Line Formation in Arbitrary Strength Magnetic Fields Angle-averaged and Angle-dependent Partial Frequency Redistribution

[95] Sankarasubramanian, K., et al., 2017, Current Science, Vol. 113, No. 4, pp. 625–627.
X-ray spectrometers on-board Aditya-L1 for solar flare studies

[96] *Saquet, E., et al. (including Anbazhagan, P., Selvakumar., G., Vasundhara, R.), 2018, Monthly Notices of the Royal Astronomical Society, Vol. 474, No. 4, pp. 4730–4739.

The PHEMU15 catalogue and astrometric results of the Jupiter's Galilean satellite mutual occultation and eclipse observations made in 2014–2015

[97] *Sarkar, A., *Sethi, S. K., Das, Subinoy., 2017, Journal of Cosmology and Astroparticle Physics, Vol. 2017, No. 7, 12.
The effects of the small-scale behaviour of dark matter power spectrum on CMB spectral distortion

[98] *Sasikumar Raja, K., *Subramanian, P., Ramesh, R., *Vourlidas, A., *Ingale, M., 2017, The Astrophysical Journal, Vol. 850, Issue 2, 129.
Turbulent Density Fluctuations and Proton Heating Rate in the Solar Wind from 9-20 R

[99] *Scott, T. C., et al. (including Sahu, D. K.), 2018, Monthly Notices of the Royal Astronomical Society, Vol. 475, No. 1, pp. 1148–1159.
Arp202: a TDG formed in a parent's extended dark matter halo?

[100] Sen, Samrat., Mangalam, A., 2018, Advances in Space Research, Vol. 61, Issue 2, pp. 617–627.
Model of a fluxtube with a twisted magnetic field in the stratified solar atmosphere

[101] Shantikumar, N. S., *Jade, S., *Shrungeshwara, T. S., 2018, Journal of Atmospheric and Solar-Terrestrial Physics, Vol. 168, pp. 58-69.
Parameterization of water vapor using high-resolution GPS data and empirical models

[102] Shantikumar, N. S., Kathiravan, S., Parihar, P. S., *Larson, E. J. L., Mohanan, Sharika., Angchuk, Dorje., Jorphel, Sonam., Rangarajan, K. E., Prabhu, K., 2017, Experimental Astronomy, Vol. 43, Issue 2, pp. 145–165.
Astronomical site survey report on dust measurement, wind profile, optical turbulence, and their correlation with seeing over IAO-Hanle. Astronomical site survey report over IAO-Hanle

[103] Sharma, Tarun Kumar., Parihar, P. S. Banyal, R. K., *Dar, A. A., Kemkar, P. M. M., Stanzin, U., Anupama, G. C., 2017, Monthly Notices of the Royal Astronomical Society, Vol. 470, Issue 1, pp. 1091–1100.
An automated extinction and sky brightness monitor for the Indian Astronomical Observatory, Hanle

[104] *Shukla, A., et al. (including Anupama, G. C.), 2018, The Astrophysical Journal Letters, Vol. 854, No. 2, L26.
Short-timescale γ-Ray Variability in CTA 102

[105] *Singh, M., et al. (including Sahu, D. K., Srivastav, S., Anupama, G. C., Brajesh Kumar.), 2018, Monthly Notices of the Royal Astronomical Society, Vol. 474, No. 2, pp. 2551–2563.
Exploring the optical behaviour of a Type Iax supernova SN 2014dt

[106] *Sinha Ray, S., et al. (including Chaudhuri, R. K.), 2017, Physical Chemistry Chemical Physics, Vol. 19, No. 33, pp. 22282–22301.
A simplified ab initio treatment of diradicaloid structures produced from stretching and breaking chemical bonds

[107] *Sinha Ray, S., *Mahapatra, U. S., Chaudhuri, R. K., *Chattopadhyay, S., 2017, Computational and Theoretical Chemistry, Vol. 1120, pp. 56–78.

Combined complete active space configuration interaction and perturbation theory applied to conformational energy prototypes: Rotation and inversion barriers

[108] Sivaram, C., 2017, International Journal of Modern Physics D, Vol. 26, No. 12, 1743010.
Dark matter (energy) may be indistinguishable from modified gravity (MOND)

[109] Sivaram, C., *Arun, K., *Kiren, O. V., 2018, Astrophysics and Space Science, Vol. 363, No. 3, pp. 40.
Forming supermassive black holes like J1342+0928 (invoking dark matter) in early universe

[110] *Skidmore, W., Anupama, G. C., *Srianand, R., 2017, Current Science, Vol. 113, No. 4, pp. 639–648.
The Thirty Meter Telescope International Observatory facilitating transformative astrophysical science

[111] Srivastav, S., Anupama, G. C., Sahu, D. K., *Ravikumar, C. D., 2017, Monthly Notices of the Royal Astronomical Society, Vol. 466, Issue 2, pp. 2436–2449.
SN 2015bp: adding to the growing population of transitional Type Ia supernovae

[112] Subramaniam, A., et al. (including Sahu, Snehalata., Tandon, S. N., Kameswara Rao, N., George, K., Mohan, R., Murthy, J., Pati, A. K., Sankarasubramanian, K., Stalin, C. S.), 2017, The Astronomical Journal, Vol. 154, Issue 6, 233.
The Horizontal Branch Population of NGC 1851 as Revealed by the Ultraviolet Imaging Telescope (UVIT)

[113] Sur, Sharanya., *Pallavi Bhat., *Subramanian, K., 2018, Monthly Notices of the Royal Astronomical Society, Vol. 475, No. 1, pp. L72–L76.
Faraday rotation signatures of fluctuation dynamos in young galaxies

[114] Surendran, A., Parihar, P. S., Banyal, R. K., *Kalyaan, A., 2018, Experimental Astronomy, Vol. 45, No. 1, pp. 5779.
Development of a Lunar Scintillometer as part of the national large optical telescope site survey

[115] Suryanarayana, G. S., 2018, Research in Astronomy and Astrophysics, Vol. 18, No. 3, 34.
Flares before and after coronal mass ejections

[116] Susmitha, A., *Koch, A., Sivarani, T., 2017, Astronomy & Astrophysics, Vol. 606, A112.
Abundance analysis of a CEMP-no star in the Carina dwarf spheroidal galaxy

[117] Tandon, S. N., et al. (including Subramaniam, A., Koshy, G., Kamath, P. U., Kathiravan, S., Kumar, A., Lancelot, J. P., Mahesh, P. K., Mohan, R., Murthy, J., Nagabhushana, S., Pati, A. K., Kameswara Rao., N., Sankarasubramanian, K., Sreekumar, P., Sriram, S., Stalin, C. S., Sutaria, F., Sreedhar, Y. H., Barve, I. V., Mondal, C., Sahu, S.), 2017, Journal of Astrophysics and Astronomy, Vol. 38, Issue 2, 28.
In-orbit Performance of UVIT and First Results

[118] Tandon, S. N., et al. (including Subramaniam, A., Sankarasubramanian, K., Sriram, S., Stalin, C. S., Mondal, C., Sahu, S., Joseph, P., Barve, I. V., George, K., Kamath, P. U., Kathiravan, S., Kumar, A., Lancelot, J. P., Mahesh, P. K., Mohan, R., Nagabhushana, S., Pati, A. K., Kameswara Rao, N.,

Sreedhar, Y. H., Sreekumar, P.), 2017, The Astronomical Journal, Vol. 154, Issue 3, 128.
In-orbit Calibrations of the Ultraviolet Imaging Telescope

[119] Tandon, S. N., *Ghosh, S. K., *Hutchings, J., Stalin, C. S., Subramaniam, A., 2017, Current Science, Vol. 113, No. 4, pp. 583–586.
Ultraviolet Imaging Telescope on AstroSat

[120] *Thomas, A. D., et al. (including Shastri, P. and Sairam, Lalitha), 2017, The Astrophysical Journal Supplement Series, Vol. 232, Issue 1, 11.
Probing the Physics of Narrow-line Regions in Active Galaxies. IV. Full Data Release of the Siding Spring Southern Seyfert Spectroscopic Snapshot Survey (S7)

[121] *Tripathi, D., et al. (including Banerjee, D.), 2017, Current Science, Vol. 113, No. 4, pp. 616–619.
The Solar Ultraviolet Imaging Telescope on-board Aditya-L1

[122] *Tripathy, S. C., *Jain, K., *Kholikov, S., *Hill, F., Rajaguru, S. P., *Cally, P. S., 2018, Advances in Space Research, Vol. 61, Issue 2, pp. 691–704.
A study of acoustic halos in active region NOAA 11330 using multi-height SDO observations

[123] Vasundhara, R., Selvakumar, G., Anbazhagan, P., 2017, Monthly Notices of the Royal Astronomical Society, Vol. 468, Issue 1, p. 501–508.
Analysis of mutual events of Galilean satellites observed from VBO during 2014–2015

[124] Vemareddy, P., 2017, The Astrophysical Journal, Vol. 845, Issue 1, 59.
Successive Homologous Coronal Mass Ejections Driven by Shearing and Converging Motions in Solar Active Region NOAA 12371

[125] Vemareddy, P., 2017, The Astrophysical Journal, Vol. 851, Issue 1, 3.
Contribution of Field Strength Gradients to the Net Vertical Current of Active Regions

[126] Vemareddy, P., *Gopalswamy, N., Ravindra, B., 2017, The Astrophysical Journal, Vol. 850, Issue 1, 38.
Prominence Eruption Initiated by Helical Kink Instability of an Embedded Flux Rope

[127] Venkatakrishnan, P., et al., 2017, Current Science, Vol. 113, No. 4, pp. 686–690.
The Multi Application Solar Telescope

[128] Vidhya, G., Pravabati., C., 2017, Journal of Cosmology and Astroparticle Physics, Issue 06, article id. 023.
Tensor Minkowski Functionals: first application to the CMB

[129] *Virgilli, E., et al. (including Valsan, Vineeth.), 2017, Journal of Astronomical Telescopes, Instruments, and Systems, Vol. 3, No. 4, 044001.
Expected performances of a Laue lens made with bent crystals

3.2 Conference Proceedings

[130] Mageshwaran, T., Mangalam, A., 2017, *New Frontiers in Black Hole Astrophysics*, Proceedings of the International Astronomical Union, IAU Symposium, Vol. 324, pp. 134–135.

Accretion and wind dynamics in tidal disruption events

[131] Muthumariappan, C., 2017, *Planetary Nebulae: Multi-Wavelength Probes of Stellar and Galactic Evolution*, Proceedings of the International Astronomical Union, IAU Symposium, Vol. 323, pp. 359–360.
3D morphology of the PN IRAS 18333-2357

[132] Raju, K. P., 2017, *Living Around Active Stars*, Proceedings of the International Astronomical Union, IAU Symposium, Vol. 328, pp. 110–112.
Studies of synoptic solar activity using Kodaikanal Ca K data

Table 3.1: **Number of publications over the past five years**

Year	Published in Journals	Published in Proceedings	Total
2013–14	103	16	119
2014–15	128	29	157
2015–16	120	31	151
2016–17	106	23	129
2017–18	129	3	132
Total	586	102	688

3.3 Technical Reports, Monographs, Circulars, ATel

[133] Muneer, S.; Anupama, G. C.; Rao, S. Venkateswara; Sagayanathan, K.; Raj, Ashish; Pavana, M., 2018, ATel, 11333.
BVRI polarimetry of PNV J16484962-4457032

3.4 HCT Publications by non-IIA Users

[134] Dutta, S., Mondal, S., Jose, J., Das, R. K., 2017, *Stars: From Collapse to Collapse*, edited by Yu. Yu., Balega, D. O., Kudryavtsev, I. I., Romanyuk, and I. A. Yakunin. ASP Conference Series, Vol. 510, 85.
Stellar Population and Star Formation History of the Distant Galactic H II Regions NGC 2282 and Sh2-149.

[135] A. Paswan., A. Omar., S. Jaiswal., 2018, Monthly Notices of the Royal Astronomical Society, Vol. 473, Issue 4, pp. 4566–4581.
Tidal interaction, star formation and chemical evolution in blue compact dwarf galaxy Mrk 22

[136] Sharma, S., et al., 2017, Monthly Notices of the Royal Astronomical Society, Vol. 467, Issue 3, pp. 2943–2965.
Stellar contents and star formation in the NGC 7538 region

4
Instruments And Facilities

4.1 System Engineering Group (SEG)

The System Engineering Group (SEG) is supporting major activities of the Institute like infrastructure creation, involvement in scientific projects related to ground- and space-based instrumentation and their maintenance activities. The SEG consists of engineers with technical staff belonging to Electronics, Mechanical, Electrical, Civil and Optics Divisions who provide support in the design, development, operation and maintenance of telescopes, their instruments and peripherals.

Some of the major activities that were carried out by the SEG during the year 2017–18 are noted below:

The optics division was involved in the works related to Thirty Meter Telescope (TMT) such as conceptual design of the High Resolution Optical Spectrograph (HROS), Micro Lenslet Array (MLA) for TMT WFOS, telecentric optics for fiber interface, TMT primary mirror segmentation design and rectangular mirror polishing for TMT M1 hexing process development.

Optics division was also involved in the Prototype Segmented Mirror Telescope (PSMT) mirror polishing, development of toroidal mirror for the ITER X-ray Survey spectrometer, development of sunshield panels for Passive Radiant Cooler for INSAT 3DS Payloads of ISRO.

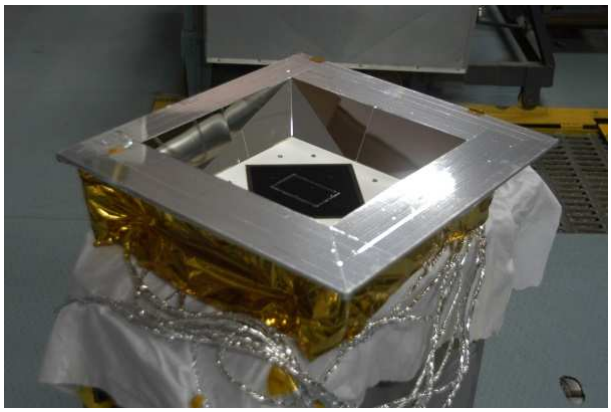


Figure 4.1: Polished sunshield panels integrated into detector well.

The BC 300 coating plant which can carry out multilayer (four) coating of thin film material on an optics of 6-inch diameter at IIA, Bangalore and 60-inch coating plant at VBO, Kavalur was serviced.

The installation and commissioning of a new vacuum coating plant for 2-m the HCT mirrors at IAO, Hanle was carried out this year.

Figure 4.2: *Left:* Conventional grinding and polishing of PSMT mirror with the existing G&P machine at photonics lab. *Right:* The interferogram captured in Ranchi test.

The Electronics and Instrumentation division was involved in the camera development using CMOS STAR250, operation of the UVIT payload, the collaborative programme of UV-sensor Readout Development for UV Sensor with CENSE-IISc Bengaluru, VBT Coating Plant Renovation (hardware & Firmware), the electronics package of VELC-ADITYA L-1, development of HCT Data Acquisition System etc. The fabrication and characterization of LPD antennas, RF analog front end modules and digital backend receivers were completed successfully very recently. The installation work at KSO shall be taken up shortly and trial observations with Sun and other calibrator sources shall follow after that. The solar limb image tracking system for the tunnel telescope at Kodaikanal Solar Observatory (KSO) is also in progress and nearing completion and the control software work is being worked out. The HCT data archive design, planning and execution of web frame work is almost completed and tested.

IIA received third prize in appreciation of the early commissioning of 100 KW Solar roof top power plant under industrial category, in the jurisdiction of Bangalore Electric Supply Company (BESCOM), Govt of Karnataka during 2016–17 at the event of Power Awards Function 2017 held at Bangalore Palace, Bangalore on 28th October 2017. Electrical engineering section is involved in the procurement, installation and maintenance of this system. The Electrical engineering section is also involved in the upgradation of the MV Panels, replacement of distribution panels and associated wiring/ switching accessories in the main and annexe buildings of IIA, Bengaluru Campus. The electrical works at Gauribidanur Hostel Building was completed successfully.

The mechanical engineering division was involved in the design and development of the opto-mechanical structure for VELC-Aditya 1, fabrication and installation of sliding roof and housing enclosure for Hα Telescope at Merak, design of Maunakea Spectroscopic Explorer (MSE)- primary optics system (M1), National Large Optical Telescope (NLOT)- mechanical systems and analysis of Prototype Segmented Mirror Telescope (PSMT), prototyping of the sub-systems of the primary mirror of the Thirty Meter Telescope (TMT) like Segment Support Assembly (SSA) at various industries in the country, Space Instrumentation work and regular maintenance of telescopes, domes and peripheral systems at VBO, Kavalur and IAO, Hanle, construction of AC plant room and installation of new PAC unit synchronised with old PAC unit for the Echelle Spectrograph of the Vainu Bappu Telescope (VBT). Engineers were also involved in the design of the opto mechanical system of the Visible Emission Line Coronagraph (VELC) design and studies of the existing SSA for the primary mirror (M1) of TMT.

The civil engineering division was involved in the construction of India TMT Optical Fabrication Facility (ITOFF) Building at CREST, Hoskaote, completion of Raman Science building at Leh in August 2017. The India TMT Coordination Centre

(ITCC) office extension works, construction of SECMOL type staff accommodation at Hanle, Ladakh and construction of hostel accommodation at Gauribidanur observatory were also carried out during this current year.

4.2 Observatories

4.2.1 Indian Astronomical Observatory

Himalayan Chandra Telescope (HCT)

The HCT offers imaging and low resolution spectrocopy in optical and near infrared (NIR) region. It also offers high resolution spectroscopy in optical region. The available suit of instruments and the fact that they are always mounted at the telescope and can be switched very easily, several science cases where near simultaneous monitoring in optical and NIR is required, are proposed. This resulted in increased demand of observing time. For 2017-Cycle-02 (2017 May – August) 44 proposals, 2017-Cycle-03 (2017 September – December) 40 proposals and 2018-Cycle-01 (2018 January – April) 46 proposals were received. The telescope time was oversubscribed by a factor 2.5 on an average, while the dark moon period was oversubscribed by a factor 3.

To keep the downtime of the HCT to a minimum, the preventive maintenance activities of HCT are carried out on monthly basis, around full moon period. During the monthly preventive maintenance, telescope and instruments were inspected and its components were cleaned. All the telescope related calibrations and look-up tables were updated periodically. Annual maintenance of the HCT was carried out during August 1–15, 2017. A thorough inspection and performance evaluation of various optical, mechanical, electrical and electronics components were carried out. A team of engineers from IAO and HCT astronomers participated in these activities.

The process for upgrading the drive of the secondary mirror and the telescope control system of the HCT is initiated. The CCD mounted with HFOSC instrument is in use since 2002. A new 2K $\times$ 4K CCD was procured for integrating it with the HFOSC instrument. During the annual maintenance, the new CCD was mounted at HFOSC and its operations were checked. The CCD was found to be working well. As and when the need arises the new CCD will be attached to the HFOSC instrument.

The NIR instrument, TIRSPEC available with the HCT uses a Teledyne 1024 $\times$ 1024 pixel Hawaii-1 PACE array detector with a cutoff wavelength of 2.5 micron. The instrument will complete $\sim$ 10 years from inception and it is expected that the focal plane array will be degraded in performance. Since this instrument is otherwise of world class design, by replacing the focal plane array with the latest available, the life and usefulness of the instrument for doing competitive science can be increased substantially. Therefore it is planned to upgrade the instrument to a fast readout science grade array Hawaii-1RG (H1RG) during this plan period. The new array controller would have 16 channels using the new PCIe interface board. The motor code and the operating system will also be upgraded to a newer version. TIRSPEC would then be upgraded in a state where it is a complete system with array, mounts cabling, controller and computer which will increase the life of the instrument.

Installation of New coating Plant at IAO Hanle

A new coating plant was installed at IAO Hanle by Hind High Vacuum Company Pvt. Ltd (HHV) with support and technical help from IAO and IIA staff in the month of August 2017. The system is configured for sputter deposition of Aluminium on a substrate while maintaining the vacuum conditions throughout the process. The vacuum chamber is constructed with two halves which are basically two tori-spherical dished ends with flange welded with suitable hooks, view port for viewing of deposition process and suitable ports for mounting of Magnetron, Ion bombardment gadgetry, whiffle tree, vacuum measuring gauges and ports for connecting vacuum line. The vacuum chamber is pumped with combination of rotary pumps, roots pumps and turbo molecular pumps to achieve the high pumping and vacuum better than 1×10^{-6} mbar.

Figure 4.3: Fully installed coating plant.

HImalayan Gamma Ray Observatory (HIGRO)

[1] **MACE**
Installation of mechanical structure of the 21-m diameter Major Atmospheric Cherenkov Experiment (MACE) telescope being developed by BARC is completed. Azimuth and elevation drive systems of the telescope were tested and are in operational mode. Camera housing is mounted on the boom and the camera related equipment are installed and tested for operation. A total of 18 nos of Camera integrated modules are installed in the camera housing. Painting of the telescope is in progress. Actuators and mirror panels are received at the site for further installation. Installation of Camera parking shelter is in progress.

Figure 4.4: MACE getting ready.

[2] **HAGAR**
The High Altitude Gamma Ray (HAGAR) observatory, operated jointly by IIA and Tata Institute of Fundamental Research (TIFR), Mumbai, has been in regular use since 2007. The telescope array has been used for monitoring supernovae remnants, active galactic nuclei and other interesting gamma-ray sources.

Earth Sciences, Atmospheric Physics related activities

Due to its topography and pristine high-altitude location, IAO-Hanle provides an opportunity to carry out research in the field of Atmospheric Physics and Earth-Science. Scientific research in these fields, carried out at Hanle includes - (i) characterization of regional aerosols incorporating the heterogeneity in space, time and spectral domains and its impact on regional and global climatology (under the Aerosol Radiative Forcing over India (ARFI) project of ISRO-GBP), (ii) studies of greenhouse gases, kinematic and structural deformation inside the earth's crust using GPS network over the region (under a joint MoU between IIA and CSIR Fourth Paradigm Institute, Formerly CSIR CMMACS, Bangalore). A sky radiometer, installed at IAO-Hanle, in collaboration with IIA, Raman Research Institute (RRI) and University of Tokyo during early 2000, to study atmospheric transparency at 220 GHz is made operational. The Hanle site has many potential qualities for calibration of several instruments used in the large network for aerosol studies such as AERONET (https://aeronet.gsfc.nasa.gov/) and SKYNET (http://atmos3.cr.chiba-u.jp/skynet/). Since the site is located in the periphery of Tibetan Plateau and Trans-Himalaya, studies of earth-crust, plate tectonic movement are major thrust area for Earth-Science research.

NLST related activities at Merak

Hα Telescope: The Indian Institute of Astrophysics (IIA) has procured two telescopes along with two Lyot Hα filters from the Nanjing Institute of Astronomical Optic & Technology (NIAOT), China in 2011. One of the telescopes was installed at the Kodaikanal observatory in October, 2014. The second telescope and its enclosure were installed during July–August, 2017 at the Merak village, in the incursion site of Pangong Lake by the team from IAO, and IIA Bangalore. Merak village is located about 150 km away in S–E direction from Leh Town.

The telescope installed at the Merak site has 20.06 cm doublet lens as an objective which makes an f/7.9 beam. This beam is collimated by another doublet of size 5.2 cm and a focal length of 18.94 cm. The light from the collimator is refocused by a re-imaging lens of size 5.8 cm and effective focal length of 25.6 cm. The final image size is about 2.1 cm for a 32 arcmin field-of-view (FOV). The Hα filter (of Lyot type) is kept in the collimated beam. A combination of lenses with an effective focal length of 16.52 cm is placed after the re-imaging lens to obtain the magnified view of the Sun. The CCD camera used to image the solar chromosphere has pixel size of about 7.5 micron, which corresponds to 0.27 arcsec in high resolution mode and 0.67 arcsec in low-resolution mode.

The guider telescope is made up of a 10 cm objective lens with an effective focal length of 174.3 cm. The lens is cut into four quadrants and each quadrant makes a solar image with partial images overlapping each other. The central portion of the overlapping part of the image is dark. A CCD camera with 756×562 pixels is kept in the dark portion of the overlapped image. Any shift in the Sun's image due to tracking or shaking will produce an error signal which is amplified and fed back to the telescope.

Movable Shelter & Pier: The telescope pier was erected in the year 2016 at Merak site. The pier height was kept 0.9 m above the ground level. The telescope shelter is made out of thin iron sheets and attached to steel structures. Next to the telescope shelter, a small room was built for keep-

ing the telescope control system as well as data acquisition system. The telescope shelter is movable on rail in the N-S direction. The overall shelter and room dimensions are about 4-m high, 3.2-m long and 4.8-m wide. During the solar observations, the dome can be moved out completely from the telescope pointing direction.

Telescope Installation: The civil work related to pier, wall and control room was completed during 2016 August/September. In 2017 August, the rail for dome movement, movable dome and a shelter for the control room was installed. The telescope installation was completed, and first light images were obtained on 31 August 2017.

The telescope can make the images at low-resolution and also at high-resolution. After the installation of the telescope, the team tested the tuning capability of filter unit by scanning the Hα line profile. This has been done by using the stepper motor control unit.

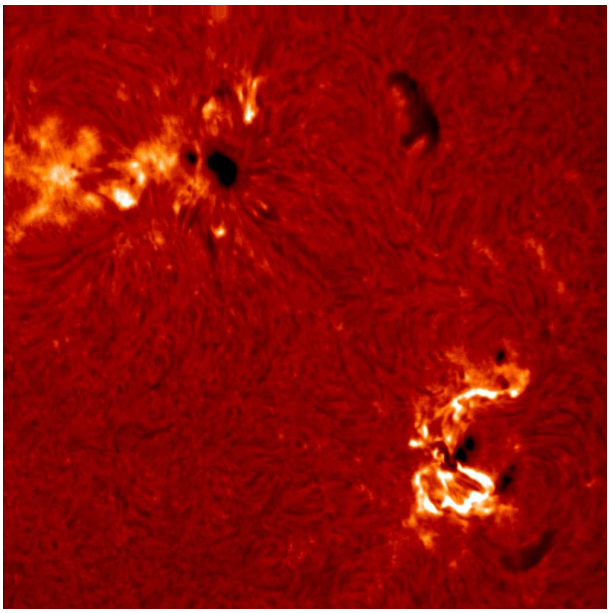


Figure 4.5: Hα observations of a sunspot active region on 2017 September 6 at ∼04:26 UT.

In this telescope, several parts of the control electronics, software and GUI are developed by IIA team. The telescope pointing system, tracking software and guiding control software were developed by IIA team in *Visual Basic*. The telescope is functioning well at Merak and the Sun′s chromospheric images were obtained in Hα wavelength regularly.

Daily images are uploaded to the Institute webpage after appropriate data calibration. In addition to scientific investigations, the data obtained are also used to monitor the seeing conditions in the site.

Civil Activities

[1] Raman Science Center, Leh

Figure 4.6: Raman Science Center at Leh.

Raman Science Center, Indian Astronomical Observatory, Leh was successfully completed in August 2017. Building architecture is based on green building technique, south faced solarium warms up space inside the building, outer walls are well insulated to retain heat. The building has various amenities like roof top observatory, museum, 12 room guest house, office space, conference room, library, kitchen and dinning

space. The basement is used for battery bank and parking. The roof top space is planned to be used for installing SPV panel. The building was occupied in September 2017.

[2] **Staff Accommodation at IAO Hanle**

Figure 4.7: Staff accommodation at IAO, Hanle.

A three rooms staff accommodation, based completely on south facing Solar Passive Rammed earth building technique was completed and occupied in September 2017. Since rammed earth is freely available around the region, the process negates any consumption of energy for preparation, transport or building. The thick walls protect the inner space from external fluctuations of temperature because of its thermal inertia thus making the building cooler in summer and warmer in winter.

4.2.2 Centre for Research and Education in Science and Technology (CREST)

The VSAT dish antennae are used to establish point-to-point dedicated satellite link between CREST Campus, Hoskote and Hanle. This link is used for communication, remote operation and transfer of the observed data. The existing antennae at CREST and Hanle are quite old and not repairable, so they are being replaced with new set of antennae.

Figure 4.8: India-TMT Optics Fabrication Facility is under construction and is expected to complete by October 2018.

The work related to the construction of Optics Fabrication Facility for segmented mirrors polishing for TMT project is progressing well. The Civil structural work is almost complete and services such as lift, HVAC, electrical, CCTV, fire fighting etc. are being installed. A separate power house to cater the needs of TMT related activities, with capacity of 750 KVA is planned and the civil work is under progress.

Security in the CREST Campus is strengthened by providing street light and installing CCTV Camera. Street lighting is provided all around the campus using 85 polls with LED light fixtures. CCTV cameras have been installed with 6 NVRs (Network Video Recorder), with storing capacity of 20–25 days.

The existing analogue intercom exchange is planned to be upgraded. For this a high end model of IP based telephone exchange

has been procured and its installation is under progress. To improve the internet connectivity in the campus a 10 MBPs fiber link is approved and the work will commence soon.

The Green House Gas (GHG) station installed by CSIR–Institute of 4–Paradigm (4PI), Bengaluru, in the CREST Campus Hoskote is working well. This station is also used as a reference station for calibration of the GHG instruments and secondary cylinders set up in the country, with the primary cylinders supplied by NOAA, USA. The GHG instruments from National Atmospheric Research Laboratory (NARL), Gadanki were calibrated at GHG station CREST.

The Hon'ble Minister, Dr Harsh Vardhan, Minister of Science and Technology, visited CREST campus on February 20, 2018. He was shown the 2-m HCT and its operation through the video link. He expressed keen interest in the recent science observations carried out using the facility. The Minister interacted with the scientists and students at CREST campus and engineers at Hanle. He also visited M. G. K. Menon Laboratory and the India-TMT Optics Fabrication Facility at CREST Campus.

Figure 4.9: The Hon'ble Minister, Dr Harsh Vardhan interacting with the scientists at CREST campus.

Figure 4.10: The Hon'ble Minister, Dr Harsh Vardhan planting a sapling in front of India-TMT Optics Fabrication Facility.

Sky Conditions at Indian Astronomical Observatory, Hanle, Ladakh

Year	Month	Photometric nights	Spectroscopic nights	Total nights
2017	April	22	24	30
	May	10	15	31
	June	8	12	30
	July	5	10	31
	August	16	16	31
	September	19	21	30
	October	28	28	31
	November	26	28	30
	December	19	25	31
2018	January	24	26	31
	February	13	19	28
	March	18	21	31
	Total	208 (57%)	245 (67%)	365

4.2.3 Kodaikanal Observatory

Whitelight Active Region Monitor (WARM)

The WARM is a two-channel, full-disk, simultaneous solar photospheric and chromospheric imaging system. The photospheric observations are in the 430.54 nm wavelength (passband ∼0.8 nm) and the chromospheric observations are in the 393.3 nm wavelength. The calibrated images are used to derive details about the sunspots and plages. The telescope is fitted with a new, and comparatively maintenance free stepper motor system. The stepper motor (model: T57H76-2804 from Tiny Controls Pvt. Ltd.) was chosen based on the required torque and motor speed. Observations indicate that tracking is smooth and as per the expected requirements. Similarly stepper motor and drive systems have been introduced for the Right Ascension (R.A.) and Declination (Dec.) axis control also. For smooth adjustment of images, fine speed of ∼3 rpm has been introduced. For coarse adjustments, a speed of ∼33 rpm has been introduced. The necessary worm and pinion wheels were fabricated in-house. The motor speed frequency is generated on the PIC micro controller from DSPIC33FJ32GP302 (Microchip), and a 16-bit controller is used. Bi-directional I/O port has been configured for the direction selection, enable/disable, and the number of pulses. Max3232 IC is used for UART communication with the control PC. GUI developed in *Visual Basic* (VB) is used for controlling the motor speeds. It will communicate with the PC and the controller board via serial communication. The software can control either all the 3 operations (i.e. tracking rate, R.A. and Dec.) simultaneously or independently.

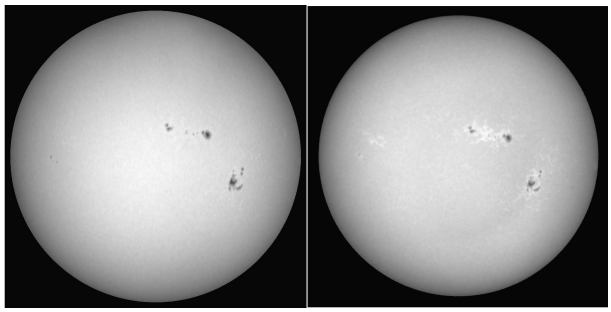


Figure 4.11: Level-1 calibrated G-band (*Left*) and Ca-K image (*Right*) obtained with the WARM telescope on 2017 September 6 at ∼02:02 UT.

Spectropolarimeter with the Kodaikanal Tunnel Telescope (KTT)

The new spectropolarimter in KTT was commissioned for observations in January 2018. The main aim of this polarimeter is to carry out spectropolarimetric observations of the solar active regions in Ca II (854.2 nm) and Hα (656.28 nm) to measure the chromospheric magnetic field. An auto-guiding system has been built and installed at KTT for this work. The principle of this auto-guiding system is to calculate the image drift from the images recorded at a selected interval and correct for the drift by tilting the second mirror of the coelostat system accordingly. The images are recorded by a CCD camera fed by a dichroic-beam-splitter placed in the path of the beam. The dichroic-beam-splitter transmits wavelengths > 600 nm, and reflects wavelengths < 600 nm. The transmitted beam goes to the spectrograph, and the reflected beam to the imaging camera.

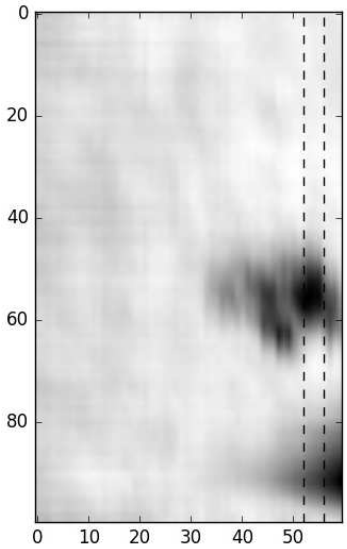


Figure 4.12: Raster image of the active region NOAA12706 in continuum obtained with the KTT spectropolarimeter.

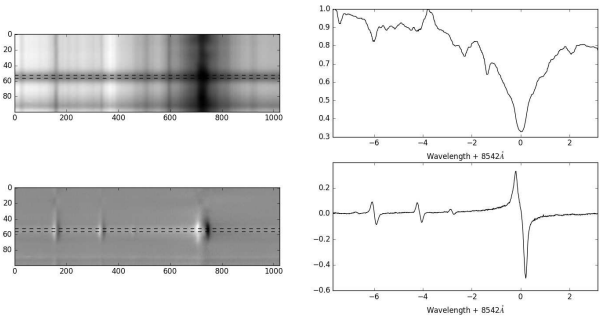


Figure 4.13: The left panel shows the Stokes I and V images of the solar active region NOAA12706 obtained using the KTT spectropolarimter. The corresponding Stokes profiles are shown in the right panel.

Radio spectral observations

A radio spectrograph antenna system is installed at KSO to enable multiwavelength studies of solar flares in conjunction with Hα observations.

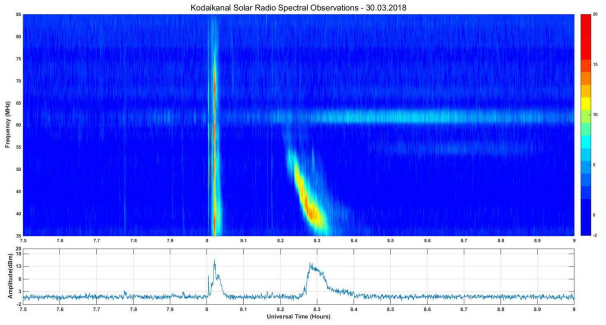


Figure 4.14: Spectrum and integrated light curve of the type III and type II solar radio bursts observed with the Kodaikanal radio spectrograph on 2018 March 30 at ∼08:00 UT and ∼08:12 UT, respectively. The bright horizontal band of emission in the spectra close to 60 MHz are due to local radio frequency interference (RFI).

Winter School on Solar Physics

The third Kodaikanal Winter School on Solar Physics was conducted during 2018 January 7–12 at the Kodaikanal Solar Observatory. The participants were mostly first and second year MSc (Physics/Mathematics/Astronomy) students, with a few from the engineering stream. A total of 37 students (selected from about ∼300 applications received) participated in the school. The school programme consisted of a series of classroom lectures covering various topics on Solar Physics as well as hands-on observations, data reduction and analysis. Most of the instructors were from IIA. In addition, there was one instructor from ISRO and another from the University of Sheffield, UK to deliver lectures on few specialized topics. The school was well appreciated by the participants.

Figure 4.15: Group photograph of the participants of the Winter School on Solar Physics held at the Kodaikanal Observatory during 2018 January 7–12.

Sky conditions: Kodaikanal

Year	Month	Number of Observations					Seeing conditions*				
		6″ Refractor	WARM Telescope		H-alpha	Tunnel Telescope	5	4	3	2	1
		PHGM	G-band	CaK							
2017	April	32	27	28	29	7	10	10	4	-	4
	May	20	26	26	26	-	10	10	3	-	3
	June	13	-	-	15	4	-	6	5	2	2
	July	18	11	11	17	4	6	5	-	4	3
	August	9	18	18	3	-	4	8	-	6	1
	September	12	7	7	-	-	7	5	-	-	-
	October	18	-	-	-	-	5	4	4	5	-
	November	12	-	-	11	-	4	3	2	3	-
	December	26	-	-	26	-	7	10	3	6	-
2018	January	21	25	18	27	3	11	10	4	-	2
	February	28	27	27	26	13	10	13	2	-	2
	March	21	25	25	21	13	10	8	4	3	-
	Total	230	166	160	201	44	84	92	31	29	17

PHGM: Photoheliograms observed through 6-inch telescope.
*Seeing conditions (1-very poor, 2-poor, 3-fair, 4-good, 5-excellent)

4.2.4 Vainu Bappu Observatory

Speckle Interferometer at the VBT

The speckle interferometer has been revamped and recommissioned successfully at Vainu Bappu Telescope in November 2017.

The revamping included the following activities: (a) Aligning and testing of the instrument in the laboratory at IIA with f/13 beam simulator. A fiber-optic halogen light source was collimated and focused again to achieve the required f/13 beam. (b) The instrument was then tested on sky on 30-inch telescope with a new spacer assembly and a spare Retiga camera from Q-imaging. It was found that although imaging was feasible, only bright targets up to magnitude of two could be observed with short exposures. (c) The instrument was then recommissioned on VBT with original spacer assembly and an ANDOR EMCCD, allowing observations of stars up to fifth magnitude under favorable, clear observing conditions. The field-selector mirror providing an on-axis circular field-of-view of $\sim$ 2.38 arcsec was removed from the original instrument. The current field-of-view is $\sim$ 9.6 $\times$ 9.6 arcsec^2 and is limited by the size of the detector.

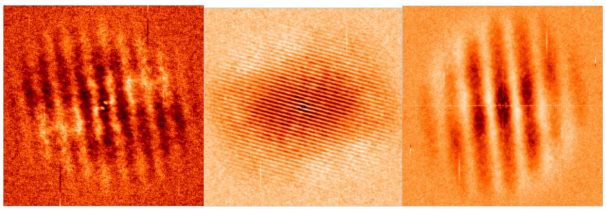


Figure 4.16: Fourier power spectra obtained from speckle images of HR 1497 (*Left*, V=4.3), HR 1788 (*Middle*, V=3.3) & HR 1931 (*Right*, V= 3.8) indicating binary nature with separations of 0.4 arcsec, 1.8 arcsec and 0.28 arcsec respectively.

A 70 Å bandpass filter centered at Hα is currently being used for imaging. The instrument can be used for observing close binary stars (with sub-arc-second angular separation) at multiple epochs and deduce/refine the orbital parameters. It can also be used for imaging extended near-earth objects and isolated giant stars with dynamic circumstellar envelope. The current system of manual guiding will be replaced with auto-guider after installing an alternate field selector unit.

The calibrated power spectra of a few representative binary targets indicate the binary nature of these targets in the fringe patterns. It has been possible to achieve resolution up to 0.3 arcsec on clear nights with seeing better than 2.5 arcseconds.

Drift Scanning using Frame Transfer CCD

A novel method was attempted to obtain drift scanning data by using a frame transfer CCD at JCBT; the telescope track rate was reduced so that the star drift time across one row (or column) is equal to the read out time of ProEM CCD operated in frame transfer mode at 5 MHz. In the conventional drift scanning (TDI) method, the telescope is kept fixed without tracking (or even at reduced track rate), the charges in the CCD are shifted across the rows (parallel shifted) at the same rate as the drift rate of the sky. The strips of sky as limited as memory of acquisition system could be recorded with effective exposure equal to the time taken by any object to drift across the CCD chip.

In the new method the read out time of one frame (without binning) is 223 milliseconds, which is drift time for any object across one row/column. The telescope reduced track rate is the difference of this rate with normal 15 arcsec/second drift. Since the

acquisition is in frame transfer mode, the object transits by one row/ column in successive frames. These corresponding rows/ columns are co-added to produce a resultant frame. A module in TrueColor package (JAVA image analysis software) was added to reduce SPE frames of ProEM CCD.

This was attempted initially as a project for a Summer school student for Asteroid survey purpose. Known Asteroids around zero declination were first considered. The factor cos(dec) was not initially included and stars trailed; to avoid this and for better SNR, 2×2 binning was used resulting in maximum addition of 512 rows/ columns. The effective exposure of the resultant frame is about 58 seconds. A 16.6 magnitude asteroid could be deducted with 128 columns addition (number reduced to avoid star trailing). Further investigation and using EM mode may help to reach fainter limit for this kind of survey. The ProEM was mounted with the E–N direction along row which is not a constraint for the experiment.

Sky conditions at VBO

The following table gives the summary of night sky conditions for the months April 2017 to March 2018. The columns list the number of nights having 2 or more continuous hours and 4 or more continuous hours of nights classified as fit for spectroscopic or photometric studies. It is to be noted that for nights classified as "photometric" the sky has to be fully clear for the stated number of hours.

Year	Month	Spectroscopic Hours		Photometric Hours	
		2 hrs or more	4 hrs or more	2 hrs or more	4 hrs or more
2017	April	23	19	0	0
	May	16	11	2	2
	June	6	2	1	0
	July	6	2	1	0
	August	2	0	0	0
	September	4	0	0	0
	October	5	1	0	0
	November	6	5	0	0
	December	19	14	6	4
2018	January	26	22	4	4
	February	24	23	15	15
	March	21	19	8	8
Total (nights)		158	118	37	33

4.2.5 Gauribidanur Radio Observatory

Spectropolarimeter upgrade using Reconfigurable Open Architecture Computing Hardware (ROACH) and iADC

Last year we commissioned a wide-band digital spectrometer backend for the Gauribidanur Low frequency Solar Spectrograph (GLOSS) to observe the radio signatures of the solar transients in the frequency range ∼40–440 MHz with high spectral and temporal resolution. This system was used for regular observations from July 2017 onwards. On a daily basis it generated dynamic spectra of radio emission from the Sun over the above frequency range in total intensity (Stokes I). The transients observed with this system were found to have better signal-to-noise (SNR) ratio compared to those observed simultaneously with the existing conventional analog spectrum analyzer. To improve the capability, and to obtain spectra of the circularly polarized emission (Stokes V) also, we are currently working on the development of new digital backend for the Gauribidanur RAdio SpectroPolarimeter (GRASP) using ROACH-1 board and iADC. This FPGA based spectro-polarimeter has the ability to observe the Stokes parameters (I & V) with high temporal (∼100 msec) and spectral (∼100 KHz) in the frequency range ∼40–440 MHz. A special 10 Gbe Ethernet packetizer has been designed and verified for data acquisition with this system. The system is currently in the calibration phase. Software for the display of the spectra in real-time, and control software have been developed using the Python language.

Gauribidanur RAdioheliograPH (GRAPH) augmentation

Figure 4.17: Assembling of the LPDA in the Gauribidanur observatory.

Phase-II of the GRAPH augmentation work is in progress. Fabrication of 128 Log Periodic Dipole Antennas (LPDAs), low-noise amplifiers, radio frequency (RF) filters, power combiners, beamformers (to steer the antenna response to the desired direction in the sky in steps of 3.25 nsec delay between the arrival time of the wavefronts from the source on the different antennas in the array) are being carried out locally in the Gauribidanur observatory.

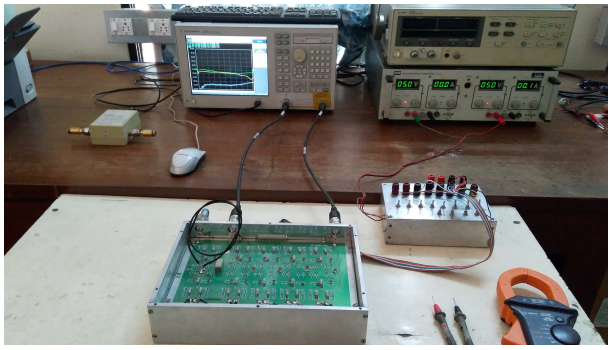


Figure 4.18: The beamformer (the PCB within the aluminium box in the foreground) and the characterization of the same using Vector Network Analyzer (VNA) and other electrical accessories.

In addition to the above, work is also going on to lay RF cables (below the ground at a depth of ∼1 m to minimize the effect of diurnal variations on the characteristics of the cable) for signal transmission from the antennas to the receiver room over a distance of ∼1 km. Each LPDA has 19 'arms' (individual dipoles corresponding to different frequencies in the range ∼120–30 MHz). The collecting area of each LPDA is ∼50 sqm at a typical frequency like 30 MHz, and it scales as the square of the wavelength. The gain of each LPDA is ∼8 dBi (with respect to an isotropic radiator), and is nearly constant in the above frequency range. The half-power width of the radiation/reception pattern of each LPDA is ∼60 deg in the E-plane (i.e. the plane parallel to the 'arms' of the LPDA) and ∼100 deg in the H-plane (i.e. the plane perpendicular to the 'arms' of the LPDA). The front-to-back ratio (i.e. the ratio of the maximum amplitudes of the response pattern of the LPDA in the forward and backward directions is ∼30 dB). Note that the response of the LPDA in the backward direction should be as minimal as possible so that the 'confusion' due to reflected radiation from the ground will be less. In the present case the amplitude of the response in the backward direction is less by a factor of ∼1000. This is comparable to the performance of the commercial LPDAs.

Radio Monitoring System

We have recently developed a data pipeline for GLOSS database system. A set of Python codes and Linux shell scripts convert the raw native binary format to FITS format. The FITS data will be transferred to the local server and an automated copy routine place the data into the international network (located in the Paris Observatory) on daily basis. Observations from different instruments are compiled and the composite spectra are generated and displayed on the website http://secchirh.obspm.fr/select.php. The descriptions of the different instruments can be found at http://secchirh.obspm.fr/instruments.php.

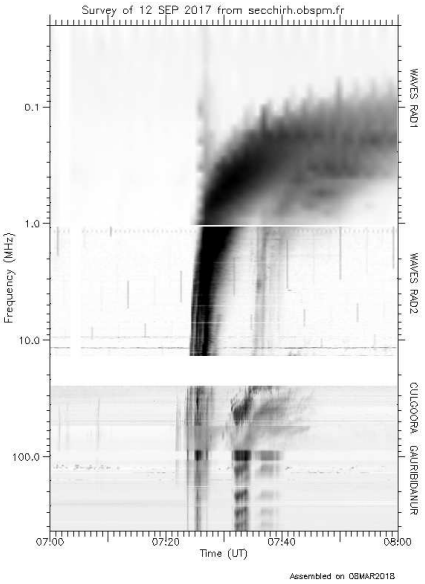


Figure 4.19: Composite radio spectra of a solar transient observed on 2017 September 12. The frequency range is ∼20 kHz–440 MHz. The upper two panels correspond to observations in the frequency range 20 kHz–14 MHz with the radio spectrographs (RAD1 and RAD2) onboard the WIND spacecraft. The lower two panels correspond to ground based radio spectral observations (∼14 MHz–440 MHz) from Culgoora and Gauribidanur observatories.

Radio observations of the solar chromosphere

A new observational facility has been set-up in the Gauribidanur observatory for daily observations of the Sun at ∼11 GHz using commercially available low cost TV dish antennas in total power mode to investigate the transient activities in the upper solar chro-

mosphere from where radio emission at the above frequency typically originates in the Sun's atmosphere. We could also successfully observe the radio emission from the "background" Sun during periods when there were no transient solar activity. A mechanical arrangement was designed in-house at Gauribidanur observatory for changing pointing of the dish with respect to the declination of the Sun. The Low Noise Block (LNB), i.e. the feed for the TV dish antenna is capable of receiving signals in the Ku-Band from 10.7–11.7 GHz. The LNB down converts this RF signal by 'mixing' with a local oscillator (LO) signal at 9.75 GHz to generate the intermediate frequency (IF) signal over the band 950–1950 MHz. The power spectrum of the latter are presently displayed using a commercial spectrum analyzer. The data corresponding to the display is recorded in a computer using a data acquisition interface between the computer and the spectrum analyzer.

Figure 4.20: The commercial dish TV antenna used for radio observations of the Sun in the Gauribidanur observatory.

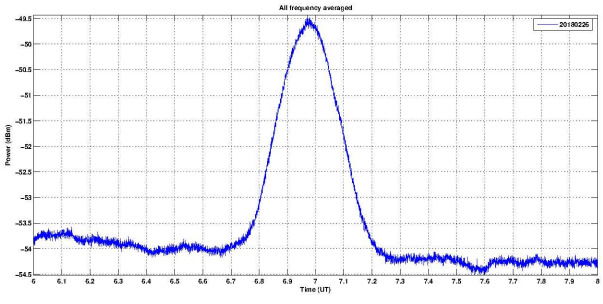


Figure 4.21: Drift scan of the Sun obtained on 2016 February 26 using a commercial dish TV antenna in the Gauribidanur observatory. The observations correspond to the frequency range 10.7–11.7 GHz.

4.3 Ultra-Violet Imaging Telescope (UVIT)

UVIT Payload Operation Centre (UVIT-POC)

The Ultra Violet Imaging Telescope (UVIT) is one of the five payloads onboard AstroSat launched by the Indian Space Research Organisation (ISRO) on 28 September 2015. The UVIT Payload Operation Centre (POC) at the Indian Institute of Astrophysics, receives UVIT data that gets dumped at the ground station from the Indian Space Science Data Centre (ISSDC). The data (Level 1) once received at the POC are processed to generate science ready Level 2 data products which are then transferred to ISSDC for archival and dissemination to the principal investigators (PIs). In addition to generating science ready products, the POC also (i) monitors the health of the payload on a daily basis using Engineering data received at the POC once every 24 hrs (ii) carries out regular calibrations (iii) carries out periodic release of the L2 processing pipeline and calibration database and (iv) develops software

tools that help the proposers in planning observations, and offline data analysis.

In addition to the above, POC is also involved in imparting training to potential users of UVIT to extract science information from data acquired with UVIT. UVIT-POC was part of two such workshops sponsored by IUCAA, Pune, one at the Aryabhatta Research Institute of Observational Sciences, Nainital during 08–11 August 2017 and the other at Christ (Deemed to be University), Bangalore during 14–16 December 2017. A two day meeting "Science with UVIT" was organised by the POC at IIA during 6–7 July 2017. Around 60 participants took part in the meeting and presented interesting results from UVIT. The second half of 07 July 2017 was devoted to discussions on a future UV mission. A workshop on optical and UV astronomical data analysis was organised at Sacred Hearts College, Challakudy on 06 January 2018, where half-a-day was devoted to UVIT data analysis.

Figure 4.22: Participants at the UVIT science meeting held at IIA during 6–7 July 2017.

Between the period 01 April 2017 and 31 March 2018, the POC has received data pertaining to 143 proposals requesting observations for a total 246 targets. Majority of the L1 data products received at the POC for the above period have been processed and sent back to ISSDC for release to the PIs. The POC is working in close co-ordination with ISRO on a daily basis to finish the analysis of the pending data and its subsequent release to ISSDC. The POC activities are supported by two research trainees (for data analysis) and one software trainee (for software development).

4.4 Computational Facilities

Computer Center Activities

All critical servers namely mail server, anti-spam server, web server, ERP server, computational servers etc., in the Data Center are kept up-to-date by upgrading the system and application software to its latest version and updating the system with latest security patches, to minimize the exposure to vulnerabilities. The firmware of all network devices viz., firewall, switches etc., are kept up-to-date on regular basis to mitigate security threats, if any.

The hardware infrastructures hosting the critical services are kept up-to-date by replacing the old servers/ hardware with new servers/ hardware when they are nearing their end of life. We have also augmented our internal network infrastructure at places within our campus to 10 Gig based on bandwidth demand for certain important projects. We have procured a new storage server to meet the data archiving demands of the users.

We have an ongoing computer trainee programme at IIA under computer division which imparts training to young engineers to provide system and application support to a wide range of users in IIA and skill them to be industry ready as a part of IIA's contribution to the socio-economic cause.

Computational Activities

An eight-node High Performance Computing (HPC) cluster has recently been procured and installed for the parallel computing community at IIA. As the HPC community at IIA is using this system heavily, we also have initiated an upgrade for this cluster. Institute is also procuring new servers to address the computing needs of sequential and Mathematica workloads.

Web Related Activities

IIA web services with latest CMS have been migrated to a new server. The new web server has been optimized for better performance with improved user interface design. The server has been implemented with better security features and centralized authentication for accessing the Intranet. As per the directive of Ministry of Finance, we are also publishing our tender enquiries, corrigenda thereon and details of bid awards on the Central Public Procurement Portal (CPPP).

ERP

We are using an Enterprise Resource Planning (ERP) software custom made for IIA, Bangalore and its various field stations. This consists of modules such as Human Resources, Accounting, Finance, and Purchase etc. Hardware infrastructure hosting the ERP software has been upgraded and optimized for better performance. The software has evolved over a period of time to include new reports as required for each module including indents and inventory.

4.5 Library

IIA library is one of the oldest Astronomy library in the world, and it acts as the primary learning resource centre for the Institute. Library houses one of the world's premier collections of books, journals, conference proceedings, databases, slides, charts, and theses in the fields of Astronomy and Astrophysics. In this academic year, we continued to strengthen the IIA Library to support the knowledge generation within our scientific community by enhancing the collection by procuring books, journals and e-resources at Bangalore, and other field stations. The library continued to be the member of National Knowledge Resource Consortium (NKRC) which helped the Institute to gain knowledge from 12 major publishers. The Library continues to provide e-mail based services like new additions of books & journals, reminder service, reservations, overdue intimation and reference service.

Document Delivery Services

IIA Library provides shared resources to support the IIA community's continuously evolving information needs. IIA library has an inter-library loan arrangement with all important government and semi-government academic institutions of India. The library responded to 78 interlibrary requests. Most of the interlibrary loan requests from scientists were taken care of using email, internet, and photocopier service. The library continued to use the facilities of IISc, RRI and other DST libraries for interlibrary loan requirements.

Digital Repository

IIA Digital Repository has the digitized scholarly publications of IIA and archival materials which is more than 200 years old. The repository collects, preserves, and disseminates in digital format the research

output created by the IIA research community. During the year, research articles, technical reports, PhD and MTech theses were uploaded to the repository. As on date, the total number of publications in the repository is 7089. As a content partner, it is also contributing to the public by sharing the metadata to the National Digital Library of India (NDLI) is envisaged as a National knowledge asset which will provide ubiquitous digital knowledge source. National Digital Library of India has felicitated our Institute and its nodal officer (Mohan B S) for the generous contribution of contents to NDLI.

Scientometric Analysis

IIA Library has given extensive inputs to the Institute's Annual and DST Reports by providing scientometric analyses of IIA research metrics from time to time.

Archives

The IIA Archives Committee was reconstituted, it has the mandate to oversee the preservation and sustenance of the current IIA Archives, evolve guidelines on access and sharing of exhibits and plan future steps to enable the wider audience to appreciate and utilise these resources. We have completed the process of re-cataloguing of the rare & special books and sent to Kodaikanal Solar Observatory Library and segregated according to publication year. The historical contents in the archives have been used by IIA scientific community besides other national and international researchers.

IIA Archives is a member of a public project called an Interconnected Digital Archive of Science (IDAS) in India developed by National Centre for Biological Sciences (NCBS), Tata Institute of Fundamental Research, in Bangalore. IIA Archives was featured in an article published in Connect (June 2018) – a quarterly magazine from IISc.

During the year the following dignitaries have visited our IIA Archives:

[1] Palliyara Sreedharan, Director, Kerala State Institute of Children's Literature (Department of Cultural Affairs, Government of Kerala), Sanskrit College Campus, Palayam, Thiruvananthapuram. He visited our IIA Archives and took video coverage of IIA Archives and Library on 7th October 2017.

[2] A team of students and a teacher from Mayo College, Ajmer visited IIA Archives on 11th January 2018.

[3] Patrick Michel from Lagrange Laboratory, University of Nice, CNRS, Cote d'Azur Observatory, France visited IIA Archives on 16th January 2018.

[4] The Hon'ble Minister, Dr Harsh Vardhan, Minister of Science and Technology, visited the IIA Library and Archives on 18th March 2018. He was shown books, authored, and conference proceedings, edited, by IIA scientists. The Archives showcases the history of IIA from its beginnings of Madras Observatory in 1792 started by the East India Company primarily for navigation, geography and, later astronomy. It is the first British effort at scientific studies in India. He was shown instruments and maps related to the surveys undertaken. Evidence of the astronomical discoveries made later were also described; notable among them include the star catalogue of 11000 stars, Transit of Venus, building of variable star catalogue by C. Raghunathachary, records of Solar eclipses in India, discovery of Helium in the solar spectrum 1862

and the discovery of the Evershed effect in 1909 in Kodaikanal.

In the visitor's book, the Hon'ble minister wrote:

"It was a real privilege and treat to visit this great institution on a Sunday and an auspicious day when we celebrate the Hindu Nav Varsh today all over the country. I enjoyed getting to know the glorious past here. My heartfelt good wishes to all my colleagues here"

Library Training and Internship Programme

The Library trainee programme is continued and the trainees have been trained in all the Library and Archives sections.

5 Future Facilities

5.1 Thirty Meter Telescope

In September 2017, the State of Hawaii Board of Land and Natural Resources (BLNR), after lengthy hearing process, reissued permit for the construction of the Thirty Meter Telescope (TMT) at Mauna kea on Hawaii Island. The permit for TMT by the government was challenged at the supreme court of Hawaii. As for the alternate site, La Palma, Spain, statutory approval process is underway and approvals are expected by October 2018. While site decision is awaited, technical work across the partnership has progressed well. India TMT made good progress on many fronts.

Annual Science Forum 2017

TMT hosted its fifth annual TMT Science Forum from November 7–9, 2017, at the Infosys campus in Mysuru, India. The theme for this year's forum was "Beyond First Light". About two hundred scientists and students from around the world participated in the meeting. The meeting featured presentations about the main science questions to be addressed by TMT next-generation instruments, and the novel technologies permitting to address these questions. Topical workshops were also organised to provide in-depth discussion about the future instrument capabilities for TMT, such as high-resolution spectroscopy, high-contrast exoplanet imaging, and the first-generation science instrument Wide-Field Optical Spectrometer (WFOS).

Segment Support Assembly (SSA)

The India-TMT SSA programme has taken a leap into the Production Qualification Phase and soon a contract will be in place with M/s Larsen & Toubro for 100 numbers of Polished Mirror Assembly (PMA) kits and 94 Subcells. India TMT Coordination Centre (ITCC) is also exploring mid-scale vendors for SSA part wise manufacturing. SSA team members have participated in the assembly and integration of six SSAs, shipped from India, at TMT Monrovia Lab in March 2018. ITCC has also taken up the development of Warping Harness Leaf springs and Central Diaphragm separately due to the critical nature of their manufacturing and process development. Two vendors have successfully manufactured two conforming Central Diaphragms. The Leaf springs manufactured at IPA were included for the accelerated life

test by TIOPO (TMT International Observatory Project Office) for reliability checking of the design.

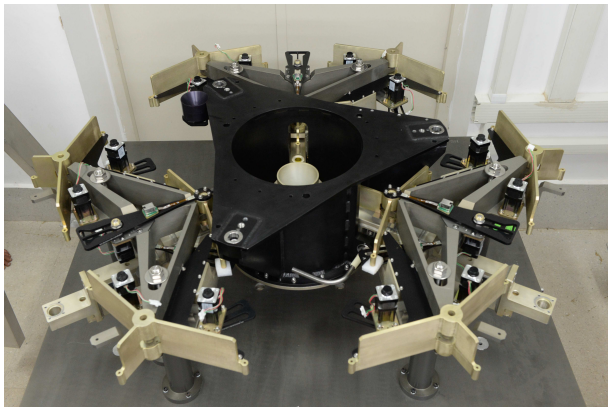


Figure 5.1: The first assembled PMA kit.

Actuators

Four actuator vendors (Southern Electronics, Bangalore, IDTR Jamshedpur, Tamboli Engineers Pvt. Ltd. Pune and Amado Tools, Bangalore) were awarded contracts for fabrication of Prototype Actuators. Fabrication, Inspection, TPI, and Secondary process of all parts by all vendors have been completed. Pre-shipment meetings have been conducted at vendors place in the presence of TIOPO members.

Figure 5.2: Assembly and testing at IDTR, Jamshedpur.

Edge Sensor

Sensor design is continuously evolving and is under finalization phase. Previous prototype used photolithography technique for creating patterns on sensor block, was very expensive, and time consuming. ITCC efforts are being made to develop the laser etching process as a faster and cost-effective alternative to the conventional lithography process used earlier. Laser etching process development is under progress at two places: SLTL, Gandhinagar and the ARCI Hyderabad. A few laser etching trials were carried out at ARCI, and were successful.

Segments

Different activities related to Segment polishing are progressing well, which includes hex cutting, pocketing process development, 2DP simulation, Whiffletree system design, etc. The Practice blank from Ohara, Japan reached ITCC facility at Hoskote Bangalore on 1st December 2017. India–TMT Optics Fabrication Facility is under construction and is expected to complete by October 2018.

Figure 5.3: Practice blank received at Hoskote, Bangalore.

Software

The development of modules for Observatory Software and Telescope Controls Software is progressing well at ThoughtWorks, Pune and Honeywell India, Pune, respectively. Number of modules have been developed and a few are released to sub-groups within the project for tests and integration.

Science and Instrument Team

The design and development of the first generation instrument, Wide Field Optical Spectrograph (WFOS) has been taken up by the Science and Instrument Team. The key contributions of the team in India are the complete end-to-end simulation of the optical design and performance analysis. India TMT has developed a simulation tool for instrument flexure and possible compensation scheme (both open and close loop). This plays an important role to interface the optical and mechanical teams. The tool simulates accurately the effects of instrument flexure on detector plane, using perturbation of key optical elements and also derive corrective motions to compensate the image shifts caused by instrument flexure. WFOS-ITMT have also developed astronomical *On-sky target allocation simulation tool* which will help in the design of the fiber positioning system. We derive completeness and targeting efficiency for various real astronomical sky fields with different target densities. We have also designed the microlens array for fiber front end of spectrograph.

In order to play a bigger role in the second generation instruments for TMT, India led white paper has been submitted towards a development of high resolution optical spectrograph.

Besides scientific results and development work, 7 scientific and technical publications emerged from the project during the current year. Five Project Engineers, one Post-Doctoral fellow, 4 PhD students, 3 MTech students and 2 Project Interns received training regarding different aspects of the project.

5.2 Visible Emission Line Coronagraph on ADITYA(L1)

Visible Emission Line Coronagraph (VELC), onboard Aditya-L1 space mission is an internally occulted solar coronagraph capable of simultaneous imaging, spectroscopy and spectro-polarimetry close to the solar limb. The payload consists of 18 optical assemblies (40 optical elements), four mechanisms (three multi-operational and one single operation), four detector systems etc. All of these systems have to be integrated, tested and calibrated to achieve the designed system performance. Stringent contamination control protocols have been evolved and implemented to minimize the scatter due to particulate and molecular contaminants. Subsystem level tests are being carried out in ISO-4 clean facility.

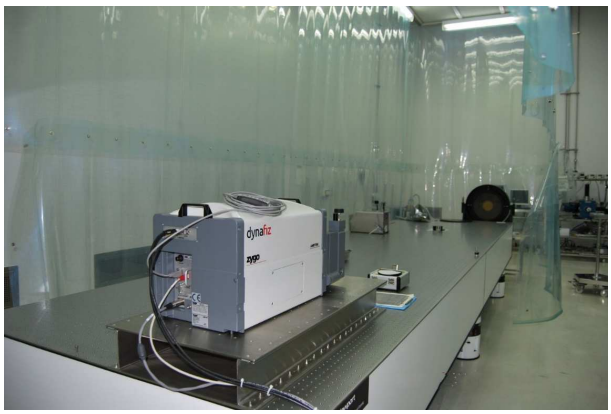


Figure 5.4: ISO-4 Clean room facility for integration and calibration of VELC.

Since VELC is a very complex instrument,

the realization philosophy for the payload is (1) Laboratory Model, (2) Qualification Model and finally (3) Flight Model. VELC will be calibrated at different stages of integration. However, the final performance of the VELC can be determined only in vacuum after necessary corrections. Vacuum calibration of VELC is critical and hence the final performance test of VELC will be carried out in vacuum environment. A new vacuum calibration facility has been established for this purpose.

Figure 5.5: Coronagraph Vacuum Calibration Facility.

Figure 5.6: Integration of Laboratory Model of VELC.

The final performance of VELC, to achieve the proposed science goals, depends on the control of instrument background which is very critical. The disk light scattered from the surface micro-roughness of primary mirror is the major contributor towards instrument scatter. Payload team has adopted multiple methods for the estimation of scatter and measurement of scattered light from the primary mirror and the payload. These include theoretical estimation, development of Near Specular Scatterometer (NSS) and development of Coronagraph Scatter Measurement Facility (CSMF) for testing the integrated payload level scatter measurements for the flight model. Strict contamination control protocols are being followed to minimize the mirror degradation during the integration and calibration process. Accelerated studies on effect of contamination on VELC is in progress. This will give an indication of the health of the payload at the end of five years of operation.

5.3 National Large Solar Telescope

After obtaining the clearance from the National wildlife board, the forest advisory committee of J&K Government met on August 10, 2017 at Srinagar. The committee approved the 7.6 ha forest land for the establishment of the National Large Solar telescope (NLST). Subsequently IIA received the sanction order for the procurement of the land in the month of October 2017. DST has been requested for grants to make the payment towards the lease of the sanctioned land. The NLST team visited Physical Research Laboratory (PRL), Ahmedabad in the month of October 2017 to involve them in the NLST project and also to discuss the areas in which they can contribute to the project. IIA team is in the process of extending the active involvement and collaboration of national and international

partners in the project. During the course of the year, IIA team has also made significant progress towards the mechanical design of the telescope and rotating table, design of the dome and building for the NLST.

Figure 5.7: The SDIMM, SHABAR and AWS instruments deployed at the site.

A detailed site survey report was prepared and submitted with the detailed project report. To substantiate and continue measurements of the site seeing parameters of the Merak site, the Solar Differential Image Motion Monitor (SDIMM) and Shadow Band Ranging (SHABAR) instruments were reinstalled at the site in the month of August 2017. The other instruments such as all sky camera, automatic weather station (AWS) are working at the site since 2016 and providing the data. The data shows that the wind speed is almost the same at 3 and 8 m heights. Wind direction is in the N-W direction most of the time. The seeing measured at 6 m heights using SDIMM and SHABAR instruments show that the median seeing at the site is close to 6 cm and its tail extends 12 cm occasionally. The seeing values at 20 m heights show that the median seeing is 8 cm.

5.4 National Large Optical-InfraRed Telescope

The work towards generating a detailed project report for a 10-m class National Optical-Infrared telescope (NLOT) is in progress. The NLOT group is collaborating with the Maunakea Spectroscopic Explorer (MSE) group for a joint development of the design of the two telescopes which are very similar.

In order to understand the segment control system, a prototype of segmented mirror telescope (PSMT) comprising of 7 segments is being developed. The optics and mechanical design of the PSMT is complete. Optics fabrication is being investigated at IIA optics laboratory. The telescope controls are being designed. Design of the mirror support system is underway. Actuator and edge sensor development is also underway.

6 Student Programmes And Training Activities

The Institute has active training and research programmes for students that are coordinated by the Board of Graduate Studies (BGS). It conducts a PhD programme in collaboration with the Pondicherry University, and an MTech–PhD (Int.) programme in collaboration with the University of Calcutta. In addition to these, the Institute also trains students through short term programmes such as the visiting students programme, the summer school and the summer project programme. In the academic year 2017–18, five students joined the IIA–PU PhD programme in June 2017, and, six students joined in January 2018. Seven students joined the IIA–CU Integrated PhD programme in June 2017. The highlights of BGS activities are summarized below.

6.1 PhD Degree Awarded

Seven students were awarded PhD Degree during 2017–18.

K. Sowmya was awarded the PhD degree on April 5, 2017 for her thesis entitled "Scattering Polarization with Pashen–Back Effect as A Tool to Diagnose the Magnetic Structuring of the Solar Atmosphere" submitted to the Pondicherry University. She carried out the above work under the supervision of K. N. Nagendra.

H. D. Supriya was awarded the PhD degree on August 14, 2017 for her thesis entitled "Exploration of The Second Solar Spectrum Through Polarimetric Studies" submitted to the Pondicherry University. She carried out the above work under the supervision of B. Ravindra and K. N. Nagendra.

Tanmoy Samanta was awarded the PhD degree on November 15, 2017 for his thesis entitled "On the coupling between lower and upper atmosphere of the Sun" submitted to the Pondicherry University. He carried out the above work under the supervision of Dipankar Benerjee.

C. R. Sangeetha was awarded the PhD degree on November 24, 2017 for her thesis entitled "Magnetoconvective Flows and Waves in the Lower Solar Atmosphere" submitted to the Pondicherry University. She carried out the above work under the supervision of S. P. K. Rajaguru.

Shubham Srivastav was awarded the PhD degree on December 13, 2017 for his thesis entitled "Observational Studies of Low Redshift Supernovae" submitted to the University of Calicut. He carried out

the above work under the supervision of G. C. Anupama.

P. Kishore was awarded the PhD degree on December 28, 2017 for his thesis entitled "Development of a Broadband Radio Spectropolarimeter for Solar Observations" submitted to the University of Calcutta. He carried out the above work under the supervision of C. Kathiravan.

Susmitha Rani Antony was awarded the PhD degree on March 2, 2018 for her thesis entitled "Study of stellar relics from the early Galaxy" submitted to the Indian Institute of Sciences, Bangalore. She carried out the above work under the joint supervision of T. Sivarani and Banibrata Mukhopadhyay under the Joint Astronomy Programme (JAP), IISc., Bangalore.

Table 6.1: **Number of PhDs awarded over the past five years**

Year	No.
April 2013 – March 2014	5
April 2014 – March 2015	7
April 2015 – March 2016	10
April 2016 – March 2017	5
April 2017 – March 2018	7
Total	34

6.2 PhD Thesis Submitted

Seven students have submitted their PhD thesis during 2017–2018.

K. Hariharan submitted his thesis entitled "Solar Radio Observations at Low Frequencies with High Spectral and Temporal Resolution" to the University of Calcutta on April 20, 2017. The research was done under the supervision of R. Ramesh.

Srinivasa Prasanna V submitted his thesis entitled "The Search for the Electic Dipole Moment Electron (eEDM) in Mercury Halides using the Relativistic Coupled Cluster Theory" to the University of Calicut on June 9, 2017. The research was done under the joint supervision of B. P. Das and Pravabati Chingangbam.

Vidya, G. submitted her thesis entitled "Geometrical and topological properties of CMB polarization fields" to the Indian Institute of Sciences, Bangalore on July 27, 2017. The research was done under the joint supervision of Pravabati Chingangbam and Prateek Sharma under the Joint Astronomy Programme (JAP), IISc., Bangalore.

Vaibhav Pant submitted his thesis entitled "Dynamics of coronal transients as seen from space observations" to the Pondicherry University on October 17, 2017. The research was done under the supervision of Dipankar Benerjee.

T. Mageshwaran submitted his thesis entitled "Physics of tidal disruption events around black holes" to the Pondicherry University on November 6, 2017. The research was done under the supervision of Arun Mangalam.

M. Honey submitted her thesis entitled "Evolution of Low Surface Brightness Galaxies" to the Pondicherry University on January 3, 2018. The research was done under the supervision of Mousumi Das.

Avinash Surendran submitted his thesis entitled "Development of a scalable generic platform for adaptive optics real time control" to the University of Calcutta on February 23, 2018. The research was done under the joint supervision of Padmakar Singh Parihar and A. N. Ramaprakash, IUCAA, Pune.

6.3 Completion of MTech programme

The following students from the 9th batch of the above programme have completed their MTech Degree under the IIA–CU integrated MTech–PhD programme.

Patti Srinath Reddy has submitted his MTech thesis entitled "Development of digital back-end system for the Gauribidanur Low frequency Solar Spectrograph (GLOSS)" to the University of Calcutta on July 2017. The work was done under the guidance of R. Ramesh.

Ritesh Patel has submitted his MTech thesis entitled "Automated detection of CMEs in STEREO/COR-1 and its application to ADITYA-L1/VELC while studying the detector characterization" to the University of Calcutta on July 2017. The work was done under the guidance of Dipankar Banerjee.

S. V. Manoj Varma has submitted his MTech thesis entitled "Pulsar timing and Interstellar medium properties with the upgraded GMRT" to the University of Calcutta on July 2017. The work was done under the joint guidance of R. T. Gangadhara and Yeshwanth Gupta, NCRA, Pune.

6.4 Visiting Students′ Internship Programme

The visiting students′ internship programme is conducted by the Institute with the aim to promote scientific research interest in college and university students. Students carrying out their PhD in Universities, and willing to visit IIA for collaborative research are also encouraged to apply for this programme. Students selected for this programme work typically for about three months on specific projects that form a part of the ongoing research at IIA. Based on the nature of the project, the students work either at the main campus of IIA in Bangalore or at any of its field stations. During 2017–18 thirty six students (selected through a rigorous process of online application and further screening) did their projects under the guidance of various academic staff members of the Institute. At the end of the tenure the students presented a seminar on their project work.

6.5 School in Physics and Astrophysics

The school in Physics and Astrophysics, coordinated by the Board of Graduate Studies, is an yearly activity of the Institute . The main aim of the school is firstly to introduce students of BSc, MSc, BE/BTech degree courses to the field of Astronomy and Astrophysics and secondly to motivate them to take up a career in Astronomy and Astrophysics. For the year 2017, the school was held at the Kodaikanal Solar Observatory, during May 16–30, 2017. The programme consisted of a series of lectures covering various topics in Physics and Astrophysics; the lectures were delivered by the IIA faculty members.

Twenty four students participated in the school, of which eleven students did short-term projects, each for a duration of six weeks during May 31 to June 30, 2017, under the guidance of IIA faculty members. Five students did their projects at IIA Bangalore, three in Kodaikanal Solar Observatory and another three students carried out their projects at Vainu Bappu Observatory, Kavalur. During the second week of July they also made presentations on the results of their project work.

In addition to the above, five students

have carried out short-term projects under the guidance of IIA faculty members during May to July 2017 under the Indian Academy of Sciences Summer Research Fellowship Programme.

6.6 Attendance/ Presentations in Meetings

Talks given in national/ international meetings

Avrajit Bandyopadhyay

- *Connection between Globular clusters and Galactic halo*, in ASI 2018 conducted at Osmania University, Hyderabad.

Bhoomika

- Presented a talk in "Recent Trends in the Study of Compact Objects – Theory and Observation (RETCO III)", 5–7 June 2017.
- Presented a talk in "High Energy Emission from Active Galactic Nuclei", 28–30 November, 2017, University of Calicut.

Chayan Mondal

- *How clumpy are the young and hot star distribution in this metal poor galaxy?*, 22–24 January 2018, "Galaxy evolution and Dynamical Structures (GEDS-I)", IUCAA, Pune, India.
- *Exploring the ultraviolet universe*, February 5–9, 2018, "36$^{\text{th}}$ meeting of Astronomical Society of India (ASI-2018)", Osmania University, Hyderabad.

Dipanweeta Bhattacharya

- *Black hole Evolution and the $M_\bullet - \sigma$ Relation*, 5–7 June 2017, Contributed talk in the conference "Recent Trends in the study of Compact Objects–III", at IIST, Trivandrum, India.

Joice Mathew

- *Design and Development of LUCI*, 2018, SPIE Astronomical Telescopes + instrumentation conference held at Austin, Texas, USA.

Nancy Narang

- Oral Presentation, May 30 to June 2, 2017, in Joint HINODE-11/IRIS-8 Science Meeting at Seattle, Washington.

S. S. Panini

- *Multilayer mirror based soft X-ray polarimeter for astronomical application*, 2017, at the 35$^{\text{th}}$ meeting of Astronomical society of India, Jaipur.
- *Design of a multilayer mirror based soft X-ray polarimeter*, November 2017, at Alsatian workshop on X-ray polarimetry at University of Strasbourg, Strasbourg, France.

Ramya M Anche

- *Polarimetric studies of Novae using a photopolarimeter*, July 2017, at Asia-Pacific Regional IAU meeting in Taipei, Taiwan.
- *Instrumental polarization effects from TMT optics in the mid-infrared region*, November 2017, at TMT Science Forum, Mysuru.

Rubinur Khatun

- *Radio Observations of Candidate Dual Active Galactic Nuclei in Double Peaked Emission Line Galaxies*, June 5–7, 2017, "Recent Trends in the Study of Compact Objects – Theory and Observation (RETCO – III)", IIST, Thiruvananthapuram.
- *Understanding a galaxy merger system using EVLA and UVIT*,
  - December 18–21, 2017, "AstroSat View of the AGN Central Engines", IUCAA, Pune.
  - February 5–9, 2018, "36$^{\text{th}}$ meeting of Astronomical Society of India (ASI-2018)", Osmania University, Hyderabad.

Samrat Sen

- *Magnetohydrostatic equilibria of flux tubes*, 12–16 February, 2018, Contributed talk in the conference "Dynamic Sun: II. Solar Magnetism from Interior to the Corona", at Cambodia.

Sandeep K Kataria

- *The Effect of Bulge Mass and Concentration on Bar Formation and Pattern Speed*, 22–24 January 2018, at "Galaxy Evolution and Dynamical Structure" meeting at IUCAA.

Sindhu, N

- UVIT Science Meeting, July 6–7, 2017 at Indian Institute of Astrophysics, Bangalore.
- ASTROSAT Meeting, 26–27 September 2017, ISRO HQ.

Tridib Roy

- *Pulsar radio emission and polarization*, 5–7 June 2017, 'Recent trends in compact object III', IIST campus, Trivandrum

Poster presentations in national/ international meetings

Anshu Kumari

- *New Evidence for Coronal Mass Ejection Driven High Frequency Type II Burst Near the Sun*, 19–23 February 2018, International Conference on "Long-term datasets for the understanding of solar and stellar magnetic cycles".

Avinash Surendran

- *SPARC: Scalable Platform for Adaptive optics Real-time Control*, November 7–9, 2017, at the TMT Science Forum, Mysore, India.

Chayan Mondal

- *How clumpy are the young and hot star distribution in this metal poor galaxy?*, February 5–9, 2018, "36$^{\text{th}}$ meeting of Astronomical Society of India (ASI-2018)", Osmania University, Hyderabad.

Deepak

- *Study of stellar populations in the disk of the Galaxy in the GAIA era*, January 22–25, 2018, "Galaxy Evolution and Dynamical Structures (GEDS2018)" meeting held at IUCAA, Pune.

Joice Mathew

- *Prospects for Near Ultraviolet observations from the lunar surface*, March 2018, LPSC 2018–Lunar and Planetary Science Conference, held at Houston, Texas, USA.

Megha, A

- *Coronal magnetic field measurements using forbidden emission lines*, February, 2018, IAU Symposium-340 held at Jaipur, India.

Nancy Narang

- Poster Presentation, February 19–24, 2018, in IAU Symposium 340 at Jaipur.

Ramya M Anche

- *Instrumental polarization and crosstalk effects from Thirty meter Telescope*, November 2017, TMT Science Forum.

Samrat Sen

- (1) *Magnetohydrostatic equilibria of flux tubes*, and (2) *Energy distribution of solar flare events*, February 19–23, 2018, in 'IAU Symposium 340: Long-term datasets for the understanding of solar and stellar magnetic cycles', at Jaipur, India.

Sandeep K Kataria

- *A study of Isolated halos distribution in Large-scale structures of universe*, 9–12 October 2017, "Post Plank Enigma, Challenges and Vision" at IUCAA.

- *Isolated halos distribution in Large-scale structures of universe in Horizon Run 4 simulations*, 6–9 March 2018, at Astronomical Society of India meeting at Osmania University, Hyderabad.

Tanya Das

- Poster Presentation, February 2018, in ASI 2018, Hyderabad.

Tridib Roy

- *Radio emission mechanism of pulsar*,
  - July 10–16, 2017, 'Physics of neutron star', Saint Petersburg Academic University, Russia.
  - Feb 5–9, 2018, "36$^{\text{th}}$ meeting of Astronomical Society of India (ASI-2018)", Osmania University, Hyderabad.

Varun Kumar

- *Inductive Edge Sensor for Segmented Mirror Telescope*, August 2017, "Preparing TMT Future Science and Technology Leaders", Santa Cruz, California, USA.

- *Prototype Segmented Mirror Telescope*, November 2017, at the "TMT Science Forum", Mysuru, India.

Attendance in meetings/ workshop

Ambily, S

- *COSPAR Capacity Building Workshop* on 'Small Satellites, Big Science', September 2017, in Daejeon, South Korea.

Anshu Kumari

- *Solar-Stellar Magnetism: Past, Present and Future*, 18$^{\text{th}}$ February 2018, at Birla Auditorium.

- *Solar Astronomy School*, 24$^{\text{th}}$ February 2018, at Birla Auditorium, Jaipur.

Kshama S Kurian

- *CIAO/Chandra Workshop* co-hosted by NCRA–TIFR and Chandra X-ray center, October 23–27, 2017, Cambridge.

- *AstroSat View of AGN Central Engines*, 18–21 December 2017, IUCAA.

Pavana, M & Avinash Singh

- *The Physics of Astronomical Transients*, December 27, 2017 to January 5, 2018, 35$^{\text{th}}$ Jerusalem Winter School in Theoretical Physics conducted by the Israel Institute of Advanced Studies.

Ramya M Anche & Sindhu, N

- *3*$^{\text{rd}}$*Indo-French Astronomy School*, 31 July to 8 August 2017, Organized by IUCAA, Pune.

Rubinur Khatun

- *Chandra/CIAO workshop*, 23–27 October 2017, at NCRA-TIFR, Pune.

Sandeep K Kataria

- *Cosmological HD & MHD simulations and data analysis techniques: solving challenges in Astronomy and Astrophysics*, as an instructor for hands-on session, 6$^{\text{th}}$ March 2018, at ASI meeting at Osmania University, Hyderabad.

Sireesha Chamarthi

- *TMT Science Forum*, November 2017, in Mysore.

6.7 Awards and Recognition

Chayan Mondal

- *Best poster award*, February 5–9, 2018, "36$^{\text{th}}$ meeting of Astronomical Society of India (ASI-2018)", Osmania University, Hyderabad.

Joice Mathew

- *2018 LPI Career Development Award*, Lunar and Planetary Institute, USRA, Texas, USA.

Nancy Narang

- *Thomas Metcalf Travel Award 2017* for Joint HINODE-11/IRIS-8 Meeting.
- Recognised as *Metcalf Lecturer* for the oral presentation in the Joint HINODE-11/IRIS-8 Meeting.

7 Public Outreach

7.1 National Science Day

The Public Outreach Committee (POC) conducted the National Science Day (NSD) programmes on February 28 at IIA. Prior to this, on February 3, 2018, competitions such as drawing and painting, essay writing, and speech were conducted. On February 28, 2018, experiments demonstration, scientific talk in the auditorium, laboratory visit, Coelostat experiment were conducted in addition to a quiz programme. About ten schools took part in all the above mentioned events and the day was a memorable one. Teachers from the schools appreciated the experiment demonstration session; also, the same was made open to the public. There was a public lecture in the evening by Prof. P. R. Vishwanath on the topic "Science through the ages" followed by sky watch for the general public and students.

Like the previous year, the NSD programmes were conducted in the observatories too. Several schools nearby the observatories participated in various activities conducted at the respective places. Prizes were distributed to the winners of all competitions at all the places.

Figure 7.1: Sky watch programme at IIA Campus on the National Science Day.

Figure 7.2: Prize distribution on the National Science Day.

Figure 7.3: Participants of the National Science Day at VBO, Kavalur.

7.2 Outreach Lecture Series

The Public Outreach Committee organized two series of lectures for college students (of all curriculum) and the general public on Saturday afternoons. The first one was conducted from February 2017–May 2017 with the title "The Journey through the Universe". Prof. G. Srinivasan delivered all the lectures. Topics such as the Sun, planetary systems, stars, etc. were covered very extensively. The second one was conducted during the period August 2017–November 2017. It consisted of 26 lectures on various topics covering the Sun and the Solar System, Exoplanets, Galactic and Extragalactic astrophysics, and Astronomical instrumentation, delivered by IIA Faculty. A total of about 800 students from various colleges in and around Bangalore attended the lecture series. The video captures of the lectures are available for viewing/ download on through IIA's Outreach webpage.

7.3 International Museum day

The International Museum day is celebrated all over the world on May 18 every year. In this regard, the Government of Karnataka had taken an initiative last year and directed all the institutions to bring out the details of their associated museums and plans for related outreach events every year. Therefore a programme for the general public was arranged at Kodaikanal observatory on May 18, 2017 to promote museum related activities. The museum was kept open from early morning till late night.

Figure 7.4: Visitors at Kodaikanal Observatory museum on the International Museum day.

7.4 Teacher training programme

Figure 7.5: One of the hands-on sessions during the Teacher training programme.

A one day training programme/ workshop was organized at IIA on June 17, 2017 for teachers from Government schools. The Committee had contacted the officers of DIET for the selection and deputation of teachers for the training. About 50 teachers from various schools located in south Bangalore attended the programmes. The primary objective was to introduce the basic principles of optics to school teachers who in turn can familiarize the same to their students. Since the principles of optics are extensively applied/ used in the field of astronomy, the present programme was organized to cover the basic concepts through presentations and through an elaborate hands-on session. In the latter, by demonstrations, our faculty members and PhD students helped the teachers to carry out the basic optical physics experiments on their own. The scientific presentations were given by faculty members. About twelve basic experiments were conducted and all the teachers were donated with basic optical components that were required for few of the important optical experiments. One more attractive part of the programme was the motivational speech given by Mr. P. Sridhar (alumni of IISc) who has been training and inspiring Government school children to make/ innovate new kinds of robots.

7.5 Founder's day programme

A one day outreach programme on the Founder's day (August 10, 2017) was organized for the Engineering college students with an objective to impart information on the available career opportunities in the field of Astronomical Instrumentation. About forty students from seven nearby Engineering colleges took part in this programme. The students were introduced the research facilities and career opportunities at IIA. After that, a dedicated session was arranged for the college students to interact with IIA PhD students to know about various ongoing Instrumentation projects that they were involved in. A scientific presentation competition was also conducted for the college students on the topic "Space Missions"; the winners were given prizes by the chief guest Prof. T. P. Prabhu who had briefly shared his pleasant memories and interaction with Dr Vainu Bappu. And in the evening, the students were allowed to visit the labs. At VBO, physics students from six nearby colleges attended the function. The chief guest Prof. Ashok Pati gave a talk on the topic "MKV Bappu – his contributions to Astronomy in India" in the morning session. There was also a presentation competition for the college students for about 15 minutes. After the programme the students were taken to VBT and JCBT and explained about IIA's research activities.

7.6 World Science Day programme

Figure 7.6: Poster session during the World Science Day programme.

This was a one day outreach programme organized by the POC on the World Science day (November 10, 2017) for the students with Physics curriculum. About fifty students from six nearby science colleges participated in the programme. The students were given introduction to the research and observational facilities of IIA. They also interacted with the PhD scholars to know about the science research projects they were working on. A scientific presentation competition on the topic "Property of light and its applications" was conducted and the winners were given prizes. The college students visited the labs in the evening. Similar events were also conducted at VBO. There were about 100 participants in the programme. Dr R. Sridharan gave a talk on "Optical Telescopes". The students were taken to VBT and explained about our activities. Similar events were also conducted at KSO for the college students.

7.7 IIA Stalls

The following are the public outreach events wherein IIA had set up its stalls:

Figure 7.7: The IIA stall at the DST pavilion.

(a) **India International Science Festival (IISF–2017) conducted at Bangalore and at Chennai**
As per the instructions from the Ministry of Science and technology, the Public Outreach Committee organized a one day outreach programme on September 09, 2017 as a precursor event to IISF–2017 which was conducted at IIT, Madras during October 13–16, 2017. The main events were jointly organized by the Ministry of Earth Sciences, National Institute of Ocean Technology, Ministry of Science and Technology, etc. The POC invited students and teachers from the local Government schools located nearby. The aim of this programme was to introduce the objective of India International Science Festival and to introduce the various themes that were part of the festival. Similar events were also conducted at our observatories. The PhD scholars and faculty members of IIA took part in the main events conducted at the Anna University campus, Chennai. The PhD scholars had presented their research work, the female

members of the faculty represented IIA in the women scientists conclave. The POC kept an outreach stall in the DST pavilion; posters and telescope models were displayed and IIA brochures were distributed to the visitors.

(b) **Bengaluru Tech Summit conducted at Palace grounds, Bangalore**
The Government of Karnataka organized a Tech Summit at the palace grounds during November 16–18, 2017 in order to bring in research institutions and the industry together to establish /promote coordination between science and technology institutions of the country and the industries. The POC kept a stall there to display IIA's observing facilities, research highlights of the Institute, major upcoming projects, etc. Many industrialists visited the stall.

(c) **Career guidance programme at Virudhunagar**

Figure 7.8: IIA staff and students interaction at KVS school.

The POC had put up a stall at KVS school, Virudhunagar on August 4, 2017 to conduct a career guidance programme for higher secondary school students in the field of Astronomy and Astrophysics. About five hundred students from various schools in and around Virudhunagar attended the programme.

(d) **Karnataka Science and Technology Academy 2018**
The Karnataka Science and Technology Academy organized a two day science expo in Reva University, Yelahanka during January, 2018. Here too, the POC put up a stall to showcase our research facilities, information about our observatories, etc.

(e) **Public outreach event organized at Botonical garden on the Super Blue Moon Eclipse day**
This year, there was a total Lunar Eclipse on January 31. Interestingly, the Moon was a Super and Blue Moon on that day. This is a rare phenomenon as a similar event took place about 150 years ago. Therefore, the Public Outreach committee organized a public eclipse watch programme (for free of cost on the small hillock at Lalbagh botanical garden on that day between 5:30 p.m. and 8:30 p.m.) in order to create scientific awareness among the general public about the cause for eclipses.

Events were also organized at the Kodaikanal Solar Observatory for public viewing of the eclipse. The event was inaugurated by Dr Murugan, District Forest Officer and all were welcomed by the Resident Scientist. Three refractor telescopes (4″, 6″ and 8″) and two equatorial mount telescopes were arranged to see Moon's craters. The Hα and Tunnel Telescopes were kept open for the public to see. The supermoon live telecast

from various stations of NASA was also arranged.

7.8 Students′ Visit to IIA and its Observatories

(a) **IIA**
A total of about 330 students from various schools and colleges visited IIA during the current academic year. The students were shown the Coelostat setup, tour to Photonics division, poster session to introduce the observing facilities of the Institute, and a talk by one of the faculty members were arranged.

(b) **GRO, Gauribidanur**
About 400 students from eight Engineering colleges visited Gauribidanur observatory. They were explained about the functionality of the radio telescopes, analog and digital receivers.

Figure 7.9: Students of Nagarjuna college visiting GRO.

(c) **IAO, Hanle**
Around 4500 visitors visited IAO Hanle during the summer months. Apart from this, study trips from three local schools and the lone degree college were also arranged. The facilities available at IAO, functioning of telescopes and instruments were explained to the visitors. A presentations about general astronomy was also a part of the study trip.

(d) **KSO, Kodaikanal**
The total number of visitors during the academic year was about 48,000. The visitors include students from 15 colleges and the general public. Several night-sky watch programmes were also arranged for the visitors on different occasions.

(e) **VBO, Kavalur**
Night sky watching programme was conducted almost on all Saturdays. A total number of 12,034 people visited VBO. This included groups from 37 schools (2875 students), 35 colleges (1789 students), 2 science forum groups, MPB-IFR, students from Aryabhat Foundation, Bhopal etc. A team of scientists, students and engineers from RRI led by their director Prof. Ravi Subramanyan stayed at VBO for two days discussing about their science projects. One of the students presented a talk titled "The First atoms, stars and galaxies of our Universe" to the VBO staff.

7.9 Public talks/lectures/ discussions

The following IIA faculty members were involved in public lectures/ outreach activities.

G. C. Anupama

- *Eruptive Transients*, public lecture at IIA.

R. Banyal

- *Exploring Light*, 17-06-2017, talk at the Teachers Training Programme, IIA.
- *Optical Detectors and Corrections*, 28-04-2017, talk at the Astronomy Olympiad Training Camp, Visvesvaraya Industrial & Technological Museum, Bengaluru.
- *Institutions of Research and Higher Learning*, 11-02-2017, public talk at the 16$^{\text{th}}$ All India People's Science Congress, NISER, Bhubaneswar.
- Planned and organized a mass gathering at Lalbagh for viewing the Total Solar Eclipse on January 31, 2018.
- Science day programme: planned and organized an experimental session for students, February 28, 2018.

B. C. Bhatt

- Visited New Delhi and represented IIA in the Exhibition organized by the Department of Science & Technology, Govt of India, in the Parliament Complex during July 28 August 11, 2017. We showcased some recent and major achievements of the Institute along with posters/models related to extramural programmes. Our Institute's stall was very well visited by a large number of Hon′ble Members of Parliament from Loksabha and Rajyasabha including Speaker of Loksabha Hon'ble Mrs Sumitra Mahajan. All visitors shown their keen interest on our research and appreciated research and development work undertaken by the Institute.

Binukumar

- High Altitude Balloon platform for UV Astronomy 10/03/2018; Indian Institute of Science (IISc), Bangalore Live demonstration of pre-launch preparations of the payload, communication systems, attitude control sub-systems and cut-off mechanism were done. A latex balloon was prepared for the launch along with the subsystems. And the procedure of the launch and payload recovery was explained.

E. E. Chellasamy

- *Seven Wonders of Universe*, 29 January 2018, public lecture at Arul Anandar College, Karumathur.
- Super Moon - January 31, 2018. Indian Institute of Astrophysics invited general public to witness Perigee–Super moon–lunar eclipse - a rare phenomenon on January 31 at 6:21 p.m. About 1200 enthusiastic public and school /college students witnessed this spectacular event from the Observatory. The observable universe and the lunar eclipse were explained to the visitors before the start of the eclipse.

P. Chingangbam

- IIA Outreach lecture on *'Cosmology – understanding the Universe'*, 23 September, 2017.

A. Goswami

- *Star Formation and Evolution*, 2 September 2017, IIA Outreach Lecture Series.

U. S. Kamath

- *Research Programmes and Facilities at IIA*, 11 October 2017, talk given to college students at IIA.
- *Introduction to Astronomy*, 28 February 2018, talk given to school students at IIA.

S. Nandi

- Actively participated outreach programme of Astronomical Society of India and Indian institute of Astrophysics (IIA). Discussed about lunar and solar eclipse for school students during 2018 ASI meeting at Hyderabad. We also conducted public show for lunar eclipse at Lalbagh on 31st January 2018. Participated National science Day event on 3rd February 2018.

R. Sridharan

- *Overcoming the Turbulence in the Atmosphere*, 14/10/2017, public lecture at IIA outreach programme, IIA Auditorium.

- Visited KVS higher secondary school, Virudhunagar to provide career guidance to the students of the same school. Presented posters (prepared by outreach committee) to the high school students, informing them about IIA's research activities. Date: 04/08/2017.

A. Subramaniam

- *Career in Astronomy & Astrophysics*, 15 July 2017, public lecture at Freedom International School, HSR Layout, Bangalore.

7.10 IIA outreach team's visits to schools and orphanages

Our outreach team visited five Government primary schools in Bangalore on Saturdays during this academic year; the team gave introductory talks on the Sun and Solar system, Stars and Galaxies. Demonstrations were also given to students on the method of using Astronomy kits. The team had also visited an orphanage located in the outskirts of Bangalore and organized a sky-watch programme after giving a talk on night sky objects. About 600 students participated in the events.

8

Other Scientific Activities By IIA Staff

8.1 Talks given in National/ International Meetings outside IIA

Invited:

G. C. Anupama

- *Studies of Supernovae in the era of future large facilities*, 7 February 2018, ASI-2018 (February 5–9, 2018), Hyderabad.
- *Transients with the 3.6-m DOT*, 5 February 2018, Workshop on Science with the 3.6-m Telescope, ASI-2018, Hyderabad.
- *Time Domain Astronomy with WFOS*, 5 November 2017, WFOS Science Workshop - TMT Science Forum (2017 November 5–7), Mysuru, India.

P. Chingangbam

- *Tensor Minkowski Functionals as a probe of cosmological fields*, 11 October 2017, Cosmology after PLANCK, IUCAA, Pune.
- *Probing reionization with Minkowski Tensors*, 12 December, 2017, Universe after the first 200 million years: Cosmic Dawn, reionization and post-reionization with 21-cm, Presidency College, Kolkata.
- *Probing statistical isotropy of cosmological fields with Minkowski Tensors*, 6 February 2018, ASI Meeting, Osmania University, Hyderabad.

K. George

- *Science with UVIT*, 08-11 August 2017, AstroSat workshop on UVIT science and data analysis, ARIES, Nainital.

A. Goswami

- *Stellar studies using High Resolution Spectrometer*, 6–9 November, 2017, TMT Science Forum 2017: TMT beyond first light, Mysore, India.

G. Pandey

- *The born again stars*, 19 January 2018, Workshop on Recent Trends in Astronomy and Astrophysics, Pondicherry University, Department of Physics, Puducherry.

T. P. Prabhu

- *Potential of Indian Telescopes for SSA*, 21 March 2018, Space in India's Foreign Policy Technology - Policy - Security Considerations, NIAS, Bangalore.

R. Sridharan

- (1) *Stellar Speckle Interferometry and Imaging*, and (2) *Adaptive Optics Related Activities at IIA*, 12/08/2017, International Topical Meeting on Applied and Adaptive Optics, IIST, Thiruvananthapuram.

A. Subramaniam

- *Early science result from UVIT on AstroSat*, 3 July 2017, APRIM IAU Meeting, Taiwan.

S. Sur

- *Probing magnetic field with SKA*, 05/02/2018, Workshop No. 2 at the Annual meeting of ASI, Osmania University Hyderabad.

- *Simulating astrophysical turbulence and magnetic fields*, 05/02/2018, Workshop No. 6 at the Annual meeting of ASI, Osmania University.

- *Faraday rotation signatures of fluctuation dynamos in young galaxies*, 18/01/2018, National conference on Plasma simulations, IISc.

- *Faraday rotation measure from magnetic fields in young galaxies*, 30/08/2017, 'Plasma Universe and it's structure formation', IUCAA.

Contributed:

S. Barway

- *Do bars in S0 galaxies prefer a bulge type?*, 23 January 2018, Galaxy Evolution and Dynamical Structures (GEDS)-I at IUCAA, Pune.

S. Das

- *Chameleon dark matter at dwarf galaxy*, 8–12 October 2017, International Workshop on Post-Planck Cosmology, IUCAA.

A. Goswami

- *Kinematics and chemical analysis of a selected sample of CH and CEMP stars*, 13–17 November 2017, A celebration of CEMP and Gala of GALAH, Monash University, Melbourne, Australia.

B. Kumar

- *Long term optical monitoring of the transitional Type Ic/BL-Ic supernova ASASSN-16fp (SN 2016coi)*, 06-02-2018, 36$^{\text{th}}$ Astronomical Society of India meeting, Osmania University, Hyderabad, India.

S. Nandi

- *A misaligned restarted radio source hosted by a binary black hole*, 18–21 December 2017, AstroSat View of AGN Central Engines, IUCAA, Pune.

K. L. Pandey

- *Role of primordial black holes in SMBH formation at high z*, 7 February 2018, 36$^{\text{th}}$ Annual Meeting of Astronomical Society of India (ASI), Osmania University, Hyderabad, India.

- *Formation of Supermassive Black Holes: Direct Collapse Model; Role of PBHs & CBR*, 6 June, 2017, Recent Trends in the Study of Compact Objects (RETCO - III), Indian Institute of Space Science and Technology (IIST), Thiruvananthapuram, India.

V. Panditi

- *Comparison of Magnetic Properties in a Magnetic Cloud and Its Solar Source on 2013 April 11–14*, 20 July 2017, IAU-335, Exeter, UK.
- *Magnetic helicity and the eruptive nature of solar active regions*, November 2017, Helicity Thinkshop-3 Tokyo, Japan.

A. Raj

- *V2676 Oph: Dust formation in moderately fast nova*, 5 July 2017, IAU meeting (APRIM-2017) in Taiwan between 3–7 July, 2017.

Lectures given in any national, international, in-house meeting, conference, workshop, school organized at IIA

Invited:

R. Banyal

- *A Dual Cavity Fabry–Perot Device for High Precision Doppler Measurements*, 19-09-2017, Seminar, IIA Bangalore.
- *Introduction to Solar Telescopes*, 07-01-2018, Kodai Winter School on Solar Physics, Kodaikanal.
- *High Resolution Imaging of the Sun*, 10-01-2018, Kodai Winter School on Solar Physics, Kodaikanal.

E. E. Chellasamy

- *Radio Astronomy*, 15–31 May 2017, Kodaikanal Solar Observatory - Summer School.
- *Solar Radio Astronomy and Radio Receivers*, 7–14 January 2018, Kodaikanal Solar Observatory - Winter School.

A. Goswami

- *Astronomical Spectroscopy*, 3 May 2017, Astronomy Olympiad Camp, Visvesvaraya Industrial and Technical Museum, Bangalore.
- *Nucleosynthesis and Stellar Evolution-I, II, III (3 talks)*, 22–24 May 2017, IIA summer school, Kodaikanal Solar Observatory, Kodaikanal.

U. S. Kamath

- *Introduction to Observational Astronomy*, May 2017, Kodaikanal Summer School.

K. Nagaraju

- *The Sun*, 19–21 May 2018, Summer School, Kodaikanal.

G. Pandey

- *Lectures on Stellar Spectroscopy*, 22–24 May 2017, Summer school 2017 at Kodai.

V. Panditi

- *Solar activity and space-weather*, May 2017, Kodai summer school, Kodaikanal.

K. P. Raju

- *Solar Physics from Kodaikanal Observatory*, 11/01/2018, Winter school on solar physics, Kodaikanal.

B. Ravindra

- *Sunspots: Theory and observations*, 8 January 2018, Winter school.

R. Sridharan

- *Astronomical Instrumentation*, 29 & 30/05/2017, Summer School held at Kodaikanal.

A. Subramaniam

- *Science with UVIT*, 3 March 2018, National Science Day, Physics Dept., Bangalore University.
- *Study of globular cluster NGC 1851 using UVIT*, 26 September 2017, second anniversary of the AstroSat mission, ISRO, Bangalore.
- *AstroSat and impact on Indian Astronomy*, 8 March 2018, Training camp on Science policy and management, NIAS, Bangalore.
- *Basics of Astronomy*, 6–7 September 2017, Workshop conducted by Indian Academy of Sciences, Shillong.

Invited lectures (not popular lecture) given in any academic institution other than IIA which is not a part of any meeting/ conference

R. Banyal

- *Optical and Adaptive Optics Design of NLST*, 04-10-2017, Physical Research Laboratory (PRL).
- *Analysis of Fabry-Perot cavity for high precision RV measurements*, 27-11-2017, Udaipur Solar Observatory, Udaipur.

P. Chingangbam

- *The shape of quantum fluctuations*, 8 February 2018, IIT Hyderabad.
- *A new probe of cosmological fields*, 25 August 2017, Korea Astronomy and Space Institute, Daejeon, South Korea.
- *Minkowski Tensors as probes of cosmological fields*, 4 September 2017, Korea Institute for Advanced Study, Seoul.
- *A novel probe of cosmological fields*, 20 July 2017, Jamia Millia Islamia, New Delhi.

B. Kumar

- *Interstellar Medium*, 20-02-2018 to 05-03-2018, Pondicherry University.

T. P. Prabhu

- *Observational Facilities in India*, 23 September 2017, 100-hour certificate course in Astronomy and Astrophysics, MPBIFR, Bangalore.

A. Subramaniam

- *UVIT on AstroSat*, 6 September 2017, North-Eastern Space Application Center, ISRO, Shillong.

S. Sur

- *Big-Data Challenges in Astronomy and Astrophysics*, 11/08/2017, First task force meeting on Big-Data in Astrophysics organized by the Office of the PSA to Govt of India, IUCAA.

8.2 Awards, Recognition, Professional Membership, Editorship etc.

R. Banyal

- Became a lifetime member of the Optical Society of India (OSI).

S. Das

- DFG Initiation grant award with Prof. Dominik Schwarz (2017).

B. Kumar

- National Post Doctoral Fellowship of Science and Engineering Research Board (SERB), Department of Science and Technology, Government of India.

T. P. Prabhu

- Continued as member, IAU Finance Committee.
- Continued as Chair, ARIES 3.6-m Devasthal Optical Telescope Time Allocation Committee.
- Appointed Associate Editor, Journal of Astrophysics and Astronomy, published jointly by the Indian Academy of Sciences and Astronomical Society of India.

A. Raj

- Received IAU Grant of 600 EUR to attend (Oral presentation) IAU meeting (APRIM-2017) in Taiwan between 3–7 July, 2017.

A. Subramaniam

- Associate editor of the Journal of Astrophysics and Astronomy, A joint publication by the Indian Academy of Sciences and the Astronomical Society of India.

S. Sur

- Associate member of the SKA Science working group on 'Cosmic Magnetism' since November 2017.

8.3 Externally Funded Projects

G. C. Anupama

- Indian PI of the International Project, *"GROWTH: Global Relay of Observatories Watching Transients Happen"*, funded by IUSSTF–SERB (2015–2018) under the PIRE programme.

R. Banyal

- PI of the project, *Development of a stabilized Fabry-Perot wavelength calibrator for precision Doppler spectroscopy*, funded by SERB/DST.

R. K. Chaudhuri

- *Profiling the electronic structure properties of relativistic and nonrelativistic systems using computationally cost effective ab initio methods*, DST No: EMR/2015/000124 (PI).
- *Time dependent linear and nonlinear response properties of atomic systems: Effect of classical and quantum plasma environment and spatial confinement*, DST No. EMR/2017/000737 (Co-PI).

S. Das

- IUSSTF (Indo-US virtual center grant).
- DFG initiation grant, 2017.

A. Goswami

- *Galactic evolution of neutron-capture elements: Insight from chemical analysis of carbon-enhanced metal-poor stars*, Funded by DST (SERB), (PI).
- *BELGO-INDIAN Network for Astronomy & Astrophysics BINA-2*, DST, (Co-PI).

B. Kumar

- *Investigation of the observational properties of stripped envelope and circumstellar medium interacting supernovae*, Science and Engineering Research Board (SERB), Department of Science and Technology, Government of India.

G. Pandey

- *Aspects in Stellar and Galactic Evolution*, project funded by DST.

V. Panditi

- INSPIRE grant from Department of Science and Technology.

K. P. Raju

- *Spectroscopy of the Solar Corona using Ground and Space-based Observations*: DST Woman Scientist Scheme for P Maya.

D. K. Sahu

- *Multi-Wavelength and Multi-Messenger Studies of the Transient Universe*, DST-BRICS project funded by DST.

A. Subramaniam

- DST-DAAD visitation programme-2017.

8.4 Workshop, Conference, School etc. Organized at IIA or outside IIA

E. E. Chellasamy

- LOC Member, *Winter School 2017*, January 7–14, 2018.

A. Goswami

- Co-ordinator *Kodai Summer School*, May 2017 at Kodaikanal Solar Observatory, Kodaikanal.

K. Nagaraju

- Convenor for *Kodaikanal Winter School on Solar Physics*, conducted at Kodaikanal during 7–12, January, 2018.

K. L. Pandey

- Member of the local organizing committee (LOC) for 6^{th} *Neighborhood Astronomy Meeting*, (5–6 April, 2018), at IIA, Bengaluru, India.

R. Sridharan

- LOC Member, *Kodai Winter School*, Kodaikanal Solar Observatory, Kodaikanal.

A. Subramaniam

- Chair of the Local Organising committee, for *the TMT Science Forum-2017*, held in Mysore, India, 6–9 November 2017.

S. Sur

- Co-convenor of Workshop No. 6 titled *'Cosmological HD & MHD simulations and data analysis techniques: solving challenges in Astronomy and Astrophysics'*, ASI 2018 at Osmania University, Hyderabad.

9 People

Director: P. Sreekumar

Academic & Scientific Staff

Senior Professor: G. C. Anupama, Jayant Murthy

Professor: Annapurni Subramaniam, Arun Mangalam, R. K. Chaudhuri, Dipankar Banerjee, B. Eswar Reddy, R. T. Gangadhara, K. M. Hiremath, Prajval Shastri, B. Raghavendra Prasad, K. P. Raju, R. Ramesh, S. K. Sengupta

Associate Professor: Aruna Goswami, B. C. Bhatt, Gajendra Pandey, U. S. Kamath, Maheswar Gopinathan, Mousumi Das, S. Muneer, Muthumariappan, P. S. Parihar, S. Paul Kaspar Rajguru, Pravabati Chingangbam, B. Ravindra, D. K. Sahu, M. Sampoorna, Sivarani Thirupathi, C. S. Stalin

Scientist E: B. A. Varghese (up to 30.09.2017)

Reader: E. Ebenezer Chellasamy, Firoza Sutaria, C. Kathiravan, Nagaraju. K, Piyali Chatterjee, Ravinder Kumar Banyal, Sharanya Sur, Subinoy Das

Scientist D: Rekesh Mohan, N. Shantikumar Singh, R. Sridharan, Sudhanshu Barway

Scientist C: G. S. Suryanarayana

Scientist B: Namgyal Dorjey, G. Selvakumar

Research Associate B: M. Appakutty

Adjunct Scientist: K. Sankarasubramanian

Adjunct Professor: A. N. Ramaprakash

Visiting Professor: K. V. Govinda, K. N. Nagendra (up to 31.07.2017), G. Srinivasan, S. N. Tandon

Honorary Professor: K. E. Rangarajan, P. Venkatakrishnan (up to 30.10.2017)

Consultant: C. H. Basavaraju, Christina Birdie (up to 12.09.2017), Lt. Col Kuldip Chandar, P. K. Nirmala Kumaran (up to 22.09.2017), Sandra Rajiva (up to 15.05.2017), K. Thiyagarajan (up to 16.10.2017), Viswanatha Narasimhaiah

Post Doctoral Fellow: Arun Surya, Ashish Raj, Bari Maqbool, Binukumar,

Hema B. P, Kanhaiya Lal Pandey, Koshy George, Sumana Nandi, Suvendu Rakshit (up to 22.08.2017), Vineeth Valsan

Technical staff

Engineer F: G. Srinivasulu

Engineer E: Amit Kumar, V. Arumugam, Faseehana Saleem, P. M. M. Kemkar, P. K. Mahesh, S. Nagabushana, R. Ramachandra Reddy, M. V. Ramaswamy, B. Ravikumar Reddy, S. Sriram, J. P. L. C. Thangadurai (up to 31.10.2017)

Engineer D: P. Anabazhagan, Dorje Angchuk, S. Kathiravan, Sanjiv Gorka, K. C. Thulasidharen, Tsewang Dorjai, P. Umesh Kamath

Principal Scientific Officer: R. Selvendran

Engineer C: Anish Parwage, K. Anupama, K. Dhananjay, A. Ramachandran, K. Ravi, Sonam Jorphail, Tashi Thsering Mahay, Vellai Selvi

Technical Officer B: Narasimhappa (up to 31.07.2017)

Engineer B: Chinchu Mohanan. K, V. S. Gireesh Gantyada, Indrajit V. Barve, Mallappa, Manoj Kumar Gubbala, M. Rajalingam, S. Ramamoorthy, Totan Chand, Tsewang Gyalson, Vinay Kumar Gond

Technical Officer: M. R. Somashekar, C. V. Sri Harsha

Tech. Associate B: P. Kumaravel, J. Manoharan, S. Venkateshwara Rao

Sr. Tech. Asst. C: R. Ismail Jabillullah, A. Muniyandi

Asst. Librarian B: B. S. Mohan, P. Prabahar

Sr. Research Asst. B: V. Moorthy

Research Associate: C. Velu

Technical Asst. C: D. Premkumar, V. Robert

Technical Associate: K. Sagayanathan, P. R. Sreeramulu Nayaka

Administrative staff

Sr. Administrative Officer: P. Kumaresan

Administrative Officer: Shripathi. K

Accounts Officer: S. B. Ramesh

Assistant Personnel Officer: Narasimha Murthy (up to 31.12.2017)

Stores & Purchase Officer: K. P. Vishnu Vardhan

Sr. Section Officer: K. Padmavathy (up to 31.12.2017), Pramila Mohan

Section Officer (SG): Maliny Rajan, N. K. Pramila, N. Sathya Bama, Uma Maileveloo

Section Officer: Diskit Dolker, Ramaswamy, P. Selvakumar, Srinivasa Rao. V, V. Vijayaraj

Section Officer (Hindi): S. Rajanatesan

Sr. Office Superintendant: A. Veronica