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Chapter 1

FROM THE DIRECTOR'S DESK

On July 1, 2013, I undertook the enviable job of directing India's oldest and largest astronomy institution for a 5-year period. The multitude of academic and research activities in this institute reflects the continued growth of astronomy and astrophysics research programs in the country. I am glad to report that during the period of 2013–14, the Institute made important contributions to research, developing and establishing advance research facilities, producing well-trained human resources and in taking science to the public at large. I present here some of the more significant achievements of the Institute during this period.

At IIA, the scope of research ranges from the Sun and the solar system, stars, our Galaxy, external galaxies and to sources and processes associated with the farthest regions of the observational Universe. In the field of Solar Physics, properties of small-scale magnetism of solar atmospheres were studied using 3D Magneto-convection simulations. The nature of small-scale vortex motions and their relationship with magnetic fields on the solar photosphere were investigated through detailed statistical analysis. Observational evidences were found supporting the idea that polar jets are likely to be produced by multiple small-scale reconnections occurring at different times in different locations. The interactions among the emerging fields give rise to magnetic reconnections followed by mass ejections with collimated hot plasma flows commonly termed as jets. It is observed that the bright point associated with the first such jet is a part of a sigmoid structure. The dynamical behaviour of a jet in an on-disk coronal hole observed with AIA/SDO is studied in detail. Paschen-Back effect in the hyperfine structure states of an atom in the solar atmosphere and the quantum interference signatures of the Ba II D2 4554 Åline in the second solar spectrum have been investigated. The solar photospheric vector magnetograms are simulated by using linear and nonlinear force-free (NLFF) magnetic fields assuming a simple axisymmetric configurations in spherical geometry. The sunspot whorls are studied by using Big Bear Solar Observatory & Kodaikanal Observatory data. The X-ray Solar Monitor (XSM) on the Indian lunar mission Chandrayaan-1 provided a unique dataset which was used to derive solar coronal abundances and study its variation as the flare progressed.

In the area of planetary studies, data from the Chandrayaan-1 X-ray Spectrometer (C1XS) experiment, provided for the first time unambiguous evidence of enhanced Sodium from the lunar surface.

In stellar and galactic astrophysics, classical novae Nova Cephei 2013 and Nova Delphini 2013 were observed in the optical and NIR using the 2m HCT and in the radio using the GMRT. High resolution spectra of Nova Delphini 2013 were also obtained with the 2.3m VBT. The 2014 outburst of the recurrent nova V745 Sco was monitored spectroscopically using the VBT. Photometric observations were made with the 1.3m JCBT. The recurrent novae T CrB, RS Oph, CI Aql,U Sco and V3890 Sgr continue to be monitored during their quiescence phase as a part of the spectroscopic monitoring programme to study the long term behaviour of these systems.

A detailed optical and UV analysis of SN 2012dn was carried out. Properties of newly formed dust grains in the luminous Type IIn Supernova 2010jl were investigated. The optical observations of type Ib supernova iPTF 13bvn obtained with the HCT, were used to compute the bolometric light curve. The hydrodynamical modelling of bolometric light curve shows that the progenitor had a pre-SN mass of *sim* 3.5 M*odot*. Therefore, an interacting binary system as the SN progenitor is proposed. From a detailed analysis of multi-wavelength photometry of young clusters, it is found that the star formation process is continuous for the clusters Be 59, NGC 604 and NGC 7510 but the process is episodic for the clusters NGC 1931 and NGC 7261. Extended V and I time-series observations of four globular clusters NGC 7099, NGC 7492, NGC 6333 and NGC 288 yielded high-precision light curves of variable stars which enable search for new variable stars in these clusters and refine periods of known variables. Low-resolution spectroscopic survey has identified a few hydrogen-deficient (H-deficient) stars in the red giant sample of the globular cluster Omega Cen.

In the area of extra-galactic Astronomy and Cosmology, a few gravitational-lensed quasars were systematically monitored. A sample of 77 Active Galactic Nuclei (AGN) was observed on a total of 262 nights using 1-2m class optical telescopes located in India and the optical flux variations on minute to hour time scales with amplitudes ranging from few hundredths to few tenths of a magnitude were determined. AGN activity and black hole masses in Low Surface Brightness galaxies were investigated by retrieving SDSS spectra of 650 galaxies from a sample of 1200 Low Surface Brightness galaxies provided in various catalogues. Dual-frequency phase-referenced VLBI observations of the Seyfert galaxy KISSR1494 were carried out. A single, slightly resolved radio component at 1.6 GHz is detected, but not at 5 GHz. This implies a spectral index steeper than -1.5±-0.5 for the galaxy. A general relativistic model of jet variability in active galactic nuclei from a helical bulk flow along a funnel shaped magnetic surface anchored to the accretion disk close to the black hole is developed. The neutral atomic Hydrogen (HI) kinematics of the Large Magellanic Cloud is revisited in the light of two new proper motion estimates. The well known arms E, S, W, B and a new stream, Outer Arm, as part of various outer components of the LMC are identified. Results from the largest CaII triplet line metallicity study of Small Magellanic Cloud field red giant stars involving 3037 objects spread across approximately 37.5 deg^2, centered on this galaxy were obtained. A median metallicity of [Fe/H]=-0.99±0.01, with clear evidence for an abundance gradient of -0.075±0.011 dex/degree over the inner 5 degrees was detected.

In the area of theoretical physics, the phases of ultra-cold atoms in lattices formed by lasers in the presence of an additional potential were examined. Multi reference Fock-space coupled cluster has been applied to evaluate the ionization potential (IP), excitation energies (EE), nuclear magnetic hyperfine constant etc. for singly ionized Eka-Lead (Fl II). Similar calculations are also performed for Lead ion (Pb II) to assess the accuracy of the theoretical estimates of Fl ion.

One of the most important activities of the Institute is the graduate student programme. As in previous years, a large number of bright students have joined the Ph.D. and Integrated M.Tech-Ph.D. programmes offered by the Institute. I am happy to report that as many as four students have been awarded the doctoral degree during this period and three students have submitted their thesis towards completion of their Ph.D. A large number of University students also participated in pursuing a variety of summer projects.

A few important instrument facilities for various observatories were designed and developed during this academic year. A full disk solar imaging telescope WARM (White light Active Region Monitor), has been designed and developed in-house to facilitate availability of long-term data products to the solar community. The Kodaikanal digitized images are now archived at the IIA data center. The archive hosts 41,000 images of the Ca-K spectroheliograms as observed over a period from 1904 to 2007. Design, detailed engineering, manufacture and assembly of "Imager" for testing the 1.3 m telescope to check the image quality and field of view of the telescope was completed. This instrument is planned to be mounted on other telescopes at VBO for similar checks. A new set-up for ground based spectropolarimetric observations of the solar radio transients in the frequency range 35–85 MHz was recently commissioned at the Gauribidanur radio observatory.

The UVIT instrument which is designed to be the world's best UV imager, suffered an unexpected setback due to the failure of the visible detector during the final vibration test. Corrective actions are being taken and the payload is expected to be delivered soon to ISRO for integration into ASTROSAT.

Among the new initiative for upcoming facilities, the Thirty Meter Telescope (TMT) project reached some key milestones. On 24th July of 2013, in

Left: Dr P. Sreekumar seen with Professor G. Srinivasan who delivered the founder's day lecture entitled "Down Memory Lane - Vainu Bappu's Dreams Revisited" on 8th August, 2013. Right: Professor T. Padmanabhan of IUCAA, Pune delivering the Vainu Bappu Memorial Lecture entitled "Conceptual Conundrums in Cosmology".

the meeting of the board of Directors at Hawaii, USA, the scientific authorities of the respective partner countries executed the master agreement agreeing for basic governing principles of the partnership, contributions, observing time etc. With the consent of Department of Science and Technology, I have signed the master agreement representing India TMT which is jointly implemented by IIA, IUCAA and ARIES. Prof. B. Eswar Reddy represented India TMT at the signing ceremony. The overall instrument configuration for ADITYA 1 Visible Emission Line Coronograph (VELC) was finalized and most of the component level designs are completed. Base line Design review is completed for all subsystems including mechanical structure. The preliminary thermal and structural analysis are completed. Considerable effort went into the selection of the detector, configuration of electronic, mechanical and thermal interfaces, optimization of camera electronics and design of on-board data processing schemes. Other projects like the National Large Solar Telescope (NLST) have gained substantial progress during this academic year with activities related to the design and development of prototype focal plane instruments. Besides these upcoming facilities, a high resolution spectrometer (HESP) is being fabricated to enhance observational capabilities for the 2m Himalayan Chandra Telescope (HCT) at Hanle. HESP is currently in an advanced stage with the instrument expected to be installed for trial observations later this year. The new 1.3m telescope established at Kavalur is currently in its final stage of field testing and optimisation.

I am delighted to inform that the Governing Council has elected Professor B.V. Sreekantan to the Honorary Fellowship of the Institute for his illustrious scientific contributions in general and to the Institute in particular as a Member of the Council (1988 – 1992) and subsequently as its Chairman (1992 – 2007). The Institute had the honour of hosting three prestigious lectures: the Vainu Bappu Memorial Lecture - "Conceptual Conundrums in Cosmology" was presented by Professor T. Padmanabhan of IUCAA, Pune on the 5th July, 2013, the IIA Founder's Day Lecture - "Down Memory Lane - Vainu Bappu's Dreams Revisited" was delivered by Professor G. Srinivasan on 8th August, 2013 and the 23rd Bicentennial Commemorative Public Lecture - "The Search for a Unified Theory" was delivered by Professor Ashoke Sen on 9th December, 2013.

I am happy to report that Professor Annapurni Subramaniam was elected as Fellow of the Indian Academy of Sciences, Bangalore and also as Fellow of the National Academy of Sciences, Allahabad. Dr. M. Sampoorna has been awarded the Young Scientist Platinum Jubilee award of NASI (National Academy of Sciences India) for the year 2013 and Mr. A. Prasad has been awarded Shyama Prasad Mukherjee Fellowship for SRF by CSIR.Prof.S.S.Hasan has been elected to the Life Membership of the Clare Hall College, Cambridge.

The public outreach activities of the Institute were spread across all field stations. The National Science Day was celebrated and sky watch for general public was organized at Bangalore as well as Kavalur campuses. The Institute has taken several steps for the implementation of the Official Language and the welfare of SC/ST and physically-challenged staff. The list of scientific publications in peer reviewed journals, conference proceedings as well as in mono-

The 23rd Bicentennial Commemorative Public Lecture entitled "The Search for a Unified Theory" was delivered by Professor Ashoke Sen, FRS on the 9th of December, 2013.

graphs, books and popular periodicals are listed in this report.

I would like to place on record the indebtedness of the Institute to Dr K. Kasturirangan (Member of the Council 1988 - 2007; Chairman: 1-4-2007 to 10-11-2013) and Prof.J.V.Narlikar (Member: 1-4-2007 to 10-1-2014). Their strong support and guidance enabled the Institute to embark on setting up several new astronomical facilities. We warmly welcome Professor P.C. Agrawal, the new Chair of the IIA Governing Council (from 11-11-2013).

Today IIA is playing an important and responsible role in developing many new astronomical facilities catering to the needs of the broader Indian astronomical community, often in close collaboration with other leading institutes in the country. These activities demand optimal use of available scientific and technical expertise. The formation of the IIA Council, the creation of the Systems Engineering Group, the expansion of the Faculty group, conducting comprehensive reviews of ongoing developmental programs, encouraging enhanced activities at field stations and enabling recruitment of essential human resources, are some of the initiatives taken during this period. I truly believe that with several new facilities in the pipeline and some nearing completion, the Institute will continue to enhance its scientific productivity and excel in the field of Astrophysics during the coming years.

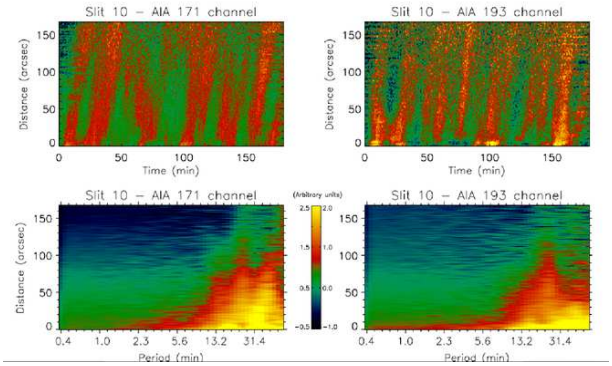
P. Sreekumar
Director

Chapter 2

RESEARCH

2.1 Sun and the Solar System

At the Kodaikanal Observatory, full disk spectroheliogram recording started in 1912 and continued uninterrupted until 2005. A detailed study of the sunspot associated super penumbral fibril structures was carried out using the digitized data sets of Kodaikanal Observatory and Big Bear Solar Observatory. A feasibility study was carried out at NJIT, during April–June 2013, using several sample cases. It was shown that the two data sets are complementary for both short and long term studies of the chromosphere in H-alpha.



Enhanced time-distance maps (top) and period-distance maps (bottom) in 171 and 193 channels of AIA, generated from the interplume region.

Polar plume/interplume regions and extended fan loop structures in active regions of the Sun are often found to host outward propagating slow magnetoacoustic waves. Besides their contribution to coronal heating and solar wind acceleration, they are important for their seismological applications. Recent studies indicate that the observed damping in these waves is frequency dependent. Imaging data from SDO/AIA is used to study this dependence in detail. Polar jets and X-ray bright points are prominent dynamical features of coronal hole regions of the Sun. Soft X-ray jets were discovered in Yohkoh/ SXT data. In the coronal hole region the ambient magnetic fields are nearly vertical and often unipolar. The interaction among the emerging fields gives rise to reconnection followed by mass ejections, with collimated hot plasma flows commonly termed as jets. Observational evidences are obtained supporting the idea that polar jets are likely to be produced by multiple smallscale reconnections occurring at different times in different locations and ejecting plasma blobs flowing up and down with a motion very similar to a simple ballistic motion.

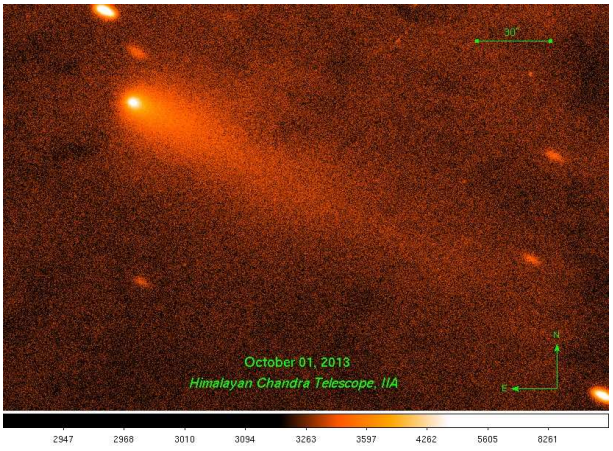
The polarized spectrum of the Sun is formed through the scattering of anisotropic radiation on atoms. Interpretation of this spectrum requires the solution of polarized line transfer in multilevel atomic systems taking account of both the Rayleigh and Raman scattering. If the initial and final states involved in scattering are the same then it is referred to as the Rayleigh scattering, and when they are different it is called the Raman scattering. A new approximate approach to this problem is formulated and is applied to a five-level Ca II atom model taking account of multi-level coupling. The linearly polarized spectrum of the Sun is formed due to coherent scattering processes in which quantum interference phenomena plays a vital role. The Ba II D2 line at 4554 Åis a good example, governed by the F-state interference effects, seen only in the lines of odd isotopes which undergo hyperfine structure splitting. These odd isotopes of Ba constitute only 18% of the total Ba abundance in the Sun, the rest 82% being even isotopes which do not exhibit F-state interferences. It is therefore necessary to account for the contributions from different isotopes to understand the observed linear polarization profiles of this line. Radiative transfer models have been derived with partial frequency redistribution (PRD) of such observations, while accounting for the interference effects and isotopic composition. The Ba II D2 polarization profile

is found to be strongly governed by the PRD mechanism. It is also found that the line center polarization is sensitive to the temperature structure of the model atmosphere.

In the quiet solar photosphere, the mixed polarity fields form a magnetic carpet, which continuously evolves due to dynamical interaction between the convective motions and magnetic field. This interplay is a viable source to heat the solar atmosphere. The line-of-sight (LOS) magnetograms are obtained from the Helioseismic and Magnetic Imager (HMI) on the Solar Dynamics Observatory (SDO). The Imaging Magnetograph eXperiment (IMaX) instrument on the Sunrise balloon-borne observatory have been used to study the evolution of the coronal magnetic field. A magneto-frictional relaxation method has been used to produce time series of three-dimensional (3D) nonlinear force-free fields from a sequence of photospheric LOS magnetograms. Vertical flows are added up to a height of 0.7 Mm in the modeling to simulate the non-force-freeness at the photosphere-chromosphere layers. Among the derived quantities, the spatial and temporal variations of the energy dissipation rate and energy flux are studied. The results show that the energy deposited in the solar atmosphere is concentrated within 2 Mm of the photosphere and there is not sufficient energy flux at the base of the corona to cover radiative and conductive losses.

The Spatial Possibilistic Clustering Algorithm has been applied on AIA spatially resolved images and HMI magnetograms to create segmentation maps for Active Regions (ARs), Coronal Holes (CHs) and Quiet Sun (QS). The AIA segmentation maps are then applied on full-disk HMI line-of-sight of magnetograms, and the different parameters such as the intensity, the magnetic field and contribution of ARs/CHs/QS features are computed and compared with the full-disk integrated intensity, absolute magnetic field and LYRA EUV and UV irradiance measurements. A one-to-one spatial correspondence between the photospheric magnetic features and coronal features has been determined. It is found that the intensity is related with the strength of the magnetic field associated with AR and QS regions, whereas the intensity of CH is not related to its magnetic field. In addition the full-disk intensity and LYRA irradiance are related to full-disk absolute magnetic field and this suggests that the magnetic field plays an important role in the EUV & UV irradiance

In January 2013, the IIA high-altitude balloon group has initiated observations of the comet ISON in preparation for the November 2013 launch of the UV spectrograph to observe it at the time of the perihelion in near UV window. The group has observed the comet in January, February, May, September and October 2013, both in imaging and spectroscopic modes using HCT and VBT telescopes providing 370-830 nm coverage. The images are being utilized as part of an international campaign observing the comet from around the globe. Analysis of comet's continuum (caused by the reflected sunlight from dust particles in the coma) provides the knowledge about the nature of the comet's dust. In addition, comet's images were used for public outreach in the 'Eyes in ISON's nation-wide campaign'.



Comet C/2012 (ISON) 2013 October 01, R band 300 sec exposure. Observers: Margarita Safonova and Pramod Kumar. The observations were performed in the Keystone mode of the HCT. Distance to the comet is 2.151 AU, where 30 is equal to 46,790 km.

2.2 Stellar and Galactic Astronomy

The classical novae Nova Cephei 2013 and Nova Delphini 2013 were observed in the optical and near infrared using the 2m HCT and in the radio using the GMRT. High resolution spectra of Nova Delphini 2013 was also obtained with the VBT. The 2014 outburst of the recurrent nova V745 Sco was monitored spectroscopically using the VBT. Photometric observations were made with the 1.3m JCBT. The evolution of the low frequency radio flux was studied using the GMRT, and found to be non-thermal similar to RS Ophiuchi. A detailed optical and UV analysis of SN 2012dn is carried out. In optical bands, it is marginally luminous ($M_B^t extmax = -19.52 pm 0.15$), however, in the itSwift UVOT bands, it is *sim* 1 to

2 magnitudes brighter than normal type Ia supernovae and shows very blue colours in the $(uvw1 - v)$ and $(U - B)$ bands. The photometric and spectroscopic behaviour of SN 2012dn is different from those of normal and SN 1991T like objects. With very strong secondary maximum, the light curve in I band peaks after maximum in B band, which is just opposite to the observed trend for normal type Ia events. During late phase light curve decline of SN 2012dn is faster. The contribution of UV bands to the bolometric flux is quite high (*sim* 20%). The peak bolometric luminosity indicates that *sim* 0.82 $M_o dot$ mass of ^{56}Ni was synthesized in the explosion. Pre-maximum spectra show clear evidence of C,sc ii 6580 AA. The optical observations of type Ib supernova iPTF 13bvn obtained with the HCT were used to compute bolometric light curve. The hydrodynamical modelling of bolometric light curve shows that the progenitor had a pre-SN mass of *sim* 3.5 M*odot*.

Optical photometric study of 5 clusters (Be 59, NGC 1931, NGC 6604, NGC 7261 and NGC 7510) with an age range of 1-10Myr has been carried out by using the Himalayan Chandra telescope (HCT)and are combined with NIR data from 2MASS and mid-IR data from WISE. The youngest cluster Be 59, with age *sim*1Myr, hosts the highest fraction of YSOs. It is found that for Be 59, NGC 604 and NGC 7510 the star formation processes are continuous; while for NGC 1931 and NGC 7261 the star formation is episodic.

A comprehensive abundance analysis for a sample of relatively unexplored RV Tauri and RV Tauri like stars is done in order to understand the post-Asymptotic Giant Branch (post-AGB) evolution. Study based on high resolution spectra and a grid of model atmospheres indicates mild s-processing for V820 Cen and IRAS 06165+3158. On the other hand, SU Gem and BT Lac exhibit the effects of mild dust-gas winnowing. From a compilation of the existing abundance data on RV Tauri objects it is also found that a large fraction of these objects are afflicted by dust-gas winnowing. With two out of three reported s-process enhanced objects belonging to RV Tauri spectroscopic class C, these intrinsically metal-poor objects appear to be promising candidates to analyse the possible s-processing in RV Tauri stars.

Extended V and I time-series observations of four globular clusters NGC 7099, NGC 7492, NGC 6333 and NGC 288 are done using difference image analysis to obtain high-precision light curves of variable stars which enable to search for new variable stars in these clusters and refine the periods of known variables. The cluster parameters are estimated by performing a Fourier decomposition of the light curves of RR Lyrae stars for which good period estimates were available. An age of 13.0 ± 1.0Gyr for NGC 7099 is estimated by fitting theoretical isochrones to our colour-magnitude diagram (CMD). For NGC 7099 we find two new RR Lyrae variables. Four other kinds of variables, including an eclipsing blue straggler system, and an SX Phoenicis star are also detected. A cluster metallicity [Fe/H]ZW = -2.01 ± 0.04, a distance of 8.32 ± 0.20 kpc (using RR0 variables) for NGC 7099 are found. IN NGC 7492 it is found that RR Lyra variable V2 is undergoing period change; using P-L relation of SX Phe stars a distance of 24.04 ± 0.20 kpc is estimated while [Fe/H]ZW = -1.68 ± 0.04 is estimated for NGC 7492. Similarly, it is found that [Fe/H]ZW = -1.62 ± 0.04, a distance of 8.99 ± 0.20 kpc for NGC 288, [Fe/H]ZW = -1.70 ± 0.04, a distance of 8.04 ± 0.20 kpc for NGC 6333.

Non-LTE and LTE abundance analyses is performed in order to determine the effective temperature, surface gravity, and chemical composition of DY Cen stars. High-resolution spectra obtained over two decades are used. The derived stellar parameters for three epochs suggest that DY Cen has evolved at a constant luminosity and has become hotter by about 5000 K in 23 years. The derived abundances remain unchanged for the three epochs. The study implies that DY Cen stars, by chemical composition, appears to be a product of a merger of two white dwarfs.

Low-resolution spectroscopic survey for identifying the hydrogen-deficient (H-deficient) stars in the red giant sample of the globular cluster Omega Cen has been carried out. Spectral analyses was performed on the basis of the strengths of (0,0) MgH band and the Mgb triplet. Four giants in the sample were identified with weak/absent MgH bands in their observed spectra, which is not as expected for their well determined stellar parameters. The Mg abundances for the program stars were determined from subordinate lines of the MgH band to the blue of the Mgb triplet, using the spectral synthesis technique. The derived Mg abundances for the program stars were as expected for the red giants of Omega Cen, except for the four identified candidates.

Abundances of 16 elements for 58 red giant members of the Hercules stream taken from published catalogue are investigated. Results show that they are quite young and metal rich with a considerable range in age (170 Myr to 4.2 Gyr) and metallicity (-0.17 dex to +0.43 dex). The results suggest that the member stars of the Hercules stream are part of the

thin disc component. This is contrary to the results in the literature which suggest that Hercules stream is a mixture of the thin and thick discs.

Considering energy limited evaporation of volatiles, the relevant hydrodynamic equations at the thermosphere of an Earth type of planets are solved and the rate of loss of hydrogen atoms due to the impinging stellar extreme ultraviolet radiation is calculated. It is found that if the ratio between the bolometric luminosity and the EUV luminosity is less than 1.4 X 10^5 then all the hydrogen atoms of a planet in the habitable zone would be evaporated within a period of a billion years making the planet inhabitable.

2.3 Extragalactic Astronomy & Cosmology

A systematic study was performed on two sources PKS 1502+036 and PKS 2004-447 using optical, X-ray and gamma-ray data from Swift and Fermi (i) to find the similarities and/or differences of these two sources with respect to the blazar class of AGN and (ii) to see if they fit into the traditional "blazar sequence". It is found that the broad-band spectral energy distribution of these sources resemble more to the flat spectrum quasars than to the BL Lac class of AGN and they fit into the traditional blazar sequence.

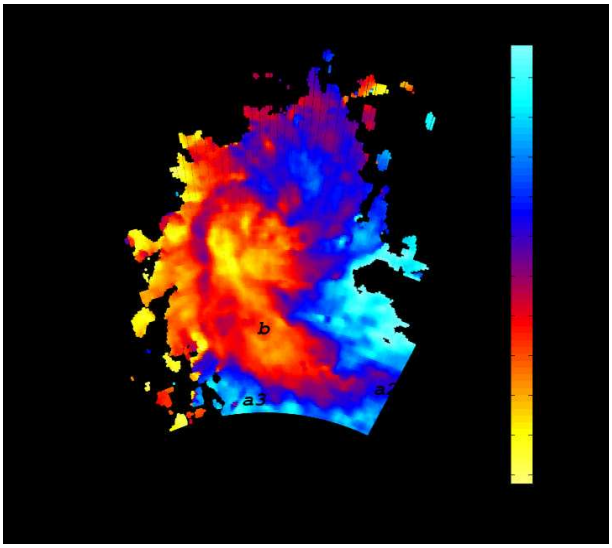
A set of six quasars is being monitored using the 2m HCT as part of the international COSmological MOnitoring of GRAvItational Lenses (COSMOGRAIL) collaboration. Towards this program, a robust time delay estimation procedure called the "Difference Smoothing Technique" has been developed at IIA. This method also takes into account the unwanted micro-lensing signals present in the quasar light curves. Using this new method, in conjunction with other techniques, a time delay of 119.3 ± 3.3 days is found for the doubly imaged quasar SDSS J1001+5027 using observations that span more than six years between March 2005 and July 2011.

A sample of 77 AGN is observed on a total of 262 nights using 1-2m class optical telescopes located in India. It is found that the INOV duty cycle for these classes are (i) 10 per cent for radio-quiet quasar using 68 nights of data, (ii) 18 per cent for radio-intermediate quasars using 31 nights of data, (iii) 5 per cent for lobe-dominated quasars using 35 nights of data, (iv) 17 per cent for low optical polarization core dominated quasars using 43 nights of data, and (v) 43 per cent for high optical polarization core dominated quasars using 31 nights of data and 45 per cent for TeV blazars using 54 nights of data.

Results from an extensive radial velocity survey of intermediate-age field stars in the Small Magellanic Cloud (SMC) have been presented. A sample of 3065 sources, predominantly from the red-giant branch population, within a region of sky of approximately 37.5 square degrees, centered on the Small Magellanic Cloud, has revealed a velocity gradient in the rest frame of the SMC that is similar in position-angle with that observed in the young, massive stellar population. The results reinforce the notion that the intermediate-age stellar population of the SMC is subject to substantial stripping by external forces. Results from the observation of CaII triplet line metallicity of Small Magellanic Cloud (SMC) field red giant stars involving 3037 objects spread across approximately 37.5 deg^2, centred on this galaxy have been presented. A median metallicity of [Fe/H]=-0.99±0.01, with clear evidence for an abundance gradient of -0.075±0.011 dex/degree over the inner 5 degrees is reported from the study. The structure and evolution of disk of the Small Magellanic Cloud (SMC) are traced by the study of V and I band photometric data of Cepheids from OGLE III catalog. The orientation measurements and the star formation history are estimated from the study.

The neutral atomic Hydrogen (HI) kinematics of the Large Magellanic Cloud (LMC) is revisited in the light of two new proper motion estimates. The intensity weighted HI velocity maps of ATCA/Parkes and GASS data sets are analysed. The line of sight velocity field for the systemic, transverse, precession and nutation motions of the disk is corrected and the kinematic parameters are estimated. The value of Position Angle (PA) of kinematic major axis estimated is found to be similar to the recent estimate of the PA using stellar tracers. The effect of precession and nutation in the estimation of PA is found to be significant. Most of the HI gas in the LMC is found to be located in the disk. 12.1% of the data points were detected as kinematic outliers. The well known Arms E, S, W, B and a new stream, Outer Arm, as part of various outlier components are identified. The GASS data analysis brings out the velocity details of the Magellanic Bridge (MB) and its connection to the LMC disk. It is suggested that Arm B could be an infall feature, originating from the inner MB, while Arm E could be an outflow feature.

A dual-frequency phase-referenced VLBI observations of the Seyfert galaxy KISSR1494 that exhibits double peaked emission lines in its SDSS spectrum is carried out. A single slightly resolved radio component at 1.6 GHz (but not at 5 GHz)) is detected,



The HI velocity map of the LMC. The locations of suggested gas outflows (a1, a2, a3) and accretion (b, c, d) are marked.

implying a spectral index steeper than -1.5±-0.5. The high brightness temperature of the radio component (1.4E+7 K) and the steep radio spectrum support a nonthermal synchrotron origin. Following the black hole mass-stellar velocity dispersion relation, the black hole mass in KISSR1494 is estimated to be 1.0E+8 $M_{\odot}$, accreting at an Eddington rate of 0.002. The radio data are consistent with either the radio emission coming from the parsec-scale base of a synchrotron wind originating in the magnetised corona above the accretion disk, or coming from the inner ionised edge of the accretion disk or torus.

2.4 Theoretical Physics

Atomic spectra plays an important role in many different situations in astrophysics. Theories that take into account relativistic and many-electron effects to determine the spectroscopic properties of closed shell atoms and ions, e.g., ionization potentials and polarizabilities have been calculated to a high degree of accuracy. A high precision calculation is performed in order to calculate the ionization potential of the heavy element xenon, which was detected fairly recently in the spectrum of a hot white dwarf. The electric dipole moment (EDM) of a physical system arises from parity and time-reversal violations. The CPT theorem implies that time-reversal violation and CP violation are equivalent. It therefore follows that the observation of an EDM is a signature of CP violation. Atomic and molecular EDM are excellent candidates for studying CP violation as well as probing new physics beyond the Standard Model of particle interactions. Using a relativistic theory which incorporated the interaction between the electrons in a rigorous manner and combining with the latest EDM measurement of xenon, limits on CP violating hadronic and semi-leptonic coupling constants are derived. The accuracy of the measurement of xenon EDM is likely to improve by three or four orders of magnitude in the next few years. This would correspondingly improve the accuracy of the limits of the CP violating coupling constants from our work and it would then be possible to constrain certain supersymmetric models.

The nuclear quadrupole moment that emerges due to the non spherical distribution of the nuclear charge plays an important role in atomic, molecular, and solid state spectroscopy besides the direct interest in nuclear physics, where its determination can be used to check nuclear models. The information of NQM is also useful for the evaluation of the nuclear magnetic resonance measurements in biological systems. Here, state-of-the-art coupled cluster based linear response theory for electron detachment processes is employed to determine the electric field gradients (EFG) of halide nuclei. The EFGs resulted from these calculations are the combined with experimental nuclear quadrupole coupling constants (NQCC) to determine the nuclear quadrupole moments (NQM) halide nuclei.

Theoretical investigations of the super-heavy elements are extremely challenging and are often the sole source of useful chemical information. In this context, multi reference Fock-space coupled cluster has been applied to evaluate the ionization potential (IP), excitation energies (EE), nuclear magnetic hyperfine constant etc. for singly ionized Eka-Lead (Fl II). Similar calculations are also performed for Lead ion (Pb II) to assess the accuracy of the theoretical estimates of Fl ion. The higher IPs and EEs of Fl II with respect to Pb II, suggest Eka-Lead (Fl) to be less metallic and more inert than Pb.

Chapter 3

STUDENTS PROGRAMS AND TRAINING ACTIVITIES

Student programs at the institute are carried out by the Board of Graduate Studies. The institute conducts a Ph.D. program, in collaboration with the Pondicherry University and an M.Tech-Ph.D. program, in collaboration with the Calcutta University. Apart from these, the institute also trains students through short term programs such as the visiting students program, the summer school and the summer project program. The highlights of these programs are summarised below.

3.1 Ph.D. Degree Awarded

Sumangala Rao was awarded the Ph.D. degree for her thesis entitled "Spectroscopic Studies of RV Tau and Related Objects" submitted to the Mangalore University. She carried out the work under the supervision of Sunetra Giridhar.

L. Anusha was awarded the Ph.D degree for her thesis titled "Advanced Numerical Methods for Polarized Line Formation Theory" submitted to the Mangalore University.

Prashanth Mohan was awarded the Ph.D. degree for his thesis titled "Models of Observational Signatures of Black Holes" submitted to the Bengal Engineering and Science University, Shibpur, West Bengal. He carried out the work under the supervision of Arun Mangalam.

Arya Dhar was awarded the Ph.D. degree for his thesis titled "Novel Quantum Phases in Ultracold Atoms in Optical Superlattices" submitted to the Mangalore University. He carried out the work under the supervision of B. P. Das.

3.2 Ph.D. Thesis Submitted

The following students have submitted their Ph.D. thesis:
K.Chandrasekhar submitted his thesis titled "Smallscale Transient Events in the Solar Corona" to the Pondicherry University, Puducherry. The research was done under the supervision of Dipankar Banerjee.

G. Indu submitted her thesis titled "The Structure, Kinematics and Evolution of the Magellanic Clouds" to the Pondicherry University, Puducherry. The research was done under the supervision of Annapurni Subramaniam.

P. Ramya submitted her thesis titled "Study of Stellar Streams in the Galaxy" to the Calicut University, Calicut. The research was done under the supervision of B. Eswar Reddy.

3.3 Completion of M.Sc. & M.Tech Program

The following student has completed his M.Sc. program:
V. Srinivasa Prasannaa, under the guidance of B. P. Das submitted his thesis titled "Single Ion Clocks: Theoretical Considerations" to the School of Sciences, IGNOU, for his M.Sc degree in Physics and Astrophysics.

The following students of the above program have completed their M.Tech. Degree under the IIA-CU integrated M.Tech-Ph.D. program.
Prasanna Deshmukh under the guidance of Pad-

makar Singh Parihar submitted his M.Tech. thesis titled "Development of Precision Controller for Thirty Meter Telescope Actuator" to the University of Calcutta.

Joice Mathew under the guidance of Jayant Murthy submitted his M.Tech thesis titled "Characterization of a Photon Counting Detector and Development of an Attitude Sensor for High Altitude Balloon Experiments" to the University of Calcutta.

Mayuresh N. Sarpotdar under the guidance of C. Kathiravan submitted his M.Tech thesis titled "FPGA based Digital Backend System for Low Frequency Radio Observations" to the University of Calcutta.

3.4 Visiting Internship Program

The visiting student's internship program is conducted by the Indian Institute of Astrophysics (IIA) with the aim to promote scientific research interest in college and university students. Students selected for this program work on specific projects that form a part of the ongoing research at IIA. Based on the nature of the project, the students will be asked to work at either the main campus of IIA in Bangalore or its field stations. Students carrying out their Ph.D. in Universities, and willing to visit IIA for collaborative research are also encouraged to apply for this program. During 2013–2014 thirty seven students did their projects under the guidance of the various academic staff members.

3.5 Summer Projects

School in Physics and Astrophysics

The summer school in Physics and Astrophysics, coordinated by the Board of Graduate Studies, is an yearly activity of the Indian Institute of Astrophysics (IIA). The main aim of the school is firstly to introduce students of B.Sc, M.Sc, B.E./B.Tech. 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 2013, the school was held at the Kodaikanal Observatory, during 14–24 May 2013.

Twenty five students participated in the school, of which twenty students each did a short term project for a duration of six weeks during June–July 2013, under the guidance of an IIA faculty in Bangalore. During the second week of July, 2013 they also made presentations on the results of their project work. The program during the period 14–24 May 2013, in Kodaikanal consisted of series of lectures including Physics and Astrophysics mostly by the faculties of IIA, IISc. and RRI. Lectures were delivered on the following topics : (1) Newtonian Dynamics, (2) Sun and Heliophysics, (3) Radiative Process, (4) Solar magnetohydrodynamics, (5) Stellar Physics, (6) Astronomical Techniques, (7) Plasma Astrophysics, (8) Galaxies, (9) Helio and Astro-seismology, (10) Observational Cosmology, (11) Relativity and Cosmology and (12) Highenergy Astrophysics.

Summer Internship Program

Some of the students who participated in the school stayed on for another 6 weeks to do short projects. Twenty students did their projects under the guidance of the various academic staff members of the Institute.

International Research Experience for Students (IRES)

International Research Experience for US Graduate Students (IRES) program, sponsored by the National Science Foundation of USA and administered by the National Solar Observatory, Tucson, USA, was hosted by IIA. Under this program a few graduate students of the United States study astrophysics in India. The program aims to expose potential researchers to an international setting at an early stage in their careers. After completing an initial three year period of successful running, this program received a positive review and continued funding from the NSF and 2013 is the seventh year of the program at IIA. The students associate with a faculty member at IIA for a research project, and also undertake visits to IIA's observatories and field stations.

Chapter 4

INSTRUMENTS AND FACILITIES

4.1 Systems Engineering Group

The Systems Engineering Group was recently formed in order to provide a coordinated support in several engineering disciplines like Electronics, Mechanical, Optics and Software in Instrumental Development, Maintenance and Facility Management Aspects. The Electrical and Civil groups also provide infrastructural development and maintenance support both at Bangalore as well as other field stations. The major activities in which the group was involved in the current year include: 1. The Aluminization of the Primary mirror at VBT as well as several mirrors from Kodaikanal tunnel and other facilities. 2. Support for major projects of IIA like UVIT, Aditya and HESP. 3. Lab testing of the Two Channel photometer with a view to commission the instrument at one of the telescopes at VBO, possibly on the 1 meter Telescope. 4. Performance testing of control system for 30 inch for positioning, tracking and guiding. 5. Commencement of the building activities of Raman Science Centre at Leh. There are also several important initiatives planned in the coming year like aluminization of secondary mirror of VBT and HCT primary mirrors, a civil structure at CREST for TMT mirror polishing, installation and commissioning of H-alpha telescopes at Kodaikanal and other projects; some of which were kept pending for quite sometime.

4.2 Photonics Laboratory

Adaptive Optics Experimentation Studies on an efficient and faster wavefront reconstruction method is being continued. Exploring wavefront sensing on extended objects has been taken up.

2.8 m and 1.6 m Coating Plant at VBO, Kavalur: Apart from periodic maintenance work at the 1.6 m and 2.8 m vacuum coating plants, aluminization work for the primary mirror of the Vainu Bappu Telescope, the primary mirror of the 30 inch telescope, 7 numbers of Kodaikanal tunnel mirrors and 7 numbers of coelostat mirrors are done

2.5 m Coating plant at IAO, Hanle: As part of the award of the annual maintenance contract to HHV, optics personnel were sent along with HHV engineers to assess the present condition of the plant. The AMC has been awarded to HHV and the spares for the plant have been ordered. Preparations are on to take up the work on the re-aluminization of the HCT primary mirror.

4.3 Electronics Laboratory

Development of CCD camera

A CCD camera for the thirty inch telescope is getting ready with the DEWAR and the internal electronics being integrated with the controller. The liquid nitrogen DEWAR is a centre filling one with a capacity of 1.5 litres has a holding time in normal mode of about 24 hrs and about 12 hrs in inverted mode. The DEWAR with all internal boards and wiring is being tested for its performance. The temperature monitoring unit designed earlier is already tested and the dewar is mounted with AD590 as well as PT-100 temperature sensors and can monitor temperatures on the surface of cold finger.

4.4 OBSERVATORIES

4.4.1 Indian Astronomical Observatory

2m Himalayan Chandra Telescope

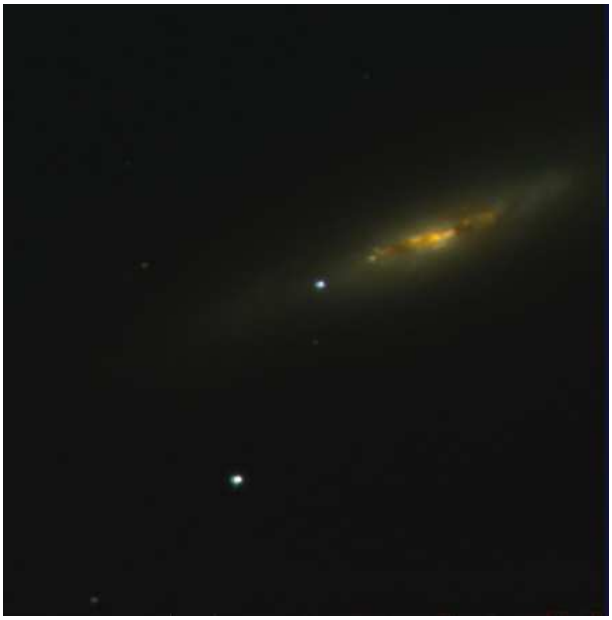
The 2m Himalayan Chandra Telescope (HCT) completed 11 years of utilization through competitive time allocation. In the three observing cycles for the year, 18 proposals were received for the 2013-Cycle2 (2013 May–August), 28 proposals for the cycle 2013-Cycle3 (2013 September–December) and 30 proposals for the cycle 2014-Cycle1 (2014 January–April). The telescope time was over subscribed by a factor 2 on an average, while the dark moon period was over subscribed by a factor 2.5-3. HCT proposals cover a wide range of scientific problems, from the observations of nearby solar system objects to the distant quasars.

The HCT was equipped with a new NIR instrument, the TIFR Near Infrared Spectrometer and Imager (TIRSPEC) developed by TIFR in collaboration with Mauna Kea Infrared (Hawaii). The detector array in the instrument is 1024x1024 Hawaii-1 array. With a 0.3 arcsec per pixel resolution, the instrument provides a Field of View (FoV) of 307 x 307 arcsec^2 in the imaging mode. In the Spectroscopic mode, a wavelength coverage from 1 micron to 2.5 micron with resolution of 1200 is available. Apart from the single order mode to cover 1.02-1.20 micron, 1.21-1.48 micron, 1.49-1.78 micron and 2.04-2.35 micron, cross disperse modes are also available to provide simultaneous wavelength coverage of 1.02-1.49 micron and also 1.50-2.45 micron.

The installation of this instrument at HCT was carried out by TIFR engineers with the help of IAO team during 2013 August–September. After a period of performance verification, the instrument was released for regular observations during January 2014. TIRSPEC replaces the NIR instrument that was available with the HCT.

The high resolution echelle spectrograph (HESP) is expected to be commissioned during 2014–2015. The preparatory work for its installation is continuing - the outer enclosure for housing the spectrograph in the pier area of the HCT was installed in November 2012, and temperature instability inside the enclosure is being monitored continuously.

The preventive maintenance of the telescope is carried out every month around full moon, which minimizes the downtime of the telescope during allotted nights. Various calibration and checks are done periodically to keep the performance of the telescope at its optimum level. In addition, annual maintenance was undertaken during the second fortnight of September 2013. The maintenance of the telescope, its backend instrument and dome assembly was carried out by the engineers and technical staff of IAO. Scientists from IIA associated with the operations of the telescope also participated in this activity.



JHKs colour-composite image of the supernova SN 2014J in the nearby galaxy M82 (J: blue; H: green; Ks: red) obtained with the TIRSPEC. The field-of-view is 5 arcmin x 5 arcmin. North is up, and east is to the left.

Auxiliary Infrastructure at IAO

The power requirement of the Observatory is met by Solar Photo-Voltaic electric power, and the existing battery banks are continuously monitored for their efficiency.

An upgrade of the hardware for the dedicated satellite-based communication link between IAO and the CREST campus of IIA used for remote operations of the 2m HCT was undertaken. The new hardware include Comtech MODEMS (1:1 Standby setup), LPOD (with 1:1 Hot Redundant System) and LNB (with 1:1 Hot Redundant System). During April-May 2013, the shifting of the link from the existing old and ageing DAMA hardware onto the New COMTECH modem and LPOD was implemented successfully at both the ends, in a phased

TIRSPEC mounted on the 2m HCT.

manner. The transition included permanent installation of the indoor (modem) and outdoor units (LPOD and LNB) with proper cabling and electrical connections, with all possible safeguards, and configuring them. The RF cable was replaced with new low loss Belden RF cable and its length was shortened to minimize the loss at both ends. After various tests and optimizations with Carrier in Carrier and IP SubMux, the satellite link with new equipment is working satisfactorily with improved link latency. This activity was undertaken by the engineers at IAO and CREST. An additional bandwidth of 3 MHz+1.5 MHz has also been allotted for satellite communication, which is awaiting clearances from the concerned authorities.

Gamma-Ray Facilities at IAO

The High Altitude Gamma Ray (HAGAR) facility is operated jointly by the IIA and Tata Institute of Fundamental Research (TIFR), Mumbai. The telescope has been in continuous use since 2007 for observations of active galactic nuclei, supernova remnants and gamma-ray emitting binary stars. The first Ph.D. thesis utilizing HAGAR data was completed by Mr Amit Shukla, IIA, during the current this year.

Bhabha Atomic Research Centre (BARC), Mumbai plans to install a 21-m imaging Atmospheric Cerenkov telescope Major Atmospheric Cerenkov Experiment (MACE) near HAGAR. Telescope control room, azimuth track, communication and power facilities are completed for installation of the telescope. Presently the complete telescope system is in its final stage of proof testing at Electronics Corporation of India Limited, Hyderabad. It is planned to be dismantled and shipped to IAO, Hanle later during the summer months of 2014.

NLOT Site Characterization Activity

The MASS-DIMM turbulence profiler acquired from TMT, USA is to be mounted on the Meade telescope that currently has the automated seeing monitor mounted. Since the mount+drive of the telescope is not very stiff, the results are unreliable beyond the wind speed of 4m/s. Therefore, the design and development of a sturdy Equatorial Fork Mount for the telescope has been initiated.

An automated lunar scintillometer developed at IIA, as an M.Tech project, has been successfully tested and installed at IAO, Hanle.

Earth Sciences

IIA has established two GPS stations at Leh and Hanle as a part of the National GPS Network. Initially it was funded by Department of Science and Technology, Government of India and later transferred to the Ministry of Earth Sciences with a view to connect all the national GPS stations to Indian National Centre for Ocean Information Service(INCOIS), Hyderabad. INCOIS has installed the VSAT communication equipments at Hanle to facilitate Hanle direct can download of data. VSAT equipment for the Leh GPS has reached Leh and is to be installed.

Space Physics Laboratories, VSSC/ISRO and IIA have collaboratively established an Aerosol Observatory at Hanle. The instruments are working well and data is being sent to SPL, Trivandrum.

Continuous carbon dioxide analyzer, PICARRO is working fine at IAO, Hanle inside the CARIBOU

building, as a part of Carbon Dioxide Observatory operated by IIA, Centre for Mathematical Modeling and Computer Simulation (CMMACS), Bangalore and Laboratoire des Sciences du Climat et de l'Environment (LSCE), France. This analyzer monitors carbon dioxide concentration of the ambient air in addition to molecular concentrations of Methane and Water Vapour in the ambient air. Manual sampling of ambient air is continuing with filling of 1 litre glass flasks periodically for subsequent detailed analysis at LSCE, France. The data is being submitted to C-MMACS.

4.4.2 Centre for Research & Education in Science & Technology (CREST)

CREST Campus of IIA houses the remote control station of 2-m HCT, IAO, Hanle. Guest Observers who are allotted time on HCT by the national time allocation committee, utilize this time from CREST with the help of a small group of astronomers supported by research or telescope trainees recruited periodically on a contract basis. During this year 3 (Three) nos. of Telescope trainees were appointed on contractual basis.

4.4.3 Kodaikanal Observatory

The Kodaikanal digitized images are now archived in the IIA data centre. The archive hosts 41,000 images of the Ca-K spectroheliograms as observed over a period from 1904 to 2007. The first results from these Ca-K digitized images have been published. The archive also hosts white light images 1904-till date (44000 plates). H-alpha spectroheliograms taken over 1904–1999 (38000 plates) have recently been digitized and archived. The calibration process is underway. The Ca-K spectroheliograms taken at the Kodaikanal Solar Observatory during 1904–2007 and digitized with 4k x 4k CCD have higher resolution (0. 86 arcsec) than the other available historical data sets.

A full disk solar imaging telescope WARM (White light Active Region Monitor), has been designed and developed in-house to facilitate long-term data products to the solar community. A two-mirror coelostat feeds sunlight to the WARM. An achromat with an effective aperture of 148 mm is used to image the Sun. The f/24 beam produces the Sun's image of 33 mm in diameter. A non-polarizing beamsplitter diverts the converging beam into two independent channels. In each channel secondary optical components are used to reimage the full disk on to two individual detectors. In the first channel a PCO2000 CCD is used to image the Sun in 430.5 nm with a pass band of 0.8 nm. In the second channel ANDOR iXON 888 CCD is used with a red filter centered at 630.25 nm. Both the CCDs are mounted on xyzq stages for focus, tilt and position adjustments. WARM is equipped with an optical bread board on to which the dual channel imaging system is set up. This set-up can serve as a test bed for the four-channel broad band imaging system planned for the proposed NLST and as a laboratory too for the development of back-end instruments.

Dual channel imaging system at WARM telescope. PCO2000 and ANDOR iXON 888 model CCDs are used to image the Sun in G-band (pass band=8A) and narrow band (pass band = 4.5 A) red filter respectively.

4.4.4 Vainu Bappu Observatory

The 1.3 meter telescope had been installed in February–March 2013, but oscillations were seen in some positions due to problems identified with the hydrostatic bearing pads. The vendor M/s DFM Engineering replaced the thrust pads of the south horseshoe bearing in May. Further problems of tripping of the drives, attributed to components of the electronics system, were solved in consultation with DFM over the next few months. In parallel, the dome drives and wheel assemblies were readjusted over a period of months to reduce vibrations. The solar power shutter drives were also tested and improved. The solar power system is being modified to also drive the electrically operated windows in the dome. Leakages noticed in the dome during the monsoon months were also rectified. The final acceptance testing of the telescope was completed in December 2013. A CCD detector

Multi-band photo-polarimeter.

of 2K X 4K pixels available at the VBO was mounted on one port for imaging using available filters. The smaller, fast ProEM 1024 detector used for telescope tracking tests was shifted to the side port of the instrument unit. Observations for testing and calibration of the system with standard stars spanning a range of brightness were started with both the detectors. Some scientific programs were also carried out.

Re-aluminization of 30 inch telescope primary mirror and re-installing the aluminized mirror in the telescope was completed. Balancing of the telescope was verified. In the meantime, the radial support system developed problems and the telescope tracking tests had to be deferred. Efforts are on to modify the support system and have the new radial support fabricated and installed in the mirror cell to prevent tilt of the mirror. Tracking performance check of the telescope can be resumed once the new unit is place.

Design, detail engineering, manufacture and assembly of "Imager" for testing the 1.3 m telescope to check the image quality and field of view of the telescope has been completed. This instrument can also be mounted on other telescopes at VBO for similar checks.

The testing and preparation of mechanical systems for the aluminizing of the primary of the VBT was carried out prior to carrying out the work. Further, the removal of the Primary mirror from the telescope, aluminizing and re-installing the aluminized mirror in the telescope was done. Aluminizing of the secondary mirror is being planned.

Design, detail engineering, manufacture, inspection and interface check of "VBT fiber optic Launching Unit" was done. The unit holds the fiber optic cable on the top flange and houses beam splitter, Collimating Lens, Reflecting mirror and the ISIS3 CCD in the housing. This unit will soon be installed on the prime focus end of the telescope.

Preparation of RFP document for refurbishment of VBT dome busbar system was done in consultation with engineers at VBO Kavalur. Preparation of required drawing for this purpose and discussion with original vendor to check the feasibility of taking up the job has been completed. Design and detail engineering of VBT Dome ventilation fan structure and the layout has been completed. Fabrication fan structure is being done at the workshop at VBO, Kavalur.

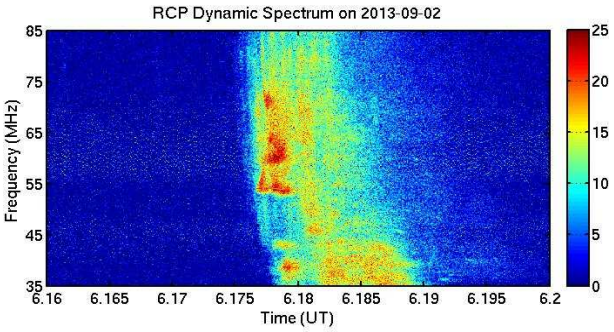
The multi-band photo-polarimeter, which was under development, was completely dismantled and reassembled after cleaning all the parts. The pulse counters were tested using laboratory signal generators and their performance was found to be satisfactory. All the macros developed for the PIC microcontrollers, which performs all the time-critical functions of the polarimeter, were checked, and the necessary modifications were made. The communication link between the electronic interface and the Linux machine used for the operation of the polarimeter was also thoroughly tested, and the stability of the link was found to be extremely good. The instrument has three photomultiplier tubes for the simultaneous recording of the signal in three spectral bands; two uncooled PMTs for the ultraviolet and blue region of the spectrum and a cooled PMT for the visual and red region. The dark counts from all the three PMTs were monitored for several days for their stability. All the optical components of the polarimeters, including the dichroic and glass filters, were mounted inside the polarimeter, and the alignment of the components were checked using a laser beam. Preparations were made for a thorough testing of the instrument as whole before taking it to Kavalur for field trials. Arrangements were made for obtaining a fiber-linked f/13 optics combination to test the data acquisition and analysis program using

an artificial white light source in the laboratory. The results were found to be satisfactory. It is planned to take it to Kavalur soon to mount it onto the 1-m Carl Zeiss telescope and observe standard polarized and unpolarized stars for assessing its actual performance at the site and hope the instrument will be available for regular observations, commencing from the next observing season.

4.4.5 Gauribidanur Observatory

Gauribidanur RAdio Spectro-Polarimeter (GRASP)

A new set-up for ground based spectro-polarimetric observations of the solar radio transients in the frequency range 35-85 MHz has been recently commissioned at the Gauribidanur radio observatory. The front-end of the GRASP consists of two log-periodic dipoles (LPDs) designed and fabricated inhouse at the observatory. While the orientation of the rms in one of the LPDs is in the east-west direction, they are in the north-south direction for the other. After filtering and amplification, the radio frequency (RF) outputs from the individual LPDs are transmitted to the receiver room via two separate optic fiber cables buried 2 m below the ground level. They are connected to the the inputs of a broadband four-port phase quadrature hybrid network. The latter has two outputs: one of them responds to the left circular polarization (LCP) and the other to the right circular polarization (RCP) components of the incident signal. The outputs of the hybrid are connected to two independent commercial spectrum analyzers to obtain the respective dynamic spectra. The sweep time and the instantaneous observing bandwidth are 100 ms and 250 kHz, respectively. The spectrum analyzers are interfaced to two personal computers (PCs) using standard GPIB interface. The computers are synchronized with a common GPS clock. This helps to achieve temporal coherence between the data acquired with the two systems. The total intensity (Stokes I) of the emission at each frequency is estimated offline by adding the observed amplitudes at the corresponding frequency in the aforementioned two spectra. The difference between the two amplitudes gives the circularly polarized intensity (Stokes V). The ratio of the above two gives the degree of circular polarization (dcp). Calibration tests indicate that the cross-talk between the two outputs of the hybrid is $<$ -40 dB, and the quadrature phase shift in the hybrid is consistent to an accuracy of 5 degrees in the above frequency range. The gain of the two LPDAs, the associated filter, amplifiers, optic fibre cable network were also nearly equal indicating that randomly polarized incident signal will result in outputs of equal amplitude in the two spectrum analyzers. The figure shows the RCP dynamic spectrum of a solar radio transient observed on 2013 September 2 with the GRASP. The source region of the transient were identified using the two-dimensional images obtained simultaneously with the Gauribidanur RAdioheliograPH (GRAPH). Presently the authors are working on a FPGA-based digital receiver system for data acquisition with multi-bit resolution. This is expected to improve the sensitivity, dynamic range, temporal and spectral resolution.

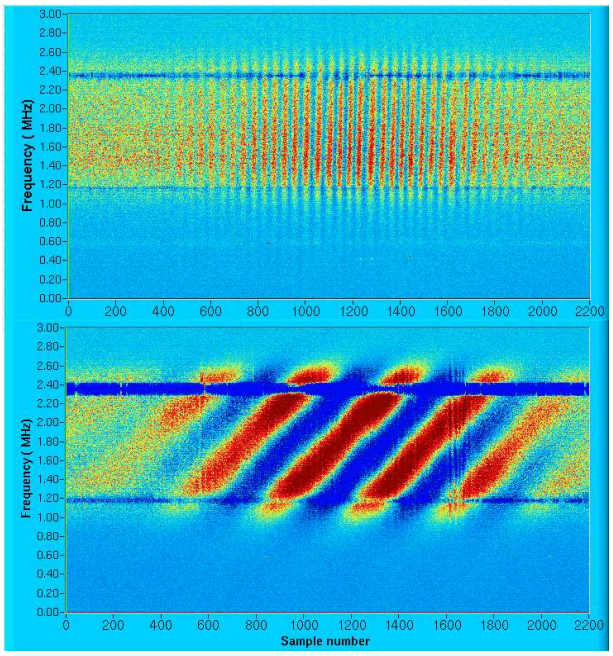


Time profile of the type III solar radio burst observed with the GRASP on 2013 February 4 at a typical frequency of 80 MHz. The upper and lower panels correspond to the LCP and RCP, respectively.

Gauribidanur RAdioheliograPH (GRAPH)

Signal from the 64 antenna groups in the GRAPH, spread over a distance of 3 km, array are presently correlated in the band averaged mode using a 4096-channel correlator system comprising of discrete digital circuit elements. As a part of the augmentation of the GRAPH, a FPGA based digital backend system is being developed inhouse at the Gauribidanur observatory. To this date, a prototype 8-channel system has been designed and fabricated. All possible correlations between signals from the different antenna groups can be performed with this system, either online or offline. A custom double side band (DSB) IP Core was designed using Verilog. Each IP comprises of a complex correlator unit contains several X-OR, X-NOR, latch, integration, and multiplexer circuits. The output from the FPGA is transmitted to the computer via a Gigabit ethernet cable. Ethernet Media Access Controller (MAC) takes care

of the ethernet framing protocols and error detection of the frames. The FPGA chip used is Virtex-5 which has an on-chip Embedded Tri-mode Ethernet MAC (TEMAC). It interfaces with a PHYsical Layer (PHY) chip (Marvell 88E1111) which is a line-driver for driving and sensing the ethernet cable for data transmission. In order to handle more number of inputs and frequency channels the packet correlator is used. With this setup, the raw voltages are sampled and filled into a First-In-First-Out (FIFO) unit. From the FIFO, the data are read and transmitted via Gigabit ethernet port using the TEMAC. A customized network frame structure is used to carry out the above set of tasks. On the computer side, the Wireshark is used to debug the frames. Using TCPDUMP, the raw voltages are dumped to the harddisk for offline analysis. Using LabVIEW, the individual channel data are extracted and the cross power spectra are obtained. Presently they are working on handling the data slips using Lossless Gigabit Remote Packet Capture (GULP) with Linux.



Interference fringes obtained during the meridian transit observations of Cassiopeia-A on a long baseline (upper panel) and short baseline (lower panel) in the GRAPH in the offline correlation mode.

4.5 Library

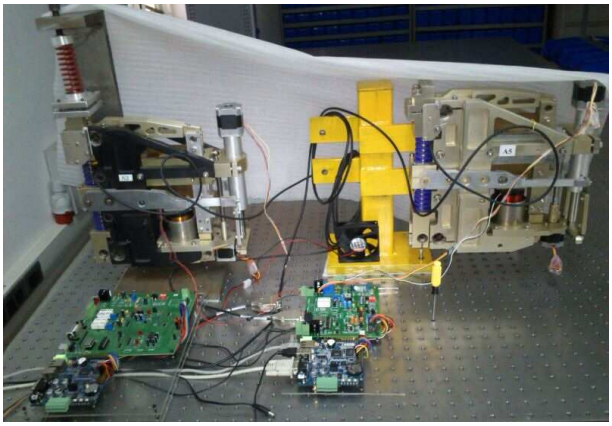
IIA library strengthened its collections by adding 304 books in print as well as continuing the e-books access to SPIE Digital Library along with SPIE E-books, ASP Conference series and EAS publication series. The online access to "Encyclopaedia of Astronomy & Astrophysics" has been added during this year. IIA library continuous to be a member of NKRC consortium and e-journals access facility is there with 19 major publishers. This year "Nature Geoscience additionally has been added.

Document Delivery Services continue: Twenty seven interlibrary loan requests from IIA faculty and students were fulfilled as they are not there in the IIA collections. More than 55 requests from other libraries and individuals were catered to from our collections as part of the document delivery service. *Open Access Repository:*IIA library is maintaining its open access repository by adding new and old research publications of IIA dynamically. IIA library has celebrated the Open Access Week during October 21–27, 2013 by creating and distributing the poster on "Connecting the Past with the Present through Open Access–IIA Archives" within the campuses of IIA. *Founders Day:* The library displayed exhibits of M. K. V. Bappu on the Founders day, 10th August, 2013 and prepared a brochure "Vainu Bappu, the versatile Astronomer (1927–1982)" which was distributed. *Archives:* The archival material has been widely used for research purposes nationally and internationally Nehru Planetarium, Nehru Centre, ISRO, Kerala State Science & Technology Museum, Trivandrum. The historical contents which is accessible through IIA Open Access Repository has attracted a visual Swedish artist Conny Karlsson Lundgren, who has used some of the contents from IIA archives on Isis Pogson, the daughter of N. R. Pogson for an art exhibition at Sweden. http://www.connykarlsson.se/87-Sylvia. *Bibliometric Analysis:* IIA library has given substantial input to Annual Report & DST Report by submitting scientometric analysis of IIA research publications. *NKRC meeting:* IIA library hosted the National Knowledge Resource Consortium (NKRC) Nodal Officers meet 2013 at Kodaikanal Observatory, IIA, Kodaikanal during June 5–7, 2013 and it was well received by 60 participants from CSIR and DST members. Christina Birdie, B. S. Mohan and P. Prabahar presented an analysis of the "Trend in IIA Research Output; link to NKRC Resources" during the NKRC meeting held at IIA, Kodaikanal.

Chapter 5

UPCOMING FACILITIES

5.1 Thirty Meter Telescope



Two prototype actuators under test at ITCC laboratory.

In the academic year 2013–2014, the TMT project reached some key milestones. On 24 July, 2013 at the meeting of the board of Directors at Hawaii, USA, the scientific authorities of the respective partner countries executed the master agreement, agreeing for basic governing principles of the partnership, contributions, observing time etc. With the consent of the Department of Science and Technology, Govt. of India, Dr. P. Sreekumar, Director, IIA, signed the master agreement, representing India TMT. Prof. Eswar Reddy represented India TMT, in person, at the signing ceremony.

ITCC organized a National Workshop on TMT science and instrumentation in November 2013 at IIA, Bangalore, which was attended by members from various research institutes and universities. This National Workshop was followed by an International Workshop, held at IIA, Bangalore in January 2013. Members from industries associated with India TMT, IISc, ISRO and TMT projects in Canada and the USA were amongst the participants. Important outcome of this meeting was firming up of India TMTs interest in the participation of first light instruments, and laying of the roadmap for collaboration in instrumentation. As a result of this meeting, India is now participating in 6 mini-studies related to the opto-mechanical design of the optical first light instrument Multi Object Imager and Echellete (MOBIE). India TMT is leading the study of estimating the telescope and AO system polarimetric budget to understand the feasibility of the TMT for polarimetric observations. India TMT is also developing the Near-Infrared guide star catalogue for TMT adaptive Optics (AO) observations. Other major activity is completing of prototype development of India

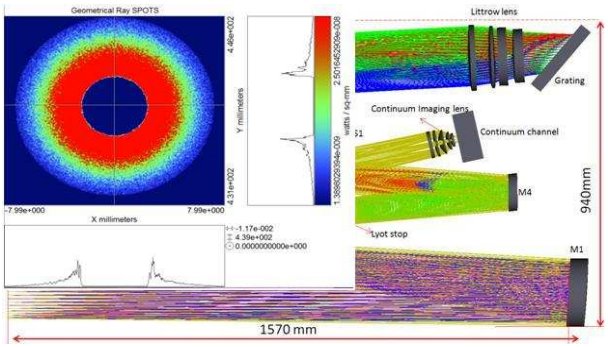
TMT in-kind work packages: Edge sensors, actuators, segment support assembly, segment polishing, design and development of mirror coating systems, observatory software. Sensors and Actuator prototype development have been completed and have passed all the technical tests conducted at Jet Propulsion Lab (JPL). Work on SSAs is being done at Godrej, Mumbai and ATL, Bangalore. Assembly of 6 SSAs are expected to be completed by end of 2014. To efficiently manage and complete the India TMT share of observatory software which includes telescope control system software, India TMT signed an MOU with CDAC. Under the MOU, India TMT may off-load some of the works to CDAS. Another key work package is polishing of about 100 segments of size 1.44-m diameter each. India TMT is in the process of choosing a technology partner to train and build stress mirror polishing machines and set up a plant at IIA CREST campus.

5.2 ADITYA 1

Visible Emission Line Coronagraph

Visible Emission Line Coronagraph (VELC) payload onboard Aditya(L1) is an enhanced version of VELC on Aditya-1. It is an internally occulted so-

Group photo of participants at TMT workshop at IIA, Bangalore



Scatter distribution at the focal plane of continuum channel.

lar coronagraph with simultaneous imaging, spectroscopy and spectro-polarimetry channels. The primary science goals include, but not limited to, Diagnostics of the coronal and coronal loops plasma (Temperature, Velocity & Density), Heating of the corona, Development, dynamics & origin of CME's, Studies on the drivers for space weather and Measurement of coronal magnetic fields in the corona (not planned by any mission so far). VELC is designed to image solar corona from ± 1.05 R_{odot} to ± 3 R_{odot} (R_{odot} is solar radius) with a plate scale of 2.5"/pixel. It has multi-slit spectroscopic channels at three emission lines namely 530.3nm, 789.2nm and 1074.7nm with spectral resolution of 65mÅ, 95mÅand 150mÅrespectively. It is also capable of carrying out dual-beam spectro-polarimetry at 1074.7nm. FOV for spectroscopy and spectro-polarimetry is from ±1.05Ro to ±1.5Ro. This project was approved by ADCOS, ISRO on 11-10-2013.

Optical design: VELC has an entrance aperture of 150mm and an off-axis parabola as a primary mirror (M1). M2 is a spherical mirror with a central hole acts as internal occultor. M3 rejects the solar disc light out of the instrument. A dichroic beam splitter (DBS1) splits the coronal light into an imaging channel at 500nm (Continuum) and to a spectroscopy channel ¿500nm. Spectrograph in VELC operates in near littrow configuration uses a plane reflective grating with 600 grooves/mm blazed at 42O as a dispersive element. A four element littrow lens acts as collimator and camera of the spectrograph. Optical design of the payload is optimized to meet science requirements. Tolerance analysis is carried out and fabrication and alignment tolerances are generated for optics. Thermal and ghost image analysis are also carried out on the finalized design. The figure shows the optical layout of VELC. VELC payload alignment and performance evaluation schemes are being worked out. Experiments are being designed for calibrations of various narrow band filters, dichroic beam splitters and diffraction gratings etc.

Mechanical design: The overall instrument configuration is worked out, most of the component level designs are completed. Base line Design review is completed (BDR) for all subsystems including mechanical structure. The preliminary thermal and structural analysis is completed. The static, dynamic and thermal distortion analysis is carried out, the first global resonant frequency is close to 100 Hz which is acceptable. The maximum stress resulting in the structure at 100Hz is within the acceptable

limits. This confirms that the mechanical configuration/design meets the specific requirements and instrument designed is stiff and strong to withstand dynamic loads. The technical specification and engineering drawings are being generated, procurement of long lead items like Titanium material etc are under progress. Equipment/instruments for up gradation of clean rooms are under progress.

There was remarkable progress and considerable effort and time was given towards selection of detector, configuring electronics interface, mechanical interface, thermal interface, optimizing camera electronics, on-board data processing schemes etc. Hence, it has been decided to retain 2K x 2K Scientific CMOS detector with 6.5 m pixel size as the visible detector for present VELC also. NIR channel for wavelength around 1 m is included in present VELC to achieve better scientific goals. For this channel, InGaAs (Indium Gallium Arsenide, 512 x 640array with 24m pixel size) is most suitable detector material when cryogenic cooling is not affordable. Contamination control: To meet the stringent requirement of particulate contamination levels, the present Class 100 Clean room facility in Prof. MGK Menon Lab will be upgraded to class 10 facility. A detailed up-gradation plan has been prepared and presented to various committees for approval. The design work for this activity is completed and we are in the process of procurement of related equipments and instruments. To measure the scatter of the mirror coupons a small scatterometer facility is designed and is being fabricated. A new particle fallout meter is planned for monitoring the surface contamination and airborne contamination levels. To meet the required low RH levels of the project two numbers of desiccant type industrial de-humidifiers have been procured and will be installed soon. Aeroglaze paint has been qualified for quoting the optical bread-board, baffles etc. of VELC. The standing review committee on scatter and contamination related issues discussed details of contamination control requirements and the measurement processes on 22 July 2014.

5.3 National Large Solar Telescope

India's National Large Solar Telescope (NLST) of two meter aperture size is proposed to be set up in Ladakh region of Himalayas at a height of around 4300 meters. A high resolution spectrograph along with a polarimeter is planned as one of the back-end instruments for NLST. Prototype development of the NLST Spectro-Polarimeter (SP) is proposed to be designed and developed for usage at the back focal plane of the Multi-Application Solar Telescope (MAST) recently installed at the Udaipur Solar Observatory. Design of the prototype SP has been discussed in detail along with the scientific goals. The SP is designed to be operated in three wavelengths to observe photospheric and chromospheric layers of the solar atmosphere simultaneously. Vector magnetic fields will be calculated in these layers. High resolution of the designed SP will provide accurate estimates of velocities. Highly resolved polarized line profiles will allow the user to obtain the height variation of vector magnetic fields when used along with suitable inversion codes.

Further to the detailed site survey report of 2011-12, observations were continued at the Pangong lake site Merak using automated weather station, all-sky camera, and sky radiometer. At the station Hanle, only the automated weather station observations were continued. However, observations for the site program at Devasthal in Uttarakhand were discontinued during the year. Detailed studies of the aerosol optical properties and sky transparency, along with sky brightness estimates, were carried out for Hanle and Merak stations. The results pertaining to aerosol optical properties are reported separately. The sky brightness estimates for extended durations show that both Hanle and Merak are well suited for coronagraphic observations. Extensive analysis of the meteorological parameters and the dependence of seeing under varying met conditions were initiated. Archiving of the extensive data was also carried out during the year.

Observations using sky radiometer model PM01L by Prede of Japan, were continued at Merak and Hanle in Ladakh to monitor the aerosol content over the region. The instrument measures sun/sky irradiance at five wavelengths in the visible and Near IR regions. The data were processed using version 4.2 of Skyrad. Pack software to obtain the aerosol optical properties. Calibration and evaluation of the performance of the instrument were carried out using in-situ data during clear sky conditions for the years 2008–2011 for Hanle and 2012 for Merak. The uncertainties of the estimated aerosol optical depth (AOD) and single scattering albedo (SSA) at the five observed wavelengths are within 0.02, and 0.2 respectively, with reference to an air mass of 1. These results indicate the high quality of the data obtained and the stability of the instrument used. The AOD and SSA results are presented in Figure 1. The two

stations therefore display the pristine conditions of the high-altitude sites. They have high sky transparency, comparable to those of sites at Mauna Loa (3400 m amsl) in the Pacific Ocean and Dome C in Antarctica. Also, the above results indicate that these sites are ideal for calibration of radiometers, similar to the station Mauna Loa where CIMEL radiometers of NASA's AERONET program are usually calibrated.

5.4 Ultra-Violet Imaging Telescope (UVIT)

UVIT is one of the five science payloads on ASTROSAT, the first Indian satellite devoted fully to astronomy, which is to be launched in the year 2014. ASTROSAT has four X-ray telescopes, which observe in soft/hard X-rays, and UVIT observes in ultraviolet and visible bands. Three of the X-ray telescopes and UVIT can observe an object simultaneously. The instrument is configured as two similar Cassegrain telescopes of 375 mm diameter. One of the two telescopes observes in FarUV (1300–1800 A), while the other observes in NearUV(2000–3000 A) and VIS (3200–5500 Å). Images are made simultaneously in all the three channels with an angular resolution of 1.8 arcsec in a field of 28 arcmin. In addition to a selection of filters for each of the three channels, low resolution (100) slitless spectroscopy is available for FarUV and NearUV channels. ASTROSAT aims to observe simultaneously in X-rays, UV and visible. UVIT would be used to study time variability of X-ray objects, on time scales ranging from seconds to days, in coordination with the X-ray telescopes, and would observe on its own objects like interacting galaxies, star forming galaxies, globular clusters, hot/evolved stars.

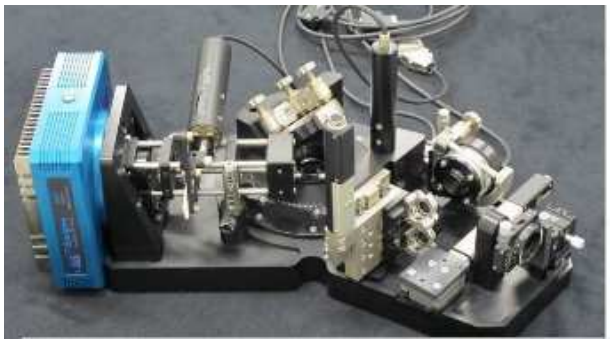
The vibration test of flight model test was completed last year, upon the post vibration tests it was found that except the VIS channel of the telescope, performance of rest all the subsystems were satisfactory. Upon diagnosis, it was found that star 250 sensor got de-bonded from its ceramic die. Presently detector of VIS channel is under repair by CSA in Canada. As a backup plan development of new detector for the VIS channel is under way in collaboration with the centers of ISRO. Unlike the original detector it would not be an intensified-imager, but would serve the important purpose of tracking drift of the satellites pointing with an accuracy of 0.2 arcseconds on time scale of seconds.

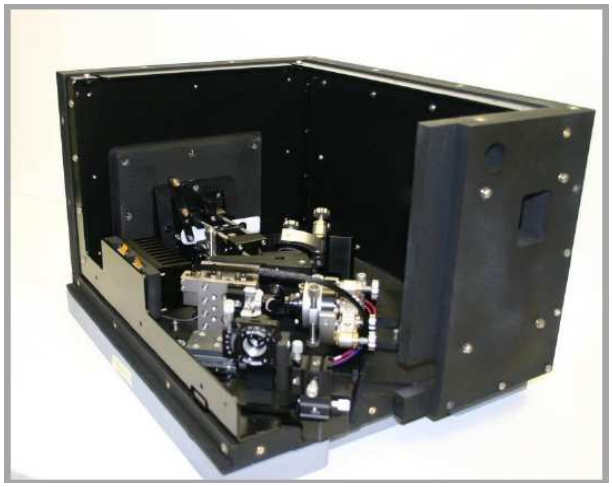
Several proposals for observations during the initial period of the mission are in the final stages of discussions. These proposals would be part of a set called "Baseline Science Proposals FOR ASTROSAT" and would showcase the science which can be done with ASTROSAT.

5.5 High Resolution Spectrometer for HCT

A high resolution spectrometer for the 2m Himalayan Chandra Telescope (HCT) at Indian Astronomical Observatory (IAO) Hanle providing high resolution R $\sim$ 60,000 with an optional low resolution of 30,000 in unsliced mode is being fabricated. With the chosen design (based on white pupil concept) a continuous spectral coverage over 350-1000nm on a single CCD frame would be available. The project is largely supported by DST grant under fast track scheme IRHPA. It is being executed as technical collaboration with Industrial Research Limited (IRL), New Zealand (recently renamed as Callaghan Innovation Research Limited since Feb 2013 (CIRL).)

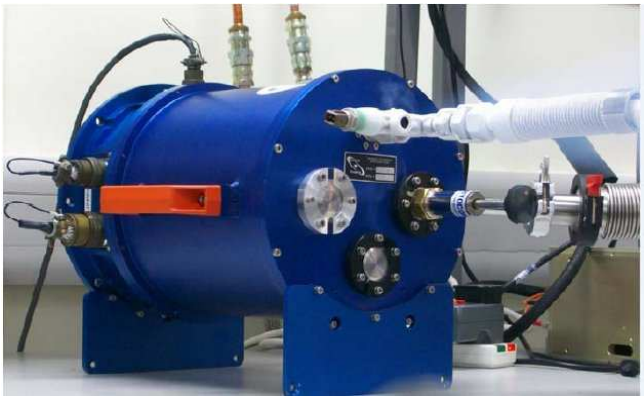
Following the completion of the optical design in November 2011, the glass and mirror blanks and standard optical items have been procured. The grinding, polishing of all optical elements was completed in November 2013. The AR coating for lenses and prisms and HR coating for collimator, slit and folding mirror was done by L3 warrior systems (USA) during December 2013-Jan 2014. Optomechanical fabrication of many system modules including Cassegrain assembly, Input optics, collimator assembly, echelle assembly, slit and fold mirror assembly, camera assembly, CCD interface assembly and exposure meter assembly are completed. The HESP F/2.6 camera (Petzval configuration) is designed to correct the various aberration introduced by the pre-optics. The performance test of the camera at Kiwistar optics is carried out using an interferometric setup. The on-axis and 4 degree off- axis performance test were made at 16 and 20^{o}C temperatures at the test wavelength 632nm. For on axis tests PV ranged 0.529 to 0.531 waves and RMS 0.098-0.0990 waves while for 4 degree off-axis PV ranged in 2.113-2.2087 waves and RMS 0.283-0.298 waves. HESP CCD system consists of E2V 234-81 chip of 4K x4K format with 15 μm square pixels. It is a back illuminated device coated with custom graded AR coating. It is operated with ARC GEN III controller. The CCD cryostat holding the CCD has a 3.6 litre capacity for LN_2 storage which folding mirror was done by L3 warrior systems (USA) during





The cassegrain unit of the High Resolution Spectrograph for HCT. It comprises of fold mirror, pinhole mirror, input selector and guide camera. The right figure shows the complete unit with its thermal enclosure.

December 2013-Jan 2014. Opto-mechanical fabrication of many system modules including Cassegrain assembly, Input optics, collimator assembly, echelle assembly, slit and fold mirror assembly, camera assembly, CCD interface assembly and exposure meter assembly are completed.



The image showing the CCD cryostat and the option of auto-fill.

The HESP F/2.6 camera (Petzval configuration) is designed to correct the various aberration introduced by the pre-optics. The performance test of the camera at Kiwistar optics is carried out using an interferometric setup. The on-axis and 4 degree off- axis performance test were made at 16 and 20^{o}C temperatures at the test wavelength 632nm. For on axis tests PV ranged 0.529 to 0.531 waves and RMS 0.098-0.0990 waves while for 4 degree off-axis PV ranged in 2.113-2.2087 waves and RMS 0.283-0.298 waves.

The system modules for the HESP were completed in April 2014. The sub-assembly tests would be conducted during May–August 2014. The full system assembly tests at Kiwistar Optics, New Zealand with IIA team is scheduled in November 2014. The spectrograph would be transported and commissioned at IAO, Hanle during May–June 2015.

Chapter 6

PUBLIC OUTREACH ACTIVITIES

6.1 Activities at Bangalore

National Science Day

Distribution of prizes to the winner of quiz competition by Dr. P. Sreekumar.

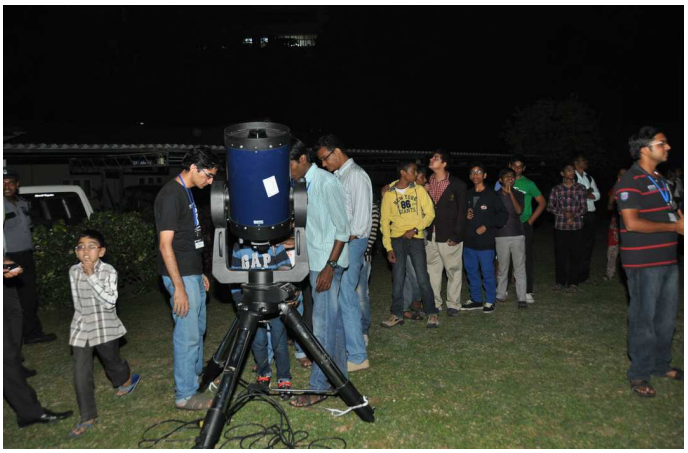
National Science Day 2014 was celebrated at the Bangalore campus of the Institute on 28 February 2014. All together 127 students from seven schools in Bangalore participated in various activities that were organised. The schools which participated were, ACTS School, Christ School, Christ Academy, Seema School, Our lady of Fatima School, Government High School from Madivala and Narayana E-Techno School. The programs started with a drawing competition in the morning for the students. After the competition, the students were taken around the campus by student volunteers of IIA to locations where various experiments and displays were setup like 1. Observing the sun through the telescope and coelostat. 2. A demo of Balloon Experiment. 3. Visit to the Photonics Laboratory. 4. Demonstration of astronomical kits. 5. An exhibition of posters and models. Later the students assembled at the auditorium and a quiz competition was conducted in which the students participated enthusiastically. Following the quiz competition, there was the prize distribution by the Director of IIA Dr. P. Sreekumar, to the winners of the drawing and quiz competitions. First prize for the drawing competition was won by Versha of 9th standard, Christ Academy and the second prize went to K. P. Meghana of 9th standard, from Seema School. The third prize was won by N. Usha of 9th standard of ACTS Secondary School. In the quiz competition, ACTS Secondary School won the first prize and Christ Academy was the runner-up. Evening events started with a popular talk delivered by Prof. D. C. V. Mallik , titled "K. S. Krishnan: His Life and Work". The science day celebration concluded with sky watch program arranged at the north lawn of IIA in which a large number of public participated. Students and staff of IIA volunteered and made this event a grand success.

School children at the quiz competition conducted at the Bangalore campus of IIA.

Going back to School: An outreach activity for school children

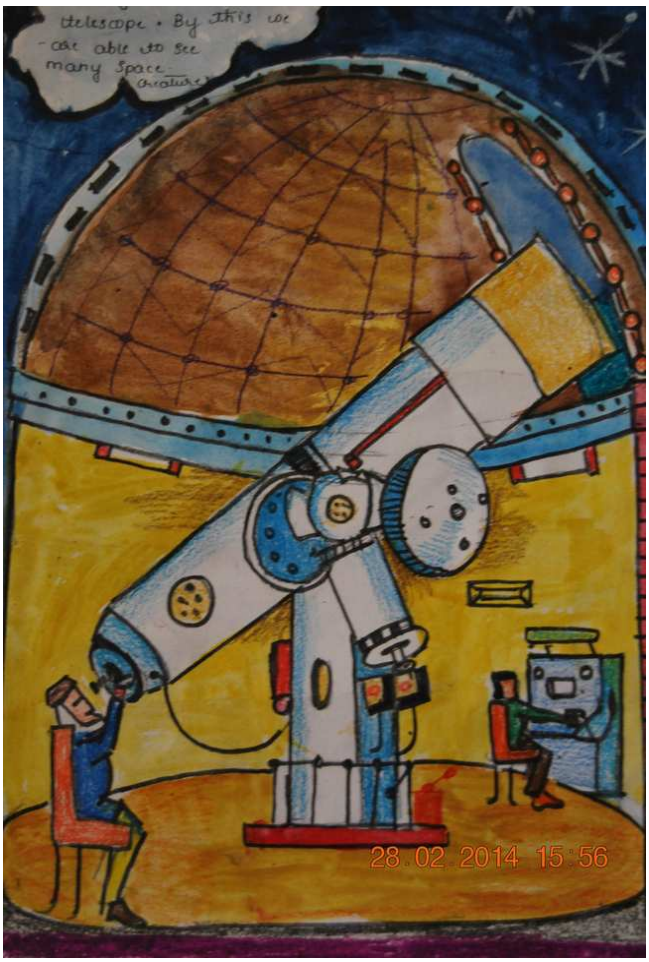
A group of IIA Ph.D student along with outreach committee members has initiated a brilliant 3-4 hours

(left) A talk session at rural residential school, Hosakere. (right) Astronomical activity kits used for demonstration as well as for distribution.



IIA graduate students showing Jupiter on the 12 inch Meade telescope to the school children, on National Science Day, at IIA campus, Bangalore.

outreach program named "Going Back to school for school children". This School outreach activity is divided in three sessions and handled by a group of IIA students. School children attend an hour long session in which a presentation on astronomy along with video screening is arranged. The second session comprises presentation of Stellarium, demonstration of astronomical kits and telescopes. Whereas, the third one is dedicated for the role-play, discussion and interaction with the students.The last two sessions are held in parallel. In addition to this astronomical activity kits are also distributed to participating students. The program is being well appreciated by student as well as teachers and a large number of request is received to conduct it to their schools. So far the program has been conducted at seven different schools in and around Bangalore, benefiting about 800 students. At present Kannada and English are the preferred medium of communication,



Display of the paintings that won the first prize in the painting competition held at CREST Hosakote.

later it is also planned to have program in few other languages like, Hindi, Telugu and Tamil.

6.2 Activities at Vainu Bappu Observatory, Kavalur

Sky Watching Program

At VBO a regular outreach activity of sky watching for the public was organised every Saturday from 7 pm to 10 pm. During this time visitors were shown celestial objects through the 6 inch Carl Zeiss reflecting telescope. In addition to this, limited number of visitors mostly students from schools/colleges were permitted, on prior request, to visit VBT telescope dome. During January 2013 to March 2014, a total of 2894 students from schools/colleges and 5149 members of the general public visited the observatory. Only senior school and college groups were shown the larger telescopes. All visitors were shown celestial objects through the 15 cm telescope on saturday evenings. Other groups that visited the observatory included a group of 40 engineers from GE Aviation, a group of 45 scientists and staff from the NAL, a group from the IIT Madras Astronomy Club, two batches of students each from the Bangalore Planetarium and from the MPBIFR, Bangalore.

Workshop on Astrophotography

An amateur astrophotography workshop was conducted at Vainu Bappu Observatory, Kavalur on 1st and 2nd February 2014. Fifteen students from IIA participated in this program along with few amateur astronomers and Astro-photographers from Bangalore and Chennai. Practical sessions were conducted on 2nd Feb, 2014 by the invited guest and Astrophotographer Dr. Suresh Mohan, where the students were trained how to capture planet and deep-sky images with the aid of just a DSLR or amateur CCDs mounted on amateur catadioptric telescopes. On the 2nd of February, 2014, presentations were given on covering different subjects of astrophotographic techniques. Hands on session was also conducted on how to use softwares which are commonly used for astrophotography, especially in post-processing images, including noise reduction and image enhancement. Program was well appreciated by participants and it has been decided by the outreach committee of IIA to conduct such a workshop on regular basis.

6.3 Activities at Indian Astronomical Observatory, Hanle

IAO attracts many visitors, and many visits were permitted to the extent possible by the limited infrastructure.

6.4 Centre for Research & Education in Science & Technology

CREST Campus of IIA houses the remote control station of 2-m HCT, IAO, Hanle. Guest Observers who are allotted time on HCT by the national time allocation committee, utilize this time from CREST with the help of a small group of astronomers supported by research or telescope trainees recruited periodically on a contract basis. During this year 3 (Three) nos. of Telescope trainees were appointed on contractual basis.

The HCT remote control station is a point of attraction at CREST for scientific visitors of IIA as well as laypersons. The centre was visited by many scientists, students, amateur astronomers, and educationists during the period. The remote operation of 2-m HCT was demonstrated through video conferencing facility to all the visitors. HCT group astronomers gave popular lectures. The Amit Smriti Project, Aryabhatta, Bhopal; Jagdish Bose Science Talent Search Program and the Astronomy Program, Birla Institute of Fundamental Research, Bangalore had organized visits by students to CREST.

National Science Day was celebrated at the CREST campus on February 28, 2014. More than 100 students from various school (New Horizon School, Global Residential School, Bharath Matha School, Omshree Public school etc.) visited the campus with their teachers. Posters in general astronomy and those highlighting the Institute's facilities and work done at IIA in the field of Astronomy & Astrophysics were displayed. Drawing and quiz competitions were also held for the students. Remote operation of 2m HCT was demonstrated through Video Conferencing to IAO, Hanle. MGK Menon Lab activities were shown through CCTVs network. These events were followed by a lecture "Basic Science and Astronomy" by B.C. Bhatt. The short movie "Cosmic collisions" was also shown to the students. The event was covered by the local press.

One Celestron CGE Pro 1100 EdgeHD model 11-inch reflector telescope has been purchased for out-

Hindi Day was celebrated at the Institute on 14 September 2013. Various competitions were held and prizes distributed. (Standing : Left to Right) Dr. S. Rajanatesan, Amit Kumar, Dr. G. Pandey, Dr. P. Kumaresan (Administrative Officer), Dr. P. Sreekumar (Director) Malini Rajan, N. K. Pramila, Y. Yerappa, K. C. Viswanath, K. Bhaskaran, K. Shankaranarayanan, K. Bhaskaran & K. G. Erappa.

reach program at CREST Campus. This telescope was installed and commissioned at CREST during December 2013. CREST Telescope Trainees have been trained to operate this telescope.

6.5 Staff Activities

6.5.1 Welfare of SC/ST Staff & Physically challenged

A senior officer of the institute has been functioning as the liaison officer to support the welfare of the SC/ST staff members. Special consideration as per norms during recruitment and regular assessment has been provided to these categories of employees. As of the end of the year, members belonging to the SC, ST and OBC categories constitute 13.36%, 11.55%, 4.33% respectively of the total staff strength. In addition, reservations continue to be extended to OBCs and physically disabled persons. Proactive efforts are continuously made towards their welfare. Facilities and mechanisms have been provided for special administrative as well as technical training of staff from the historically

6.5.2 Official Language Implementation

Four meetings were conducted in the Institute and the reports were sent to the Dept. of Science & Technology, New Delhi.

Hindi Workshop

In order to speed up the implementation of Official Language in the Institute and to improve the staff members capacity for doing official work in hindi, one Hindi Workshop was conducted for the employees working in Administration on 29 August, 2013. The report was sent to the Dept. of Science & Technology, New Delhi.

Hindi Day/Fortnight Celebration

The institute celebrated Hindi Fortnight from 2 September 2013 to 14 September 2013. During the occasion six competitions were conducted in the institute viz. “Hindi-English Noting” competition on 2 September 2013, “Hindi Speech competition on 4 September 2013, “Hindi Easy Writing competition on 6 September 2013, “Hindi Song” competition on 10 September 2013, “Picture Narration” competi-

tion on 11 September and "Hindi Visual-Quiz competition on 13 September 2013. 14 September 2013 was celebrated as "Hindi Day in the institute. Dr. P. Sreekumar, Director presided over the function. Dr. P. Kumaresan, Administrative Officer gave the welcome speech. Chairman addressed the audience and said that as it is the moral responsibility of all staff members to accomplish official work in hindi, they have to try to do more official work in hindi. Dr. Gajendra Pandey, Reader read the Home Ministers message of Hindi Day. Cash awards were given to the winners. The function was concluded with a vote of thanks by Dr. S. Rajanatesan, Section Officer(Hindi). Two hindi competitions were conducted viz. Hindi Administrative Glossary and Hindi Visual-Quiz on the 17 September 2013 respectively at VBO, IIA, Kavalur. Cash awards were given to the winners.

Chapter 7

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In Journals

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*Basavaraju, R. M., Akondi, V., *Weddell, S. J., Budihal, R. P. 2014. *Myopic aberrations: Simulation based comparison of curvature and Hartmann Shack wavefront sensors.* Optics Communications 312, 23-30.

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Chapter 8

STAFF LIST 2013 – 2014

Academic & Scientific Staff

Director: P.Sreekumar (w.e.f. 01.07.2013)

Director (Acting): Bhanu Pratap Das (upto 30.06.2013)

Distinguished Professor: S. Sirajul Hasan

Senior Professor: Bhanu Pratap Das, H. C. Bhatt, Jayant Murthy, T. P. Prabhu, Sunetra Giridhar

Professor: G. C. Anupama, S. P. Bagare, A. K. Pati, K. N. Nagendra, K. E.Rangarajan, B. Raghavendra Prasad, R. K. Chaudhuri

Associate Professor: Annapurni Subramaniam, Aruna Goswami, Arun Mangalam, B. C. Bhatt, S. Chatterjee, Dipankar Banerjee, B. Eswar Reddy, R. T. Gangadhara, Gajendra Pandey, K. M. Hiremath, J. Javaraiah, R.Kariyappa, C. Muthumariappan, S. Muneer, Prajval Shastri, P. S. Parihar, S. Paul Kaspar Rajguru, K. P. Raju, K. B. Ramesh, R. Ramesh, D. K. Sahu, A. Satya Narayanan, S. K. Sengupta, K.Sundararaman, Sushma G.V.Mallik, M. Srinivasa Rao

Reader: Firoza Sutaria, C.Kathiravan, Mousumi Das, Pravabati Chingangbam, Preeti Kharb, B.Ravindra, Sivarani Thirupathi, C. S. Stalin, M.Sampoorna, Subinoy Das

Scientist D: U. S. Kamath, B. A. Varghese

Scientist C: E. Ebenezer Chellasamy, B. S. Nagabhushana, Ravinder Kumar Banyal, N. Shantikumar Singh, G.S.Suryanarayana

Scientist B: Muthu Priyal, Nazia Afreen Ahmed, Namgyal Dorjey, Rajendra Bahadur Singh, K. Prabhu, G.Selvakumar

Research Associate B: M. Appakutty

Adjunct Scientist: Durgesh Tripati, K. Shankarasubramanian

Visiting Professor: S.N.Tandon

Visiting Scientist: S. G. Bhargavi, Koshy George, Margarita Safonova, Ramya Sethuram

Honorary Professor: V. K. Gaur

(Post Doctoral/Visiting Fellow: Jayashree Roy, Jessy Jose, Rajesh Gopal, Smitha Subramanian

Technical staff

Engineer G: A. V. Ananth

Engineer F: M. S. Sundararajan, G. Srinivasulu

Engineer E: P. M. M. Kemkar, P.K.Mahesh, R.Ramachandra Reddy, J. P.L.C. Thangadurai

Librarian: Christina Birdie

Engineer D: Amit Kumar, P. Anbazhagan, V. Arumugam, S. S. Chandramouli, Dorje Angchuk, Faseehana Saleem, S. Kathiravan, S. Nagabushana, B. Ravikumar Reddy, M. V. Ramaswamy, S. Sriram

Scientific Officer SD: Rekhesh Mohan, L. Yeswanth

Principal Document Officer: Sandra Rajiva

Engineer C: K. Anupama, Anish Parwage, K.

Dhananjay, Sanjiv Gorka, Sonam Jorphail, Tashi Thsering Mahay, K. C. Thulasidharen, Tsewang Dorjai, P. Umesh Kamath, Vellai Selvi, Venkata Suresh Narra

Sr. Technical Officer: K.Jayakumar, K.Kuppuswamy, R.Selvendran

Technical Officer B: N.Sivaraj, Narasimhappa

Engineer B: Mohd.Faisal Nawaz, V.Natarajan, K. Ravi, A. Ramachandran, S.Ramamoorthy, N. Raj Kumar, S.Suresh

Technical Officer: A. V. Velayuthan Kutty

Tech. Associate B: D. Babu, P. Kumaravel, J. Manoharan, S. Pukalenthi, C. V. Sri Harsha, M. R. Somashekar, S. Venkateshwara Rao

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

Draughtsman E: V. K. Subramanian
Sr. Tech. Asst. C: R. Ismail Jabillullah, T. K. Muralidas

Tech. Associate: V. Gopinath, Mallappa

Sr. Tech. Asst. B: D. Kanagaraj, A. Muniyandi, M. Nagaraj, K. N. Sagayanathan

Sr. Research Asst. B: V. Moorthy

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

Consultant: Lt. Col Kuldip Chandar

Sr. Consultant: M. Nageswara Rao

Administrative staff

Administrative Officer: P. Kumaresan

Principal Staff Officer: K. Thiyagarajan

Accounts Officer: S. B. Ramesh

Purchase Officer: Y. K. Raja Iyengar

Stores Officer: D. Lakshmaiah

Sr. Asst. Accounts Officer: G. R. Venugopal

Sr. Section Officer: Meena, Narasimhamurthy, Pramila Mohan, S. Rajendran

Section Officer: K. Padmavathy, N. Valsalan, Ramaswamy, Diskit Dolker

Section Officer (Hindi): S. Rajanatesan

Sr. Office Superintendant: Maliny Rajan, N. K. Pramila, N. Sathya Bama, Uma Maileveloo, A. Veronica

INDIAN INSTITUTE OF ASTROPHYSICS

BANGALORE

AUDITED STATEMENTS OF ACCOUNTS
2013-2014

CONTENTS

B.R.V. Goud & Co.
Chartered Accountants

AUDITOR'S REPORT

The Members of Indian Institute of Astrophysics,

Report on the Financial Statements

We have audited the financial statements of the "INDIAN INSTITUTE OF ASTROPHYSICS" Koramangala, Bangalore – 560 034, which comprise the Balance Sheet as at 31st March, 2014 and the Statement of Income and Expenditure Account for the year then ended and a summary of significant accounting polices and other explanatory information.

Management's Responsibility for the Financial Statements

Management is responsible for the preparation of the financial statements. This responsibility includes the design, implementation and maintenance of internal control relevant to the preparation of the financial statements that are free from material misstatement, whether due to fraud or error.

Auditor's Responsibility

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

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

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

No 37/1, 1st Floor, M.N.K. Rao Road
Basavanagudi, Bangalore - 560 004
Phone: 080 - 26566448, 26577448

TeleFax: 080 - 26566337
E-mail: audit@brvgoud.co.in
Website: www.brvgoud.co.in

Opinion

In our opinion and to the best of our information and according to the explanations given to us, the said accounts give the information required and give a true and fair view in conformity with the accounting principles generally accepted in India:

a. in the case of the Balance Sheet, of the state of affairs of the INDIAN INSTITUTE OF ASTROPHYSICS as at 31st March, 2014;

b. in the case of the Income and Expenditure Account of the Excess of Income over Expenditure for the year ended on that date

We further report that:

a. the Balance Sheet and Income and Expenditure Account dealt with by this report, are in agreement with the books of accounts
b. in our opinion, proper books of account as required have been kept by the Institute so far as appears from our examination of those books.

for B.R.V. GOUD & CO.,
Chartered Accountant
FRN No. 000992S

B.R.V. GOUD & CO. CHARTERED ACCOUNTANTS B'LORE-4

(A B Shiva Subramanayam)
Partner
M No. 201108

Place : Bangalore
Date : 01.09.2014

INDIAN INSTITUTE OF ASTROPHYSICS, BANGALORE -560034

BALANCE SHEET AS AT 31ST MARCH, 2014

(Amount in Rs.)

		SCH	AS at 31.3.2014	AS at 31.3.2013
I. SOURCES OF FUNDS				
CAPITAL FUND		1	67,20,79,995	68,66,60,390
GENERAL FUND		2	5,000	2,32,03,892
PROJECT FUND			13,19,55,169	-
CURRENT LIABILITIES & PROVISIONS		3	5,72,90,073	7,61,80,707
TOTAL			**86,13,30,237**	**78,60,44,989**
II. APPLICATION OF FUNDS				
FIXED ASSETS		4	57,68,94,983	50,64,24,706
CURRENT ASSETS				
ADVANCES AND DEPOSITS		5	22,29,24,705	20,74,61,375
CASH AND BANK BALANCES:		6		
IIA Account	1,18,84,974			
Projects Account	4,96,25,575		6,15,10,549	7,21,58,908
TOTAL			**86,13,30,237**	**78,60,44,989**
Notes on Accounts:		15		

Note:- The Schedules and Notes on accounts referred to above form an integral part of the Balance Sheet & Income & Expenditure Account.

S.B.Ramesh
Accounts Officer

P. Kumaresan
Administrative Officer

P.Sreekumar
Director

As per our report of even date,
for B.R.V.GOUD & Co.,
Chartered Accountants
F.R.NO: 000992S

B.R.V. GOUD & CO. CHARTERED ACCOUNTANTS B'LORE-4

(A.B.Shiva Subramanyam)
Partner
M.No: 201108

Place: Bangalore
Date: 01.09.2014

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INDIAN INSTITUTE OF ASTROPHYSICS, BANGALORE - 560034

INCOME AND EXPENDITURE ACCOUNT UNDER PLAN
FOR THE YEAR ENDED 31ST MARCH, 2014

(Amount in Rs.)

	SCH	2013-14	2012-13
A. INCOME			
Grants-in-aid	7	39,77,21,652	35,11,19,785
Other Income	8	34,31,643	26,69,241
TOTAL - A		**40,11,53,295**	**35,37,89,026**
B. EXPENDITURE			
Salaries and Allowances	9	28,80,90,675	28,76,89,101
Office Expenditure	10	1,44,99,584	1,62,46,219
Working Expenses	11	8,61,59,721	8,12,00,906
Stores & Consumables	12	47,71,500	69,32,032
TOTAL - B		**39,35,21,480**	**39,20,68,258**
C. SURPLUS / (DEFICIT) FOR THE YEAR (A - B)		**76,31,815**	**(3,82,79,232)**
Notes on Accounts:	15		

S.B.Ramesh
Accounts Officer

P. Kumaresan
Administrative Officer

P.Sreekumar
Director

As per our report of even date,
for B.R.V.GOUD & Co.,
Chartered Accountants
F.R.NO: 000992S

B.R.V. GOUD & CO. CHARTERED ACCOUNTANTS B'LORE-4

(A.B.Shiva Subramanyam)
Partner
M.No: 201108

Place: Bangalore
Date: 01.09.2014

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INDIAN INSTITUTE OF ASTROPHYSICS, BANGALORE - 560034

INCOME AND EXPENDITURE ACCOUNT UNDER NON-PLAN

FOR THE YEAR ENDED 31ST MARCH, 2014

(Amount in Rs.)

	SCH	2013-14	2012-13
A. INCOME			
Grants-in-aid	13	85,00,000	1,07,10,000
TOTAL - A		**85,00,000**	**1,07,10,000**
B. EXPENDITURE			
Salaries and Allowances	14	85,00,000	1,07,10,000
TOTAL - B		**85,00,000**	**1,07,10,000**
C. SURPLUS / (DEFICIT) FOR THE YEAR (A-B)		-	-
Notes on Accounts:	15		

S.B.Ramesh
Accounts Officer

P. Kumaresan
Administrative Officer

P.Sreekumar
Director

As per our report of even date,
for B.R.V.GOUD & Co.,
Chartered Accountants
F.R.NO: 000992S

B.R.V. GOUD & CO. CHARTERED ACCOUNTANTS B'LORE-4

(A.B.Shiva Subramanyam)
Partner
M.No: 201108

Place: Bangalore
Date: 01.09.2014

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INDIAN INSTITUTE OF ASTROPHYSICS, BANGALORE - 560034

RECEIPTS AND PAYMENTS ACCOUNT UNDER PLAN
FOR THE YEAR ENDED 31ST MARCH, 2014

Amount in Rs.

		SCH	2013-14	2012-2013
RECEIPTS				
Opening balance:	IIA A/c		1,11,20,747	3,05,89,430
	External Projects A/c		6,10,33,161	-
Grant-in-aid		A	49,92,00,000	47,35,00,000
Other Receipts		B	19,51,695	42,64,769
Advance Recoveries, Credits/Adjustments		C	10,09,04,839	13,38,25,465
	TOTAL		**67,42,10,442**	**64,21,79,664**
PAYMENTS				
Recurring Expenditure		D	34,20,57,594	34,04,23,177
Non-Recurring Expenditure		E	7,62,12,245	9,76,68,924
Deposits and other payments		F	19,44,35,054	13,19,33,655
Closing balance:		6		
IIA Account			1,18,79,974	1,11,20,747
External Projects Account			4,96,25,575	6,10,33,161
	TOTAL		**67,42,10,442**	**64,21,79,664**

S.B.Ramesh
Accounts Officer

P. Kumaresan
Administrative Officer

P.Sreekumar
Director

As per our report of even date,
for B.R.V.GOUD & Co.,
Chartered Accountants
F.R.NO: 000992S

B.R.V. GOUD & CO. CHARTERED ACCOUNTANTS B'LORE-4

(A.B.Shiva Subramanyam)
Partner
M.No: 201108

Place: Bangalore
Date: 01.09.2014

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INDIAN INSTITUTE OF ASTROPHYSICS, BANGALORE -560034

RECEIPTS AND PAYMENTS ACCOUNT UNDER NON-PLAN FOR THE YEAR ENDED 31ST MARCH, 2014

Amount in Rs.

	SCH	2013-14	2012-2013
RECEIPTS			
Opening balance		5,000	5,000
Grant-in-aid	G	85,00,000	1,07,10,000
TOTAL		**85,05,000**	**1,07,15,000**
PAYMENTS			
Recurring Expenditure	H	85,00,000	1,07,10,000
Closing Balance	6	5,000	5,000
TOTAL		**85,05,000**	**1,07,15,000**

S.B.Ramesh
Accounts Officer

P. Kumaresan
Administrative Officer

P.Sreekumar
Director

As per our report of even date,
for B.R.V.GOUD & Co.,
Chartered Accountants
F.R.NO: 000992S

B.R.V. GOUD & CO. CHARTERED ACCOUNTANTS B'LORE-4

(A.B.Shiva Subramanyam)
Partner
M.No: 201108

Place: Bangalore
Date: 01.09.2014

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ACCOUNT FOR THE YEAR ENDED 31-3-2014

PARTICULARS	As at 31.03.2014 Rs.	As at 31.03.2013 Rs.
SCHEDULE -1		
CAPITAL FUND		
As per Previous Balance Sheet	68,66,60,390	73,60,74,893
Add: Grants received during the year		
(Non-Recurring Expenditure)	9,14,78,348	12,23,80,215
	77,81,38,738	85,84,55,108
Add: Tranfered from General Fund	2,31,98,892	-
	80,13,37,630	85,84,55,108
Add/(Less): Surplus/(Deficit) for the year (Plan)	76,31,815	(3,82,79,232)
	80,89,69,445	82,01,75,876
Less: Depreciation on fixed assets for the year	(13,68,89,450)	(13,35,15,486)
TOTAL	**67,20,79,995**	**68,66,60,390**
SCHEDULE -2		
GENERAL FUND		
As per Previous Balance Sheet	2,32,03,892	2,32,03,892
Add/(Less): Surplus/(Deficit) for the year (Non-Plan)	-	-
TOTAL	**2,32,03,892**	**2,32,03,892**
Less: Tranfered to Capital Fund	2,31,98,892	-
TOTAL	**5,000**	**2,32,03,892**
SCHEDULE -3		
CURRENT LIABILITIES & PROVISIONS		
Amount payable Contractors	-	52,29,264
Income tax(TDS)	-	14,30,700
Employee Loan Recoveries	-	9,92,750
Professional Tax Payable	32,832	-
Audit Fee	84,270	56,180
Earnest Money Deposit	31,25,748	37,41,500
Security Deposit - Contractors	37,80,768	32,36,152
Caution Deposit	6,40,880	4,61,000
External Projects Fund Balances	4,96,25,575	6,10,33,161
TOTAL	**5,72,90,073**	**7,61,80,707**

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SCHEDULE-4

FIXED ASSETS AS AT 31.03.2014

		Gross Block				Depreciation Block					Net Block	
Sl.No.	Description	As on 31.03.2013	Additions During the year	Transfer/ Adjustment	As on 31.03.2014	Rate %	Upto 31.03.2013	For the Year	Transfer/ Adjustment	As on 31.03.2014	As on 31.03.2014	As on 31.03.2013
		Rs.	Rs.	Rs.	Rs.		Rs.	Rs.	Rs.	Rs.	Rs.	Rs.
1	2	3	4	5	6	7	8	9	10	11	12	13
1	Land	2,48,98,870	-	-	2,48,98,870		-	-	-	-	**2,48,98,870**	2,48,98,870
2	Buildings	33,72,73,734	60,75,515	1,45,97,114	32,87,52,135	3	7,03,83,353	98,62,564	4,37,913	7,98,08,005	24,89,44,131	26,68,90,381
	Buildings - WIP		2,57,51,927	-	2,57,51,927	0	-	-	-	-	2,57,51,927	-
3	Vainu Bappu Telescope	5,30,54,848	-	-	5,30,54,848	10	5,30,54,847	0	-	5,30,54,847	1	1
4	2m Telescope - Hanle	45,27,41,497	2,14,455	-	45,29,55,952	10	45,27,41,496	21,446	-	45,27,62,942	1,93,011	1
5	HAGAR - Hanle	5,07,75,585	2,55,211	-	5,10,30,796	10	2,52,83,316	51,03,080	-	3,03,86,396	2,06,44,400	2,54,92,269
6	Capital Equipments	89,44,83,336	4,39,23,677	-	93,84,07,013	10	73,62,37,277	9,38,40,701	-	83,00,77,978	10,83,29,035	15,82,46,059
7	Furniture	2,45,89,631	7,00,845	-	2,52,90,476	10	2,45,89,630	70,085	-	2,46,59,715	6,30,762	1
8	Vehicles	1,51,19,568	-	-	1,51,19,568	10	1,17,96,385	15,11,957	-	1,33,08,342	18,11,226	33,23,183
9	Computers	12,57,68,273	45,47,721	-	13,03,15,994	10	10,69,33,571	1,30,31,599	-	11,99,65,170	1,03,50,824	1,88,34,702
10	Books and Journals	13,03,27,000	85,32,321	-	13,88,59,321	10	12,15,87,762	1,38,85,932	-	13,54,73,694	33,85,627	87,39,238
11	Typewriter	2,55,369	-	-	2,55,369	10	2,55,368	0	-	2,55,368	1	1
12	External Project - (HESP-DST) WIP	-	13,19,55,169	-	13,19,55,169	0	-	-	-	-	13,19,55,169	-
	Total Rs.	**2,10,92,87,711**	**22,19,56,841**	**1,45,97,114**	**2,31,66,47,438**		**1,60,28,63,005**	**13,73,27,363**	**4,37,913**	**1,73,97,52,456**	**57,68,94,983**	**50,64,24,706**

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PARTICULARS	As at 31.3.2014	As at 31.3.2013
	Rs.	Rs.

SCHEDULE - 5

CURRENT ASSETS, ADVANCES & DEPOSITS

A) Inventory		
Stock on hand - Stores & Consumables	5,02,995	5,10,783
(As Certified by the Management)		
B) Advances and Deposits to Staff & Service Providers		
i) DEPOSITS		
Deposit for hiring Residential accommodation	6,31,491	6,31,491
Deposit - CPWD for Road work at Hoskote	5,75,062	5,75,062
Deposit with Hamsa Service Station	6,000	6,000
Deposit with KEB	3,13,174	1,49,800
Deposit to St.Philomena Hospital	10,000	10,000
Deposit with Telephone Department	3,77,438	3,77,438
Security deposit with TNEB	2,35,604	2,35,604
LOANS & ADVANCES		
Contingent Advance	3,21,850	9,25,505
Festival Advance	1,13,919	88,794
House Building Advance	46,54,920	44,92,118
LTC advance	4,17,300	-
Motor Car Advance	20,75,494	22,98,629
Motor Cycle Advance	17,72,211	17,36,890
Computer Advance	13,64,840	21,55,253
Travelling Advance	6,51,810	-
Margin back up for letter of credit	1,74,15,000	1,81,37,468
Amount receivable from Staff	-	1,10,000
Advances to Officers Mess-ITBP Leh	-	45,000
Deposit to Angam at Hanle	-	50,000
Prepaid Expenses	4,86,267	-
NLST Project	4,44,12,632	3,88,48,960
IIA - UVIT - Project	12,09,99,581	12,02,03,956
HESP-IIA Project	2,55,87,117	1,58,72,624
TOTAL	**22,24,21,710**	**17,51,30,540**
TOTAL (A+B)	**22,29,24,705**	**20,74,61,375**

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PARTICULARS	As at 31.3.2014	As at 31.3.2013
	Rs.	Rs.

SCHEDULE - 6

CASH AND BANK BALANCES

Cash on Hand		
Bangalore	35,209	27,188
Kodaikanal	21,945	19,770
Kavalur	10,490	76
Gauribidanur	-	12,540
Leh	6,689	47,050
Hoskote	425	26,673
Cash at Banks		
Bank of Baroda, Bangalore (2/74)	2,82,64,491	6,80,02,471
Bank of Baroda, Bangalore (SB A/c 1/1565)	1,20,05,560	-
Bank of Baroda, Bangalore (TMT SB A/c 1/1675)	1,43,67,872	-
State Bank of India, Kodaikanal	3,55,566	16,62,952
State Bank of India, Kodaikanal (SB A/c)	7,02,900	-
Indian Overseas Bank, Kavalur	10,06,688	1,63,385
State Bank of India, Leh	19,84,868	10,01,971
State Bank of Mysore, Bangalore	1,65,894	1,98,060
State Bank of Mysore, Hoskote	10,78,268	1,98,645
Union Bank of India, Bangalore	1,90,511	6,38,184
Union Bank of India, Bangalore (SB A/c)	5,00,000	-
Canara Bank, Gauribidanur	7,90,628	1,36,571
HDFC Bank, Bangalore	22,544	23,372
TOTAL	**6,15,10,549**	**7,21,58,908**
Plan	**1,18,79,974**	**1,11,20,747**
Non-Plan	**5,000**	**5,000**
Project Fund	**4,96,25,575**	**6,10,33,161**

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PARTICULARS		2013-2014 Rs.	2012-2013 Rs.
SCHEDULE - 7			
Grant-in-aid		48,92,00,000	47,35,00,000
Ministry of Science & Technology			
(Dept of Science & Technology)			
Less : Amount transferred to Capital Fund			
(Non Recurring Expenditure during the year)			
Fixed Assets	7,54,04,558		
UVIT-IIA A/c	7,95,625		
NLST-IIA A/c	55,63,672		
HESP-IIA A/c	97,14,493	9,14,78,348	12,23,80,215
TOTAL		**39,77,21,652**	**35,11,19,785**
SCHEDULE- 8			
OTHER INCOME			
Bank Interest		12,24,431	21,60,118
Interest on Advances to Employees		13,62,288	5,09,123
Licence Fees		3,89,154	3,19,864
Others / Misc Income		4,55,770	18,51,468
TOTAL		**34,31,643**	**48,40,573**
SCHEDULE-9			
SALARIES AND ALLOWANCES			
Pay and Allowances (Plan)		**28,80,90,675**	**28,76,89,101**
SCHEDULE - 10			
OFFICE EXPENDITURE			
Postage & Courier		2,48,948	3,69,465
Conveyance		1,94,289	52,876
Printing and Stationery		11,75,038	12,48,346
Entertainment Exp		-	36,195
Vehicle Maintenance		22,97,628	17,85,741
Advertisement Expenses		7,73,413	21,53,989
Audit fee		84,270	56,180
Legal Fee		-	2,91,102
Guest House Expenses		34,13,950	22,10,395
Travel - International		20,02,521	28,89,262
Travel - Domestic		43,09,527	51,52,668
TOTAL		**1,44,99,584**	**1,62,46,219**

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PARTICULARS	2013-2014	2012-2013
		Rs.
SCHEDULE-11		
WORKING EXPENSES - PLAN		
Property Tax	11,22,951	19,07,511
Electricity & Water Charges	95,00,574	1,33,27,287
Telephone charges	25,21,876	23,85,723
Travel Expenses	42,73,001	32,28,467
Repairs, mainteance for Computers, Electrical, Electronics, Mech & Optical Equipments & Manpower Outsource Charges	5,91,75,272	4,80,11,058
Other Expenses	44,61,978	52,50,992
Conference/Meetings/Workshops/Schools	19,80,638	24,37,235
Rent for Hiring Accommodation	6,90,035	6,85,900
Canteen Expenses	23,54,184	31,37,028
Lease rent for Observatories (VBO,Kavalur & Gauribidanur)	79,212	8,29,705
TOTAL	**8,61,59,721**	**8,12,00,906**
SCHEDULE - 12		
STORES & CONSUMABLES		
Opening Balance	5,10,783	6,33,547
Add: Purchases during the year	47,63,712	68,09,268
	52,74,495	74,42,815
Less: Closing Stock	5,02,995	5,10,783
Consumption during the year	**47,71,500**	**69,32,032**
SCHEDULE - 13		
GRANTS-IN-AID (NON - PLAN)		
Grant-in-aid	85,00,000	1,07,10,000
Ministry of Science & Technology		
(Dept.of Science & Technology)		
SCHEDULE 14		
SALARIES & ALLOWANCES - NON PLAN		
Pay and Allowances	85,00,000	1,07,10,000
TOTAL	**85,00,000**	**1,07,10,000**

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PARTICULARS	2013-2014	2012-2013
		Rs.

SCHEDULE - A
GRANT - IN - AID (PLAN)

Grants-in-aid	48,92,00,000	47,35,00,000
TMT Project Grant	1,00,00,000	-
Ministry of Science & Technology (Dept of Science & Technology)		
TOTAL	**49,92,00,000**	**47,35,00,000**

SCHEDULE - B
OTHER RECIEPTS

Bank Interest - IIA	12,24,431	21,60,118
Interest on Advances to Employees	2,68,463	1,49,807
Licence Fee	3,563	6,476
Others	4,55,238	19,48,368
TOTAL	**19,51,695**	**42,64,769**

SCHEDULE - C

ADVANCE RECOVERIES, CREDITS / ADJUSTMENTS

Salary Deduction from Staff	52,40,153	-
Contingent Advance	24,96,428	27,34,896
Caution deposit from Research scholars	(7,000)	(7,000)
Earnest Money Deposit	14,05,748	19,65,500
House Building advance recovery	12,390	-
Computer Advance Recovery	1,02,310	1,16,958
Festival Advance Recovery	3,000	3,750
Motor Car Advance recovery	-	1,284
Motor Cycle Advance recovery	18,688	14,473
Security deposit from Contractors	5,44,616	21,64,741
Deposit to Bank for LC	2,47,95,000	(2,08,28,468)
Canara Bank Loan	3,63,433	-
Income tax	27,83,490	-
Amount from Aditya Project	67,08,536	59,98,770
Amount from UVIT ISRO Project	1,41,243	51,28,123
External Projects	5,62,96,804	13,65,32,438
TOTAL	**10,09,04,839**	**13,38,25,465**

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PARTICULARS	2013-2014 Rs.	2012-2013 Rs.
SCHEDULE - D		
RECURRING EXPENDITURE - PLAN		
A) Salary and Allowances		
Pay and Allowances	13,02,11,524	14,23,08,276
Research Scholars/Em.Professor	1,90,17,255	-
Honorarium	3,82,915	5,32,150
Pension Contribution-Institute	74,25,475	67,33,501
Payment to pension fund	2,25,00,000	3,09,03,288
Medical Expenses	2,22,37,703	1,84,95,874
CPF Institute Contribution	1,58,805	4,03,560
New Pension scheme Institute contribution	24,32,428	36,42,695
Gratuity/leave encashment/Retirement benefits	2,07,89,621	2,64,71,044
Uniform and Washing Allowance	16,100	43,720
Ad-Hoc Bonus	2,72,290	4,44,990
Children Education Allowance	18,72,053	20,86,114
LTC & Leave encashment of LTC	48,87,051	38,96,631
	23,22,03,220	**23,59,61,843**
B) Administrative Expenditure		
Postage & Courier	2,51,537	3,69,465
Conveyance	1,94,289	1,81,150
Printing and Stationery	11,75,038	12,48,346
Entertainment	-	36,195
Vehicle Maintenance	16,98,393	17,85,741
Advertisement Expenses	7,73,413	21,53,989
Audit fee	56,180	2,76,767
Legal / Professional Fee	-	70,515
Guest House & Mess Expenses	39,32,451	27,90,428
	80,81,301	**89,12,596**
C) Travelling Expenses		
Travel - Domestic	49,87,565	51,26,382
Travel - International	20,74,139	28,51,993
	70,61,704	**79,78,375**
D) Working Expenses		
Property tax	11,22,951	19,07,511
Electricity & Water charges	1,00,35,756	1,33,60,023
Telephone charges	25,14,230	23,85,723
Lease rent for Observatories (Kavalur & Gauribidanur)	79,212	8,29,705
Rent for Hiring Accommodation	6,40,035	6,85,900
Repairs & Maintenance	2,86,58,663	2,26,43,234
Manpower Outsource Exp	3,45,00,356	2,53,67,824
Consumables for computers,electrical,electronics,optical components	49,69,499	64,68,298
Laboratory Expenses	3472867	4909881
Travel expenses	43,91,376	34,45,146
Meeting/Workshop/Schools/Conferences etc.	18,78,900	22,19,226
Canteen expenses	24,47,524	33,47,892
		-
TOTAL	**9,47,11,369**	**8,75,70,363**
TOTAL(A+B+C+D)	**34,20,57,594**	**34,04,23,177**

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PARTICULARS	2013-2014	2012-2013
	Rs.	Rs.

SCHEDULE - E

NON-RECURRING EXPENDITURE - PLAN - NET

Computers	45,47,721	59,47,219
Capital equipment	4,47,34,341	5,59,72,577
Works and Services	1,72,30,328	2,70,52,178
Furniture	6,97,868	8,96,316
Books & Journals	85,32,321	65,92,514
Vehicles	-	5,492
HAGAR	2,55,211	1,24,420
2 M Telesope	2,14,455	10,78,208
TOTAL	**7,62,12,245**	**9,76,68,924**

SCHEDULE -F

DEPOSITS & OTHER PAYMENTS (Current Assets)

Contingent Advance	28,10,261	34,46,096
UVIT - Project	-	5,60,995
House Building Advance	16,08,160	8,69,361
Margin for LC	2,40,72,000	-
Computer Advance	60,000	4,90,000
Motor Car Advance	5,40,000	5,40,000
Festival advance	2,51,250	2,33,394
Motor cycle advance	1,26,000	7,02,000
Institute supported projects	9,14,35,136	5,87,93,632
Deposit with KEB	1,63,374	67,000
Earnest Money Deposit	20,21,500	5,12,000
Amt paid to V R Builders	52,29,264	-
Salaries Recoveries paid	6,21,09,269	4,91,08,024
HESP-IIA	-	1,58,72,624
Medical Advance	1,00,000	-
Amount from Aditya Project	39,08,840	7,38,529
TOTAL	**19,44,35,054**	**13,19,33,655**

PARTICULARS	2013-2014	2012-2013
	Rs.	Rs.

SCHEDULE-G
GRANT-IN-AID (NON-PLAN)

Grant-in-aid Ministry of Science & Technology (Dept.of Science & Technology)	85,00,000	1,07,10,000

SCHEDULE - H
RECURRING EXPENDITURE - NON-PLAN

Salary and Allowances		
Pay and Allowances	85,00,000	1,07,10,000
TOTAL	85,00,000	1,07,10,000

S.B.Ramesh
Accounts Officer

P. Kumaresan
Administrative Officer

P.Sreekumar
Director

As per our report of even date,
for B.R.V.GOUD & Co.,
Chartered Accountants
F.R.NO: 000992S

B.R.V. GOUD & CO. CHARTERED ACCOUNTANTS B'LORE-4

(A.B.Shiva Subramanyam)
Partner
M.No: 201108

Place: Bangalore
Date: 01.09.2014

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SCHEDULE: - 15

SIGNIFICANT ACCOUNTING POLICIES AND NOTES ON ACCOUNTS FOR THE YEAR ENDED 31.03.2014

A. SIGNIFICANT ACCOUNTING POLICIES:

1. ACCOUNTING CONVENTION:

The Financial Statements are prepared on the basis of Historical cost convention and on the accrual method of accounting, except Bank Interest, which is accounted on 'Cash Basis', as in previous years. The guidelines given by the Government of India for drawing Financial Statements for central autonomous bodies have been adopted, to the extent that they are directly applicable.

2. FIXED ASSETS:

Fixed assets are stated at cost of acquisition less depreciation.

3. DEPRECIATION:

Depreciation is provided on **Straight Line Method** at rates as stated in the Fixed Assets Schedule. The amount of depreciation is debited to capital fund and not to the Income & Expenditure Account, since the amount spent on non recurring expenditure out of the grant received every year from DST is credited to the capital fund, as a stated in Accounting policy No.5 'Government Grants'

4. INVENTORY:

Stocks on hand such as spares, materials, consumables are valued at cost.

5. GOVERNMENT GRANTS:

Government grants received from DST are accounted on realization basis and the same have been separately shown under Plan and Non-Plan in the Annual accounts of the Institute. Out of the total Plan grant amount received, an amount equal to the amount of non recurring expenditure incurred during the year is directly credited to the Capital Fund A/c, the balance of Plan grants is reckoned as Income and shown in Income & Expenditure Account.

6. FOREIGN CURRENCY TRANSACTIONS:

Transactions denominated in foreign currency are accounted at the exchange rates prevailing as on the dates of the transaction.

7. RETIREMENT BENEFITS:

- Institute's Contribution to Provident Fund and Pension Fund are charged to Income and Expenditure Account of the Institute. Apart from this, any deficit in the Provident Fund and Pension Fund amount is borne and provided for in the accounts of the Institute.

- Estimated liability for gratuity on the date of Balance Sheet has not been quantified. The same is accounted for, on actual payment.

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B. NOTES ON ACCOUNTS:

1. In the opinion of the Management, the Current Assets, Advances and Deposits have a value on realization in the ordinary course of activities, equal at least to the aggregate amount shown in the Balance Sheet.

2. Financial records and related data has been migrated from the ERP to Tally.

3. Figures pertaining to the previous year have been regrouped/reclassified to suit the current year's classification.

4. Figures have been rounded off to the nearest rupee.

S.B.Ramesh
Accounts Officer

P. Kumaresan
Administrative Officer

P.Sreekumar
Director

for B.R.V. GOUD & Co.,
Chartered Accountants

B.R.V. GOUD & CO. CHARTERED ACCOUNTANTS B'LORE-1

(A.B.ShivaSubramanyam)
Partner
M No 201108

Place: BANGALORE
Date : 01.09.2014