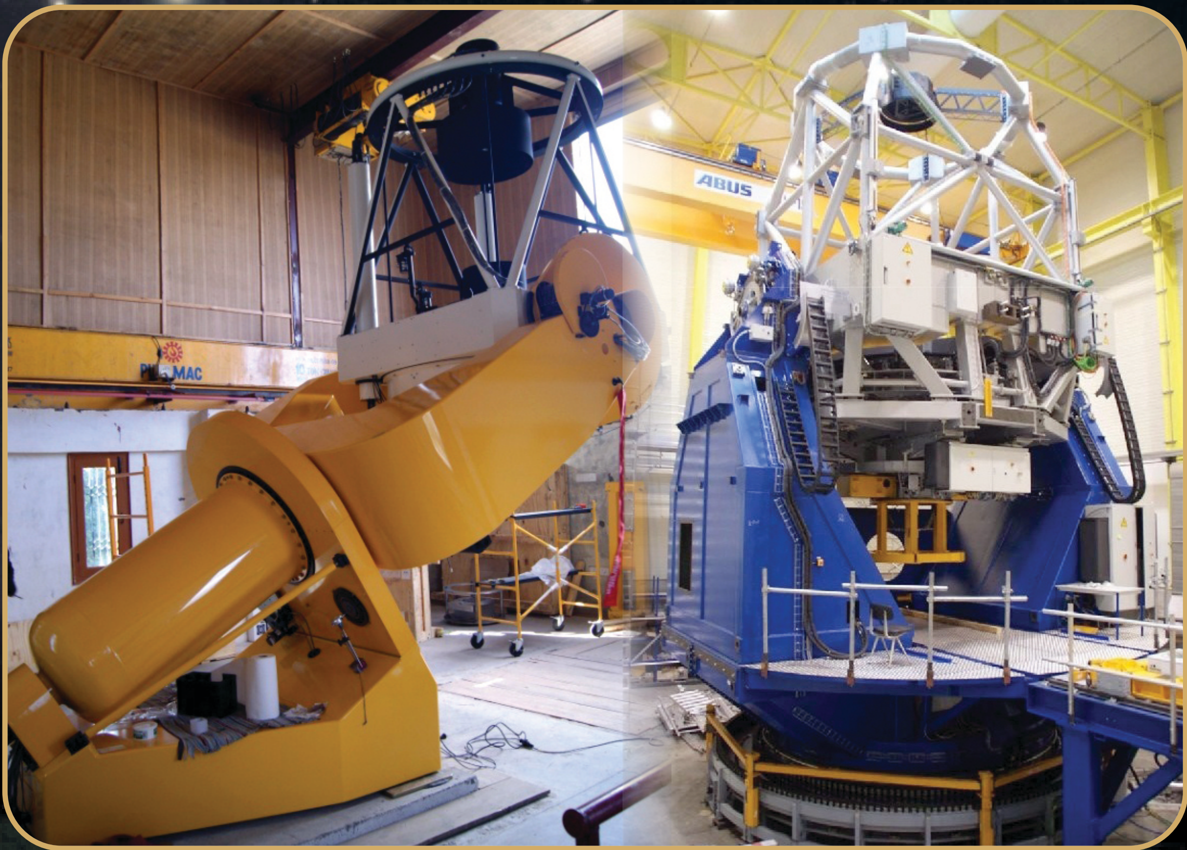
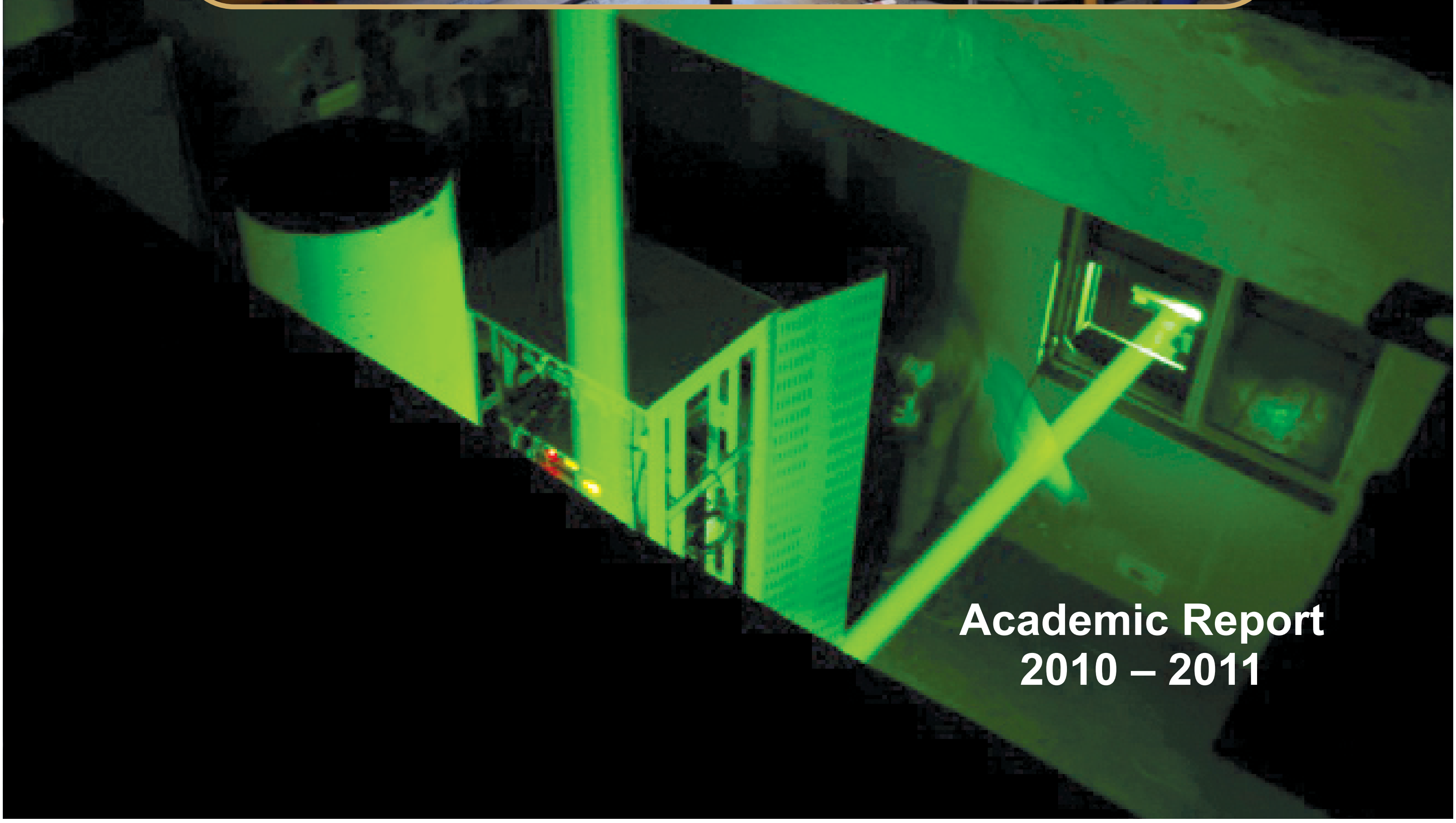
Aryabhatta Research Institute of Observational Sciences

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

Manora Peak, Nainital (India)





Academic Report
2010 – 2011

ARYABHATTA RESEARCH INSTITUTE
OF
OBSERVATIONAL SCIENCES

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

Manora Peak, Nainital - 263 129, India

ACADEMIC REPORT

2010 - 2011

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Front cover:
Upper left: 1.3-m Devasthal Optical Telescope; **Upper right:** Fully assembled 3.6-m telescope with dummy mirrors at AMOS workshop, and **Lower:** Mie LIDAR system at ARIES, Nainital.

Back cover:
Upper left: H-alpha image of star burst galaxy M82 overlaid upon broadband VR image of the galaxy; **Upper right:** The BVR composite image of Orion star forming region, and **Lower:** The BVR color composite image of the central portion of the galaxy NGC598. All the images are taken with newly installed the 130-cm telescope at Devesthal.

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Abbreviations

ABLN&C	Atmospheric Boundary Layer Network and Characterization
ADFOSC	ARIES Devasthal Faint Object Spectrograph and Camera
AERONET	Aerosol Robotic Network
AGL	Above Ground Level
AGN	Active Galactic Nuclei
AIMPOL	ARIES Imaging Polarimeter
AIPS	Astronomical Image Processing System
AMOS	Advanced Mechanical and Optical Systems
amsl	Above Mean Sea Level
AOD	Aerosols Optical Depth
AR	Active Region
ARIES	Aryabhatta Research Institute of Observational Sciences
ASTROSAT	Indian Satellite Mission for Multiwavelength Astronomy
AT – CTM	Atmospheric Trace Gases – Chemistry, Transport and Modeling
ATP	Acceptance Test Procedure
BAL	Broad Absorption Line
BATSE	Burst and Transient Source Experiment
BBSO	Big Bear Solar Observatory
BC	Black Carbon
BLL	Boundary Layer Lidar
BL Lac	BL Lacertae
BNSTP	Baker – Nunn Schmidt Telescope Project
BRCs	Bright-Rimmed Clouds
BSNL	Bharat Sanchar Nigam Limited
CAWSES	Climate And Weather of the Sun-Earth System
CCD	Charged Coupled Device
CD-ROM	Compact Disc – Read Only Memory
CMDs	Center Meridian Distances
CME	Coronal Mass Ejection
DAMA	Demand Assigned Multiple Access
DH Cep	DH Cepheus
DOT	Devasthal Optical Telescope
DSP	Digital Signal Processing
DST	Department of Science & Technology
EIWG	Earth - Ionosphere Wavelngth
ELF	Extremely Low Frequency

EMCCD	Electron Multiplying Charge Coupled Device
ERNET	Education and Research Network
FORSA	Forum for Resource Sharing in Astronomy and Astrophysics
FOV	Field – of - View
FSRQs	Flat Spectrum Radio Quasars
FWHM	Full Width at Half Maximum
GATE	Graduate Aptitude test in Engineering
GHz	Giga Hertz
GMRT	Giant Meterwave Radio telescope
GOES	Geostationary Operational Environmental Satellite
GPS	Global Positioning System
GRB	Gamma-Ray Burst
GRG	Giant Radio Galaxies
GSFC	Goddard Space Flight Center
GVAX	Ganga Valley Aerosol Experiment
HD	Henry Draper
HVS	High Volume Sampler
IDV	Intra-Day Variability
IHY	International Heliophysical Year
IIA	Indian Institute of Astrophysics
IIG	Indian Institute of Geomagnetism
ILMT	International Liquid Mirror Telescope
INASAN	Institute of Astronomy, Russian Academy of Science
ISP	Internet Service Provider
ISRO-GBP	Indian Space Research Organization – Geosphere Biosphere Programme
IST	Indian Standard Time
IUCAA	Inter-University Centre for Astronomy and Astrophysics
JEST	Joint Entrance Screening Test
JTAC	Joint Time Allocation Committee
KLF	K-band Luminosity Function
kpc	Cubic Kiloparsecs
KRC	Knowledge Resource Centre
KVA	Kilo-Volt-Ampere
LASCO	Large Angle Spectrometric Coronograph
LBLs	Low Energy Peaked Blazers
LC	Light Curve
LIDAR	Light Detection and Ranging
LOS	Line - of - Sight

LZOS	Lytkarino Optical Glass Factory
MDI	Michelson Doppler Imager
MF	Mass Function
MHD	Magnetohydrodynamic
MHz	Mega Hertz
MODIS	Moderate Resolution Imaging Spectroradiometer
MPL	Micro Pulsed Lidar
NASA	National Aeronautics and Space Administration
NCAR	National Centre for Atmospheric Research
NCRA	National Centre for Radio Astrophysics
Nd:YAG	Neo Dymyum: Yttrium Aluminum Garnet
NET	National Eligibility Test
NGC	New General Catalog
NIES	National Institute for Environmental Studies
NIR	Near Infra Red
NLST	National Large Solar Telescope
NOAA	National Observatory of Astronomy and Astrophysics
OMI	Ozone Monitoring Instrument
OPAC	Optical Properties of Aerosol and Cloud
OPAC	Online Public Access Catalouge
PIT	Project Implementation Team
PMB	Project Management Board
PMC	Project Management Committee
PMRC	Project Management Review Committee
PPS	Precision Precast Solutions
PV	Peak – to - Valley
PWM	Pulse With Modulation
QPO	Quasi Periodic Oscillations
QSL	Quasi-Seperatix Layer
QSOs	Quasi-Stellar Objects
RAC	Radio Astronomy Centre
RCS	Range Corrected Signal
RFBR	Russian Foundation of Basic Research
RMS	Root-mean-Square
RQ	Radio-Quiet
RQQSOs	Radio-Quiet Quasi-Stellar Objects
SAAO	South African Astronomical Observatory
SBDART	Santa Barbara DISORT Atmospheric Radiative Transfer

SBIG	Santa Barbara Instrument Group
SCs	Solar Cycles
SDSS	Sloan Digital Sky Survey
SNe	Supernovae
SOHO	Solar and Heliospheric Observatory
SOXS	X-Ray Spectrometer
ST	Sampurnanand Telescope
SXI	Soft X-Ray Imager
SXR	Soft X-Ray
T&E	Test and Evaluation
TIFR	Tata Institute Of Fundamental Research
TOA	Top – of - Atmosphere
TR	Transmit - Receive
TRACE	Transition Region and Coronal Explorer
TRM	Transmit Receive Module
TSP	Total Suspended Particles
UBVRI	Ultraviolet-Blue-Visual-Red-Infrared
UC	Ultracompect
ULE	Ultra Low Expansion
UPCL	Uttarakhand Power Corporation Limited
UPS	Uninterruptible Power Supply
USO	Udaipur Solar Observatory
UT	Universal Time
UV	Ultra - Violet
VLA	Very Large Array
VLF	Very Low Frequency
WFE	Wavefront Error
WWLLN	World Wide Lightning Location Network
XMM	X-Ray Multi Meter
YSOs	Young Stellar Objects

Executive Summary

The Institute continued its endeavor to make important contributions in some front-line areas of astronomy & astrophysics and atmospheric sciences. The Academic Report for the year 2010-2011 summarizes the ongoing activities pertaining to knowledge creation as well as developments within various research and technical groups of the Institute. The out come of these activities have been published in the form of research papers in refereed National and International scientific journals. The major developmental and academic activities carried out during 2010-2011 are summarized below:

1. The successful commissioning of the 130-cm telescope at Devasthal has been an important event of the year. The telescope was inaugurated by Dr. T. Ramasami, Secretary, Department of Science and Technology, Govt. of India on December 19, 2010.

2. The activities related to the 3.6 meter Devesthal optical telescope (DOT) are going in full swing. The work on primary (M1) mirror was in progress at LZOS, Russia. Although the wavefront error of 223 nm RMS (2314 nm PV) had already been achieved in March 2011, the required specification (40 nm RMS) is expected to be achieved by June 1011. The assembly and integration of the telescope with dummy mirrors has been completed in February 2011. The contract for manufacture, supply, erection and commissioning of the telescope enclosure has been awarded to M/s Pedvak Cranes Pvt. Ltd., Hyderabad. The assembly and integration of the coating plant has been done by M/s HHV, Bangalore.

3. The ARIES Devasthal Faint Object Spectrograph and Camera (ADFOSC) will be the first light instruments at the axial port of the Cassegrain focus of the 3.6-m Devesthal Optical Telescope. The instrument will cover the wavelength range 350-1000 nm and it will have two distinct mode of operation – (i) Direct broad and narrow-band imaging capabilities with spatial resolution of less than 0.2 arcsec in 10 arcmin field of view and (ii) Low-to-medium resolution spectroscopy with spectral resolution (250-4000) covering the optical wavelengths 360-1000 nm. The design of the ADFOSC is in advanced stage.

4. The mechanical alignment of the Baker-Nunn Schmidt Telescope with the North pole has been done. The optical alignment of the telescope is expected in October 2011.

5. The committee has evaluated the antenna and TR modules for the upcoming ST radar at ARIES, Nainital and recommended for the mass production by ECIL, Hyderabad. The civil work of the ST radar is in advanced stage.

6. The construction of a guest house at Devasthal is in advanced stage.

7. Academic staff members vigorously pursued the research work in their respective fields. Major parts of the scientific research of the Institute were published in scientific journals of international repute (e.g. Astrophysical Journal, Monthly Notices of Royal Astronomical Society and Atmospheric Research). Forty one papers were

published/accepted in refereed journals, and another eleven were published as circulars and conferences proceedings. Two Ph. D. theses have been awarded and another five have been submitted. Academic and technical interaction with various institutions and universities were continued. Following are the major scientific results:

i) A comprehensive multiwavelength analysis of the young cluster NGC 1624 associated with the HII region Sh2-212 using optical UBVRI photometry, optical spectroscopy and GMRT radio continuum mapping along with the near-infrared (NIR) JHK archival data reveals 120 probable candidate YSOs in the region. These YSOs are found to have an age spread of ~5 Myr with a median age of ~2-3 Myr and a mass range of ~0.1-3.0 M . A significant number of YSOs are located close to the cluster centre. An enhanced density of reddened YSOs located/projected close to the molecular clumps detected by Deharveng et al. (2008) at the periphery of NGC 1624 has been detected. This indicates that the YSOs located within the cluster core are relatively older in comparison to those located/projected near the clumps.

ii) A multiwavelength linear polarimetric observations towards the direction of NGC 1893 young open cluster region reveal presence of two dust layers located at a distance of ~170 and ~360 pc. The dust layers produce a polarization P ~2.2 per cent. The small dispersion in polarization angle indicates the presence of a uniform dust layer beyond 1 kpc. The estimated mean value of λ_max indicates that the average size of the dust grains within the cluster is similar to that in the general interstellar medium.

iii) The study of X-ray emission from massive O-type stars DH Cep and HD 97434 shows that there is no firm evidence for short-term variability in the X-ray intensity during the observations time span (<40 ks). The spectral analysis of these stars reveals X-ray structure being consistent with two-temperature plasma model. The X-ray emitting plasma is found to be generated at a temperature of lesser than 1 keV. It could originate from small shocks in the radiation-driven outflows.

iv) GRBs are divided into two classes according to their durations. Analysis reveals that the conventional classification of GRBs with the duration of bursts is influenced by the softness of the objects. There exists a bimodality in the duration distribution of GRBs for each group of bursts and the time position of the dip in the bimodality histogram shifts with the softness parameter. The findings suggest that the conventional classification scheme should be modified by separating the two well known populations in different softness groups, which would be more reasonable than doing so with a single sample.

v) The multi-wavelength data for a M7.9/1N class solar flare, which occurred on 27 April 2006, have been analyzed. This study provides the first multiwavelength observational evidence of loop-loop interaction, their reconnection, and triggering of solar flare. It is suggested that the shear motion/rotation of the foot point of smaller loop, which is anchored in the opposite polarity spot, may be responsible for the flare energy buildup and its release due to the loop-loop interaction.

vi) Solar filaments show the position of large-scale polarity-inversion lines and are used for the reconstruction of large-scale solar magnetic field structure on the basis of Hα synoptic charts for the periods when magnetographic measurements are not available. The daily Hα filtergrams from the archive of Big Bear Solar Observatory have been analyzed for the period of 1999 – 2003. The analysis shows variety of crossing and interacting filaments. A number of examples of these filament patterns are compared with their photospheric magnetic field distributions. This reveals that all crossing filaments exhibit a quadrupolar magnetic configuration of the photospheric field, and presume the presence of null points in the corona that may be an important location of the energy release and MHD activities.

vii) The influences of the springtime Northern Indian biomass burning are shown for the first time over the central Himalayas by using three years (2007- 2009) of surface and space based observations along with a radiative transfer model. The analysis highlights that the Northern Indian biomass burning can induce an additional cooling at the surface and top of the atmosphere in the lesser polluted high altitude regions of the central Himalayas. These biomass burning induced changes over the central Himalayan atmosphere during spring may also lead to enhanced short-wave absorption above clouds and might have important implications for the monsoonal rainfall.

viii) First time measurements of BC mass concentration at Pantnagar, a low altitude semi-urban location in central Himalayan foothills, has been reported. It was found that diurnal trend in the BC variation at Pantnagar, is entirely opposite to those at Naintal, implying the manifestation of evolving atmospheric boundary layer due to convective eddies over these locations. Observations of vertical profiles of aerosols using micro pulsed lidar (MPL) system at ARIES, quite frequently showed an elevated aerosol layer in the altitude range of 2460 – 4460 meter, On the other hand, the MPL profiles during an intense dust-storm showed drastic changes in the lidar backscatter ratio on dust day as compared to that on pre-dust days. Meanwhile the measured AODs, also showed a different spectral behavior on dust day as compared to that on pre-dust days.

8. The Institute has a vibrant graduate studies programme with more than 30 research students. The institute continued to host a variety of programmes for man-power development through (i) research and engineer trainee programme, (ii) projects as part of academic course work, (iii) visits of students and staff from other institutions, and (iv) summer project student programme.

9. Several public outreach activities took place during the year including a summer program for school student during May 15 to June 30, 2010. Nineteen students of Class VIII to X participated in various projects at ARIES under the guidance of scientists and research scholars.

10. A number of scientists and engineers of the Institute participated in national and international conferences/ workshops/ colloquia with invited and/or contributed presentations.

A number of young and meritorious scientists and engineers have joined ARIES. ARIES faculty members are actively collaborating with scientists and engineers of other institutes in India and abroad. The continued developments in infrastructure and academic activities at the Institute indicate a bright future of the Institute.

Place: Nainital RAM SAGAR
Date: 10 August, 2011 Director

The Institute

ARIES (Aryabhatta Research Institute of observational sciencES), came into existence in the year 2004 (formally known as State Observatory), continued to focus on its aim of becoming a leading research center in observational Astronomy & Astrophysics and Atmospheric Sciences. ARIES is setting up new observational facilities not only at its main campus at Manora peak but also at new campus 'Devasthal' which is at a distance of about 60-km from ARIES. Devasthal has the advantages of having dark skies and excellent observing conditions. In addition its unique position (79^o.5 East), almost in the middle of 180° wide longitude band between Canary Island (20^o West) and Eastern Australia (157^o East), allows to carry out time critical complementary observations which might not be possible from either of these two places because of day time.

ARIES has an academic staff of 28 core academic faculty members, 2 post-doctoral fellows and 30 research scholars. The main research interests of Astronomy & Astrophysics division are in solar, planetary, stellar, galactic and extra-galactic astronomy including stellar & quasar variabilities, X-ray binaries, star clusters, nearby galaxies, quasars absorption and emission line studies and inherently transient events like supernovae and highly energetic gamma-ray bursts. Moreover, to strengthen the scientific contribution, the Institute has extended its horizon to theoretical and numerical studies in Relativistic Astrophysics. Research focus in Atmospheric Sciences division is mainly in the lower part of the atmosphere and covers the studies on trace gases and aerosols.

In addition ARIES faculty members also participate in pedagogical activities like lectures, seminars, popularization of science along with many developmental programs to improve the infrastructure of our existing as well as upcoming observational facilities. These activities are carried out with the support of technical staff consisting of 13 engineers, 36 assistants and 18 administrative staff members.

Facilities: The Institute hosts 104-cm telescope at Manora peak, Nainital. There are two 15-cm telescopes dedicated to solar observations. The 104-cm optical telescope is being used as main observing facility by the ARIES scientists since 1972. It is equipped with 2k x 2k, and 1k x 1k liquid nitrogen cooled CCD cameras, fast photometer, spectrophotometer, polarimeter along with standard astronomical filters. The telescope uses a SBIG ST-4 camera for auto-guiding through an auxiliary 20-cm telescope.

In order to improve observational facilities the Institute is setting up optical telescopes at Devasthal. The successful commissioning of the 130-cm telescope at Devasthal has been an important event of the year. The telescope is equipped with a 512 x 512 electronically cooled CCD camera and standard astronomical filters. Setting of the infrastructure on larger scale for upcoming 360-cm telescope is under progress.

The ARIES scientists are participating in the thirty meter international telescope project. The scientists from the solar group are also participating in the national projects like space coronagraph and national large solar telescope (NLST) project.

The atmosphere science division has several instruments for observations of physical and optical properties of aerosols. Facility for balloon-borne observations (low altitude) of ozone and meteorological parameters has also been setup at ARIES. A lab has been set up for measurement of trace gases like, ozone, CO, NO, NO_y, SO_2, hydrocarbons and greenhouse gases.

A high energy pulse LIDAR system has been designed and integrated at ARIES for the study of vertical distribution of aerosols and clouds in troposphere, and dynamic temperature of stratosphere by operating the Lidar in Mie and Rayleigh mode, respectively. ARIES is installing a Stratosphere Troposphere (ST) RADAR in the Manora peak campus to obtain wind information (speed and direction) up to 20-km above earth's surface with a 150-m spatial resolution to understand the local weather. The infrastructure for new upcoming ST-Radar is under progress.

Student training and short term visit programme: A few bright M. Sc. students can spend 2-3 months at ARIES to work on topics related to Astronomy & Astrophysics or Atmospheric Sciences. Apart from this, students with an outstanding academic record and an aptitude for instrumentation or software development can also spend a few months at ARIES. In addition ARIES also organizes training schools for M. Sc. final year students/young research scholars to aquatint them with observational sciences.

Evening Program: As a part of science popularization program, ARIES is open to public in the evenings for night-sky viewing using the telescopes. Visitors can also attend the slide-shows and view the picture gallery describing celestial bodies. ARIES also organizes schools and workshops for school children especially during summer vacations as well as participates in other science popularization programs outside the campus organized for students and common public.

Ph. D./PDF Program: ARIES offers Ph. D. program in the field of Astronomy & Astrophysics and Atmospheric Sciences. The minimum qualification for a research scholar is a M. Sc. degree in Physics/Astronomy/Astrophysics/Atmospheric Sciences and they should be JEST/NET/GATE qualified. The students can register for the Ph. D. degree at a number of Indian universities which have recognized ARIES as a research centre.

ARIES offers post-doctoral fellowships and visiting positions in the following selected branches of Astronomy & Astrophysics, Atmospheric Sciences, Engineering & Instrumentation and Software development;

Atmospheric Sciences: Trace gases, aerosols characterization, radiation budget, satellite data analysis and modeling.

Sun and Solar System: Sun, solar activity, comets, asteroids, and planets.

Extragalactic Astronomy: Nearby galaxies, Wolf-Rayet galaxies, active galaxies, optical follow-up of gamma ray bursts (GRBs) and supernova, quasar luminosity variability; quasar absorption/emission line studies; Radio astronomy.

Interstellar Matter: Gas (atoms and molecules) and dust between the stars and within interstellar clouds.

Stellar Astronomy: Stars, star clusters, stellar variabilities, ages of the stars and their spectral properties.

Theoretical Astrophysics: Theoretical and numerical studies of relativistic phenomena like accretion onto compact objects, astrophysical jets, GRBs etc.

X-ray Astronomy: X-ray emitting binary stars.

I. GALACTIC ASTRONOMY

a. Star formation

Triggered star formation:

A comprehensive multiwavelength analysis of the young cluster NGC 1624 associated with the H II region Sh2-212 using optical UBVRI photometry, optical spectroscopy and GMRT radio continuum mapping along with the near-infrared (NIR) JHK archival data has been carried out. From optical observations of the massive stars, reddening E(B-V) and distance to the cluster are estimated to be 0.76-1.00 mag and 6.0 ± 0.8 kpc, respectively. The analysis yields a spectral class of O6.5V for the main ionizing source of the region, and the maximum post-main-sequence age of the cluster is estimated as ~4 Myr. Detailed physical properties of the young stellar objects (YSOs) in the region are analysed using a combination of optical/NIR colour-colour and colour-magnitude diagrams. The distribution of YSOs in the (J-H)/(H-K) NIR colour-colour diagram shows that a majority of them have $A_v \leq$ 4 mag. However, a few YSOs show A_v values higher than 4 mag. On the basis of NIR excess characteristics 120 probable candidate YSOs have been identified in this region, which yield a disc frequency of ~20 per cent. These YSOs are found to have an age spread of ~5 Myr with a median age of ~2-3 Myr and a mass range of ~0.1-3.0 $M_\odot$. A significant number of YSOs are located close to the cluster centre. An enhanced density of reddened YSOs located/projected close to the molecular clumps detected by Deharveng, et al. (2008) at the periphery of NGC 1624 has been detected. This indicates that the YSOs located within the cluster core are relatively older in comparison to those located/ projected near the clumps. From the radio continuum flux, the spectral class of the ionizing source of the ultracompact H II (UCH II) region at the periphery of Sh2-212 is estimated to be ~B0.5V. From the optical data, the slope of the mass function (MF) Γ, in the mass range $1.2 \leq M/M_\odot < 27$, can be represented by a single power law with a slope -1.18 ± 0.10, whereas the NIR data in the mass range $0.65 \leq M/M_\odot < 27$ yield Γ=-1.31 ± 0.15. Thus the MF agrees fairly with the Salpeter value. The slope of the K-band luminosity function (KLF) for the cluster is found to be 0.30 ± 0.06, which is in agreement with the values obtained for other young clusters. [**J. Jose, A. K. Pandey,** K. Ogura, D. K. Ojha, B. C. Bhatt, **M. R. Samal, N. Chauhan,** D. K. Sahu and P. S. Rawat].

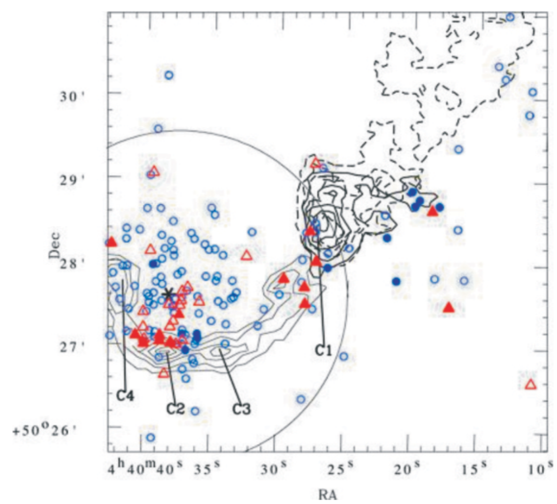


Figure 1. Spatial distribution of YSOs (blue circles) and the *J* drop out sources (red triangles). The sources with $H - K \geq 1.0$mag are shown using filled circles and triangles, respectively and the asterisk represents the centre of NGC 1624. The contours represent the ^{13}CO(2–1) emission map from Deharveng et al. (2008) in the velocity range between −34.0 and −32.7 km s^{-1} (continuous thin contours), −36.1 and −35.1 km s^{-1} (continuous thick contours) and −36.8 and −35.9 km s^{-1} (dashed contours) respectively. The partial circle

b. Star clusters

Multiwavelength polarimetric study towards the open cluster NGC 1893:

A multiwavelength linear polarimetric observations for 44 stars of the NGC 1893 young open cluster region along with V-band polarimetric observations of stars of four other open clusters located between ℓ ~160° and 175° reveal presence of two dust layers located at a distance of ~170 and ~360 pc. The dust layers produce a polarization P_v ~2.2 per cent. The study indicates that in the Galactic longitude range from ℓ ~160° to 175° and within the Galactic plane (|b| < 2°), the polarization angles remain almost constant, with a mean of ~163° and a dispersion of 6°.

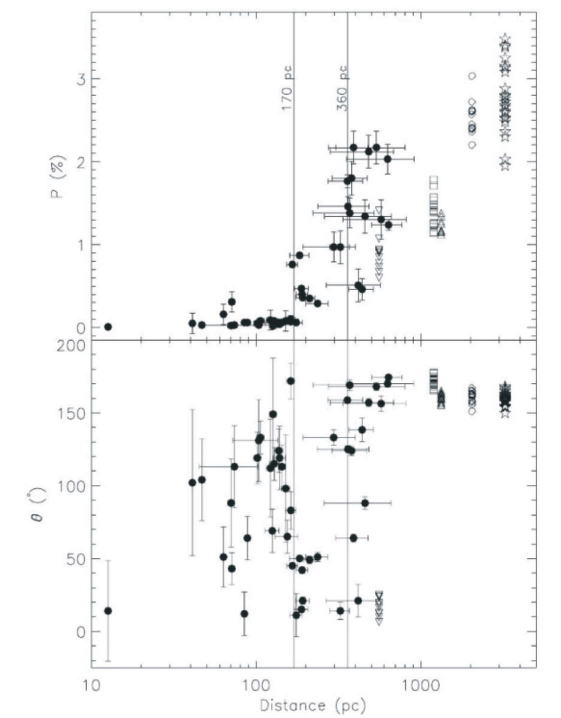


Figure 2. The change in P_V (per cent) and θ_v (∘) as a function of distance (pc) towards the direction of NGC 1893 is plotted in the upper and lower panels. The vertical solid lines are drawn at 170 and 360 pc.

The small dispersion in polarization angle could be due to the presence of a uniform dust layer beyond 1 kpc. The study reveals that in the case of NGC 1893, the foreground two dust layers, in addition to the intracluster medium, seem to be responsible for the polarization effects. It is also found that towards the direction of NGC 1893, the dust layer that exists between 2 and 3 kpc has a negligible contribution towards the total observed polarization. The weighted mean for percentage of polarization (P_{max}) and the wavelength at maximum polarization (λ_{max}) are found to be 2.59 ± 0.02 per cent and 0.55 ± 0.01 μm, respectively. The estimated mean value of λ_{max} indicates that the average size of the dust grains within the cluster is similar to that in the general interstellar medium. The spatial variation of the polarization is found to decrease towards the outer region of the cluster. [**C. Eswaraiah, A. K. Pandey, G. Maheswar, B. J. Medhi, J. C. Pandey,** D. K. Ojha and W. P. Chen].

c. X-ray Astronomy

X-ray emission from O-type stars: DH Cep and HD 97434:

The study of X-ray emission from massive O-type stars DH Cep and HD 97434 shows that there is no firm evidence for short-term variability in the X-ray intensity during the observations time span (<40 ks). The spectral analysis of these stars reveals X-ray structure being consistent with two-temperature plasma model. The hydrogen column densities derived from X-ray spectra of DH Cep and HD 97434 are in agreement with the reddening measurements for their corresponding host clusters NGC 7380 and Trumpler 18, indicating that the absorption by stellar wind is negligible. The X-ray

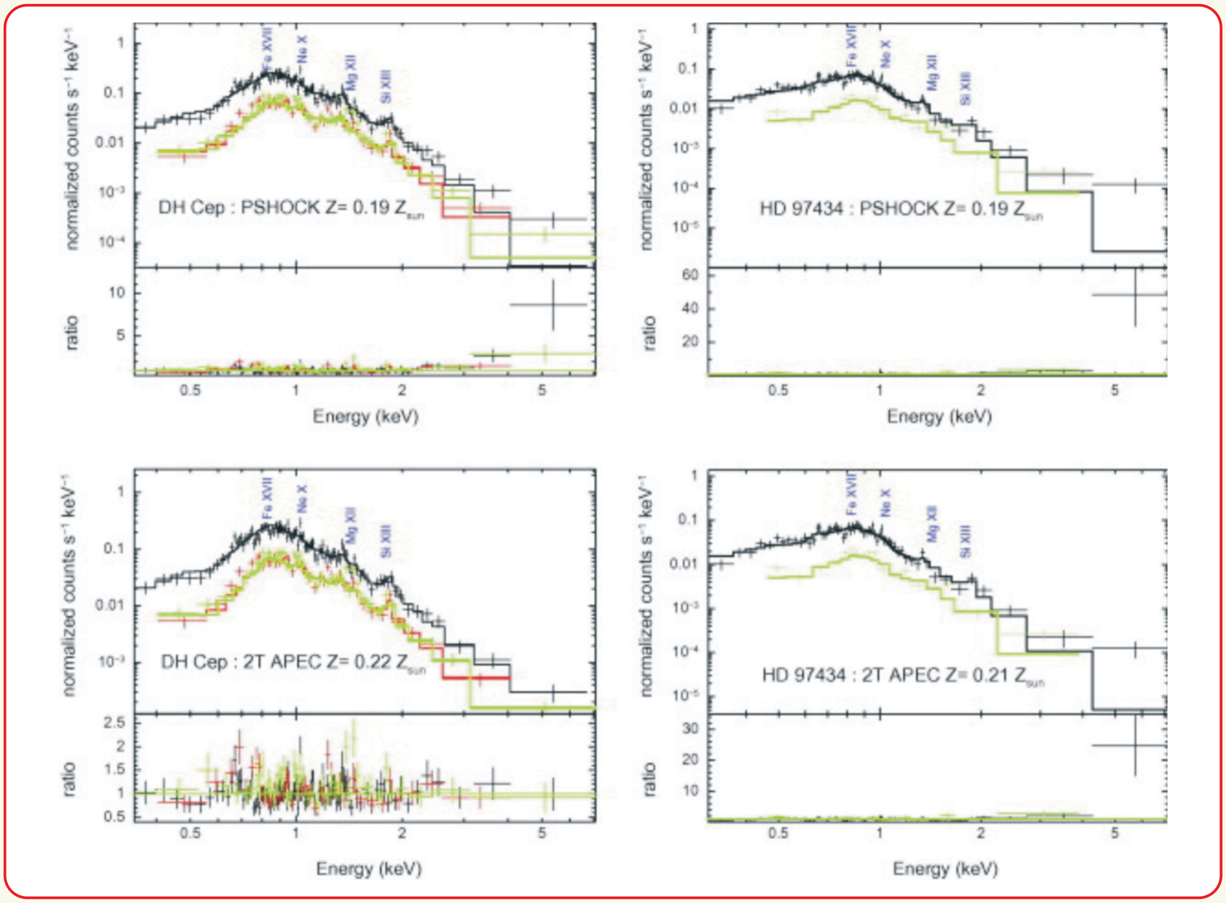


Figure 3. Best-fit X-ray spectra of massive stars. left panel: for DH Cep. right panel: for HD 97434. The solid line histograms represent the best fit PSHOCK (in upper panels) and 2*T* APEC model (in lower panels) with absorption model PHABS for PN, MOS1 and MOS2 data.

emitting plasma is found to be generated at a temperature of lesser than 1 keV. It could originate from small shocks in the radiation-driven outflows. A hotter component is indicated in DH Cep. The best-fit values of abundances are found to be 0.2 times of the solar abundances. [**H. Bhatt, J. C. Pandey, B. Kumar, R. sagar** and K. P. Singh].

II. EXTRA GALATIC ASTRONOMY

Short-term flux and colour variations in low-energy peaked blazars:

The mesurement of multiband optical flux and colour variations for a sample of 12 low-energy peaked blazars (LBLs) on short timescales (day-to-month) were carried out. The sample contains six BL Lacertae objects (BL Lacs) and six flat spectrum radio quasars (FSRQs). These photometric observations were made during 2008 September to 2009 June by using five optical telescopes: one in India and four in Bulgaria. Short-term flux and colour variations in eleven and eight of these blazars were detected, respectively. Data indicate that six blazars (3C 66A, AO 0235+164, S50716+714, PKS 0735+178, OJ 287 and 3C 454.3) were observed in pre- or post-outburst states, five (PKS 0420-014, 4C 29.45, 3C 279, PKS 1510-089 and BL Lac) were in a low state, while one (3C 273) was in an

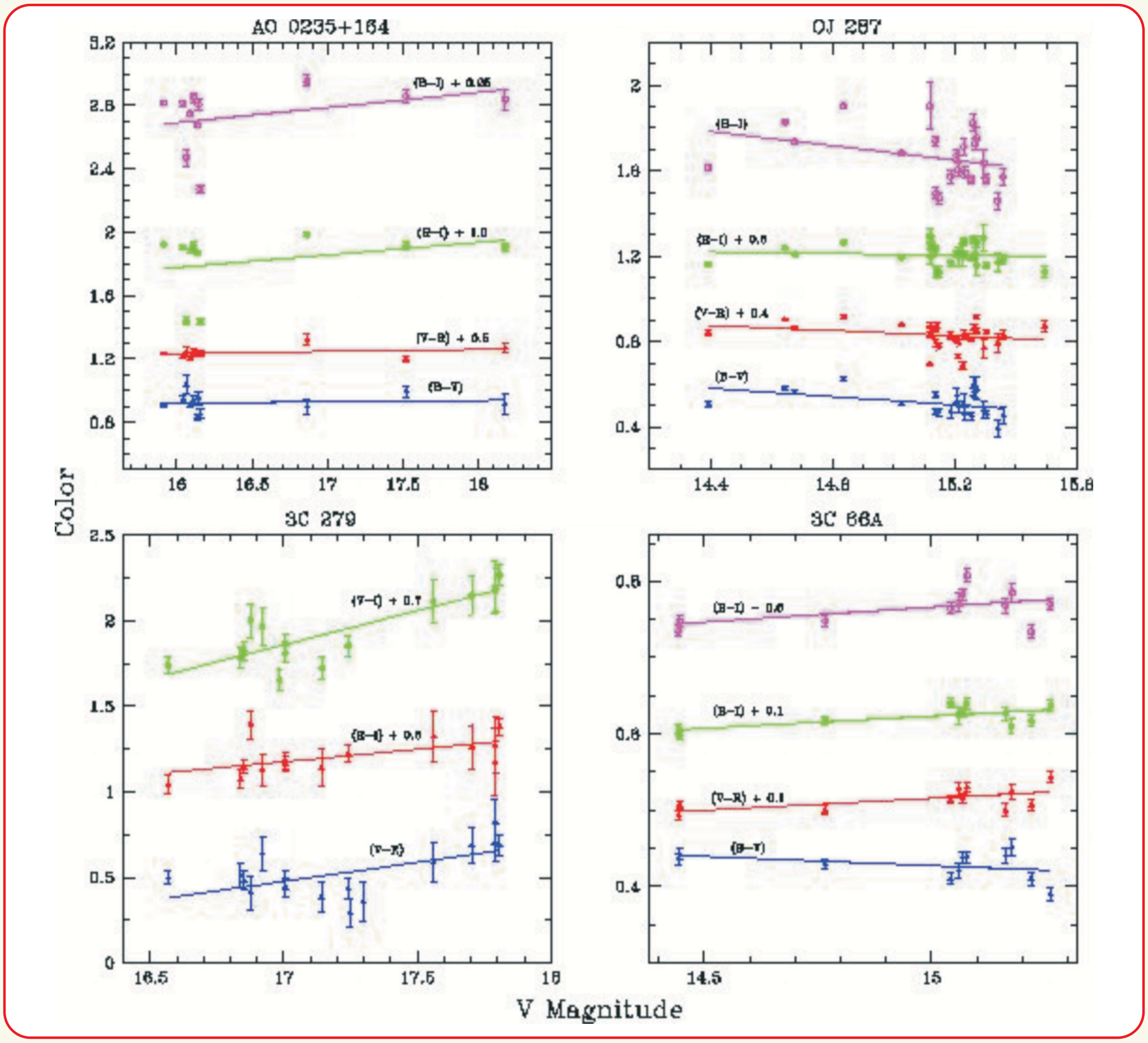


Figure 4. Colour–magnitude plots of the blazars AO 0235+164, OJ 287, 3C 279, & 3C 66A.

essentially steady state. The duty cycles for flux and colour variations on short time-scales in these LBLs are ~92% and ~33%, respectively. The colour versus magnitude correlations seen here support the hypothesis that BL Lac objects tend to become bluer with increase in brightness; however, FSRQs may show the opposite trend, and there are exceptions to these trends in both categories of blazar. Emission models for active galactic nuclei that might explain these results are also discussed. [**B. Rani, A. C. Gupta,** et al.].

Detection of Intra-day Variability Timescales of Four High-energy Peaked Blazars with XMM-Newton:

A sample of 24 XMM-Newton light curves (LCs) of four high energy peaked blazars, PKS 0548-322, ON 231, 1ES 1426+428, and PKS 2155–304 were selected. These data comprise continuous LCs of 7.67-18.97 hr in length. A search for any possible quasi-periodic oscillations (QPOs) and intra-day variability (IDV) timescales in the LCs of these blazars were also carried out. A likely QPO in one LC of PKS 2155-304 was found. In the remaining 23 LCs, hints of possible weak QPOs in one LC of each ON 231 and PKS 2155–304 were found, but neither is statistically significant. It was also found that there is a IDV timescales that ranged from 15.7 to 46.8 ks in eight LCs. In 13 LCs any variability timescales were longer than the length of the data. Assuming that the possible weak QPO periods in the blazars PKS 2155-304 and ON 231 are real and are associated with the innermost portions of their accretion disk, it has been estimated that their central black hole masses exceed about 10^7 $M_{\odot}$. [**H. Gaur, A. C. Gupta,** P. Lachowicz and P. J. Wiita].

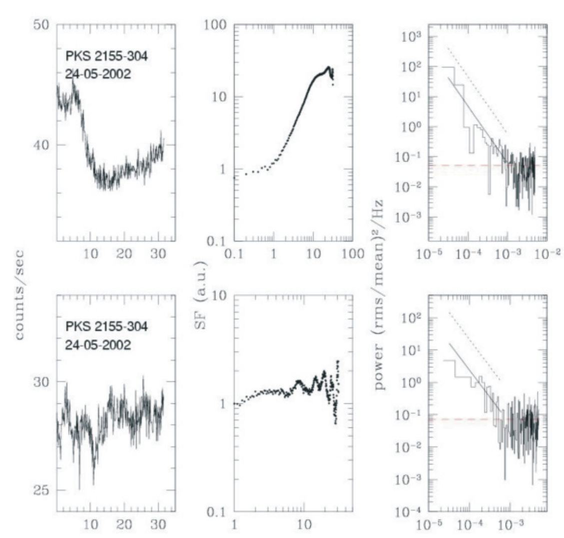


Figure 5. LCs (left panels), structure functions (middle panels), and power spectral densities (right panels) of PKS 2155-304. The dates of each observation are given in the LC panels.

Duration distributions for different softness groups of gamma-ray bursts:

Gamma-ray bursts (GRBs) are divided into two classes according to their durations. Softness of bursts plays a role in the conventional classification of the objects. The BATSE (Burst and Transient Source Experiment) catalog was used to analyze the duration distributions of different groups of GRBs associated with distinct softness. Analysis reveals that the conventional classification of GRBs with the duration of bursts is influenced by the softness of the objects. There exists a bimodality in the duration distribution of GRBs for each group of bursts and the time position of the dip in the bimodality histogram shifts with the softness parameter. The findings suggest that the conventional classification scheme should be modified by separating the two well-known populations in different softness groups, which would be more reasonable than doing so with a single sample. According to the relation between the dip position and the softness parameter, an empirical function that can roughly set apart the short-hard and long-soft bursts is also obtained. [Y. Qin, **A. C. Gupta,** J. Fan, C. Su and R. Lu].

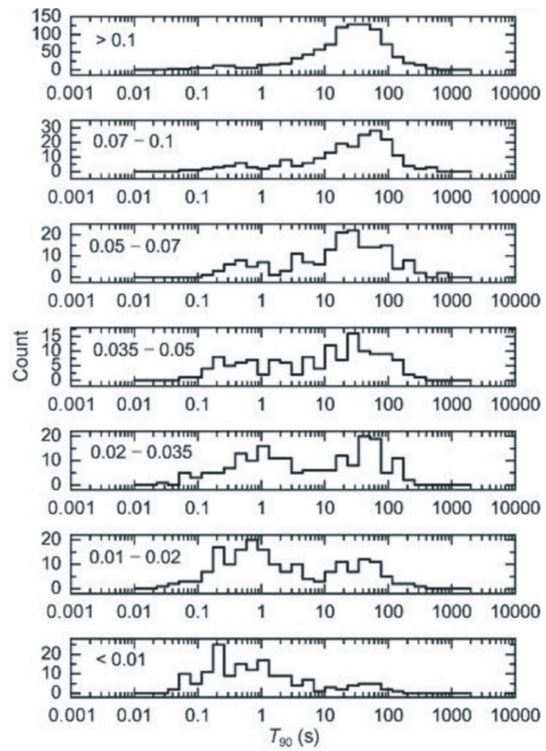


Figure 6. The duration distributions of seven groups of the BATSE bursts divided according to the softness parameters. The range of the adopted softness parameter is mentioned at the upper left corner of each panel.

Quasi-periodic Oscillations of ~15 Minutes in the Optical Light Curve of the BL Lac S5 0716+714:

Over the course of 3 hr on December 27, 2008 optical (R band) observations of the blazar S5 0716+714 at a very fast cadence of 10 s were carried out. Using several different techniques, quasi-period fluctuations with an approximately 15 minute were found to be present in the first portion of these data at a >3 sigma confidence level. This is the fastest quasi-periodic oscillation that has been claimed to be observed in any blazar even in any AGN at any wavelength. While these data are insufficient to strongly constrain models for such fluctuations, the presence of such a short timescale when the source is not in a very low state seems to favor the action of turbulence behind a shock in the blazar's relativistic jet. [**B. Rani, A. C. Gupta,** U. C. Joshi, S. Ganesh and P. J. Wiita**].**

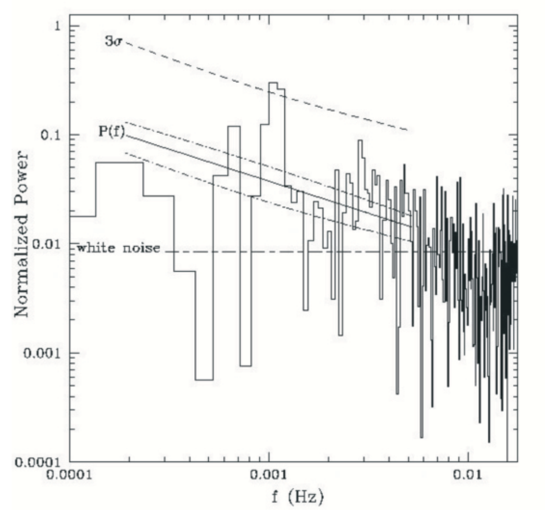


Figure 7. PSD of S5 0716+714. $P(f)$ is the best-fitting SPL with index −0.58±0.06 (the dot-dashed lines are the calculated uncertainty in the model); a 3σ confidence limit and the white-noise level are shown.

Optical microvariability properties of BALQSOs:

Optical light curves of 19 radio-quiet (RQ) broad absorption line (BAL) quasi-stellar objects (QSOs) were obtained to study their rapid variability characteristics. Systematic CCD observations, aided by a careful data analysis procedure, have allowed to clearly detect any such microvariability exceeding 0.01–0.02 mag. Observations cover a total of

13 nights (~72 h) with each quasar monitored for about 4 h on a given night. This sample size is a factor of 3 larger than the number of RQ BALQSOs previously searched for microvariability. A new scaled F-test statistic is also introduced for evaluating the presence of optical microvariability, with demonstration that why it is generally preferable to the statistics usually employed for this purpose. Considering only unambiguous detections of microvariability it was found that ~11% of RQ BALQSOs (two out of 19 sources) show microvariability for an individual observation length of about 4h. This new duty cycle of ~11% is similar to the usual low microvariability fraction of normal radio-quiet QSOs (RQQSOs) with observation lengths similar to those of ours. This result provides support for models where RQ BALQSO do not appear to be a special case of the RQQSOs in terms of their microvariability properties. [**R. Joshi, H. Chand, A. C. Gupta** and P. J. Wiita].

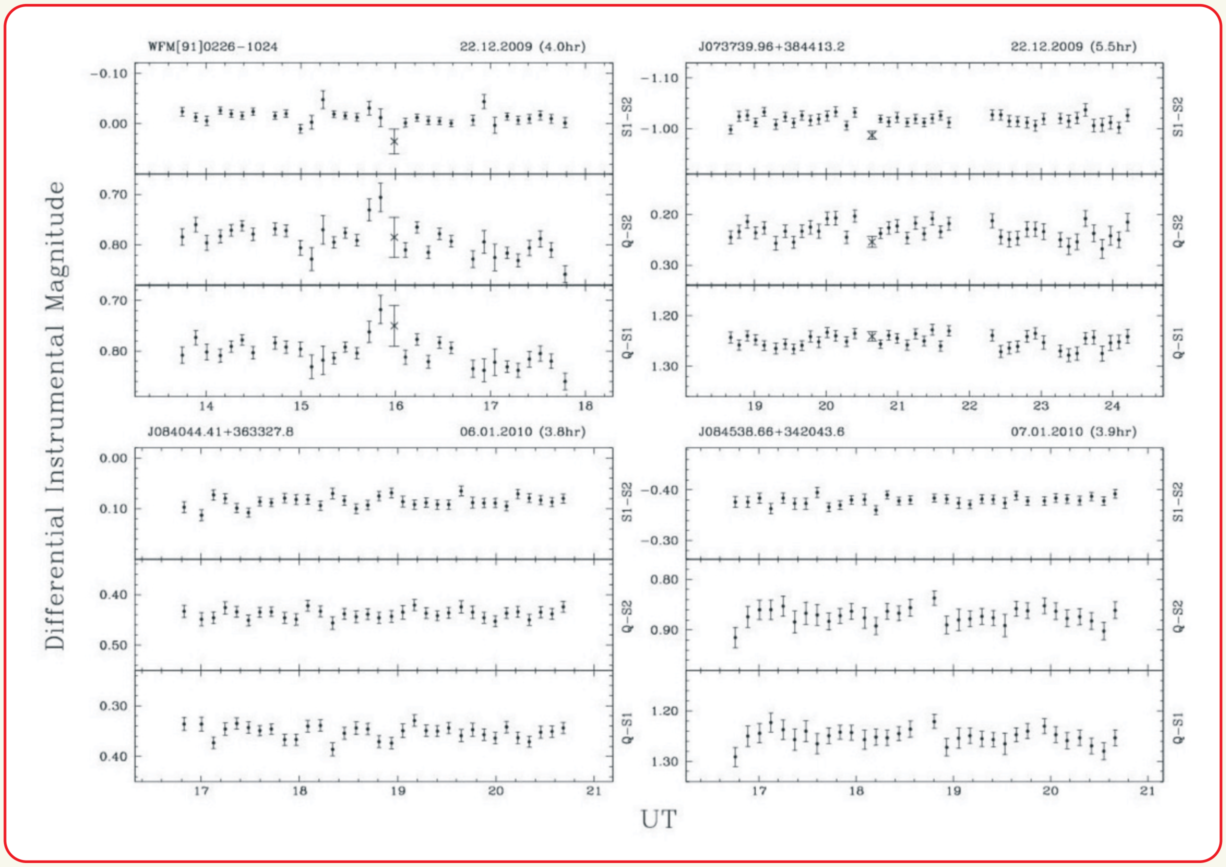


Figure 8. Differential light curves (DLCs) for the first four BALQSOs in our sample. The name of the quasar and the date and duration of the observation are given at the top of each night's data. The upper panel gives the comparison star–star DLC and the subsequent lower panels give the quasar–star DLCs, as defined in the labels on the right-hand side. Any likely outliers (at >3σ) in the star–star DLCs are marked with crosses, and those data are not used in our final analysis.

A multifrequency study of the large radio galaxies 3C46 and 3C452:

Low-frequency observations starting from ~150MHz with the Giant Metrewave Radio Telescope, and high-frequency observations with the Very Large Array of two large radio galaxies 3C46 and 3C452 have been carried out. These observations were made with the objectives of estimating their spectral ages and examining any evidence of diffuse extended emission at low radio frequencies due to an earlier cycle of activity. While no evidence of extended emission due to an earlier cycle of activity has been found, the spectral ages have been estimated to be ~15 and 27 Myr for the oldest relativistic plasma seen in the regions close to the cores for 3C46 and 3C452, respectively. The spectra in the vicinity of the hot spots are consistent with a straight spectrum with injection spectral indices of ~1.0 and 0.78, respectively, somewhat steeper than theoretical expectations. [**S. Nandi, A. Pirya**, S. Pal, C. Konar, D. J. Saikia and **M. Singh**].

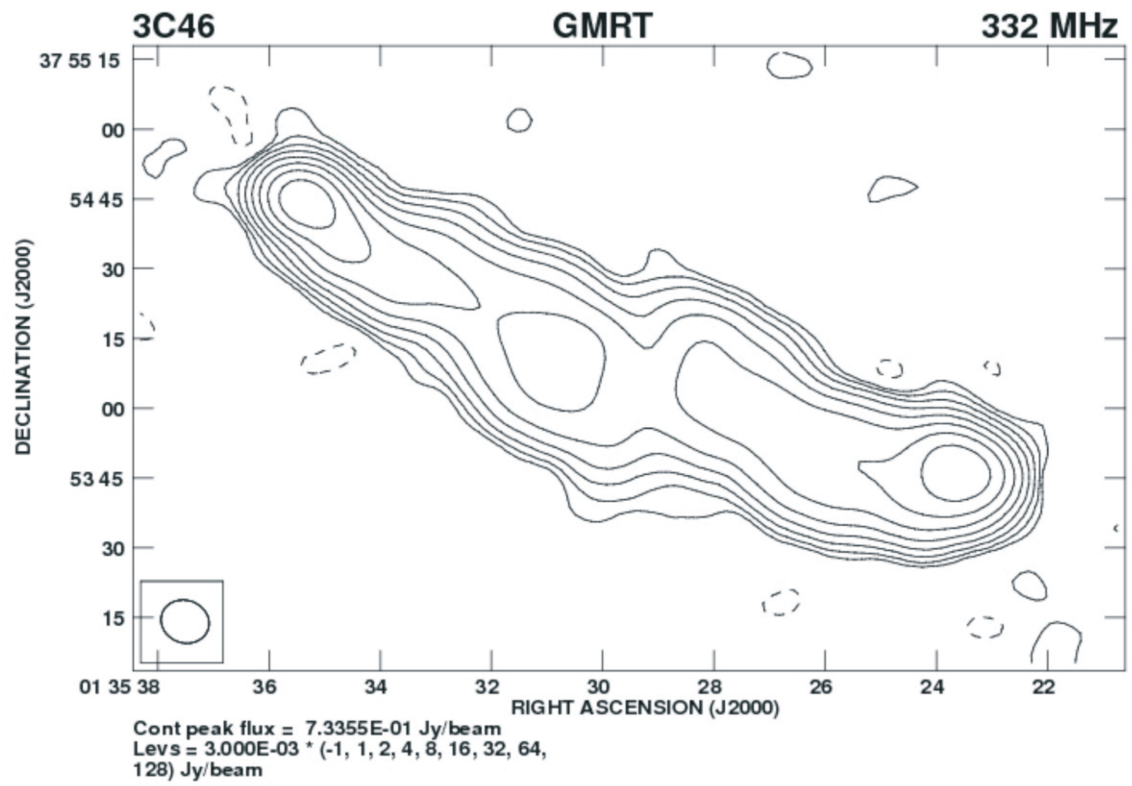


Figure 9. GMRT low-frequency image of 3C46 at 332 MHz

Multiwavelength Study of Loop-Loop Interaction as a Driver of M-class Flare:

The multi-wavelength data for a M7.9/1N class solar flare which occurred on 27 April, 2006 have been analyzed. GOES soft X-ray images provide the most likely signature of two interacting loops and their reconnection that triggered the solar flare. On the other hand, TRACE 195 Å images also reveal the loop-loop interaction and formation of 'X' points with converging motion (~30 km/s) at the reconnection site in-between interacting loop systems. This provides an evidence of progressive reconnection and flare maximization at the interaction site in the active region. The absence of type III radio burst during this time period indicates no opening of magnetic field lines during the flare energy release, which implies only the change of field lines connectivity/orientation during loop-loop interaction and reconnection process. The Ondrejov dynamic radio spectrum exhibits an intense decimetric (DCIM) radio burst (2.5--4.5 GHz, duration ~3 min) during flare initiation that reveals the signature of particle acceleration from the reconnection site during loop-loop interaction. The double peak structures at 4.9 and 8.8 GHz radio fluxes provide the most likely confirmatory signature of the loop-loop interaction at the flare site in the active region. RHESSI hard X-ray images also confirm the loop-top and foot point sources of the corresponding two loop system and their coalescence during the flare maximum, which act like the current carrying flux-tubes with resultant opposite magnetic fields and the net force of attraction. It is suggested that the shear motion/rotation of the foot point of the smaller loop, which is anchored in the opposite polarity spot, may be responsible for the flare energy buildup and then its release due to the loop-loop interaction. [**P. Kumar, A. K. Srivastava,** B. V. Somov, P. K. Manoharan, R. Erdelyi and **W. Uddin**].

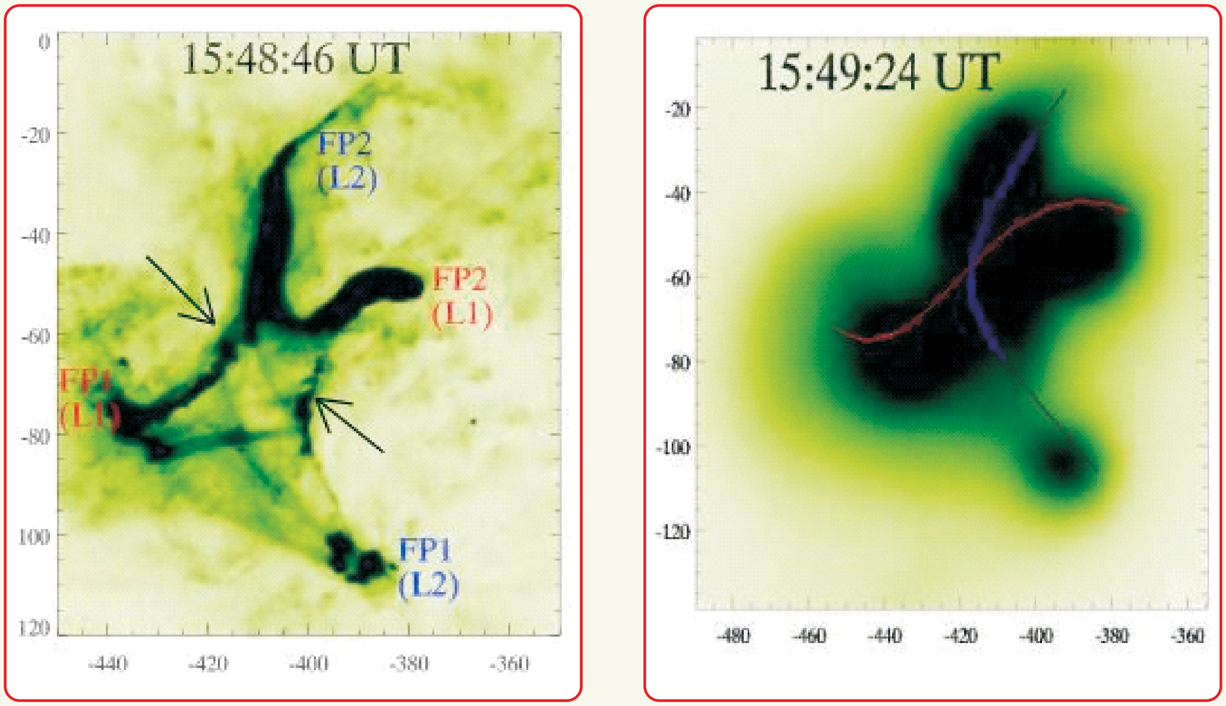
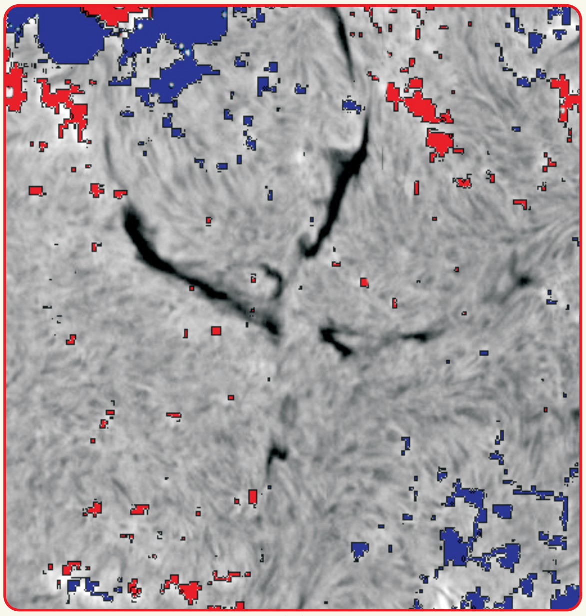


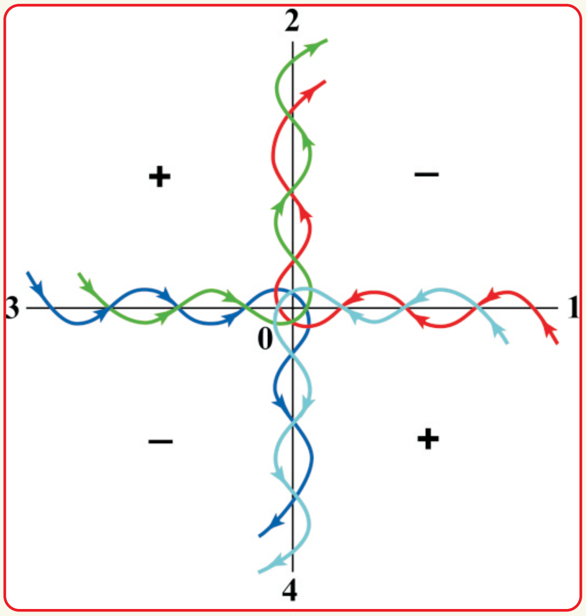
Figure 10. The left panel shows the high resolution TRACE image of the interacting loop systems. While the right panel shows the interaction of these loops soft X-ray GOES/SXI images.

The Crossing Filaments:

Solar filaments show the position of large-scale polarity-inversion lines and are used for the reconstruction of large-scale solar magnetic field structure on the basis of Hα synoptic charts for the periods when magnetographic measurements are not available. Sometimes crossing filaments are seen in Hα filtergrams. The daily Hα filtergrams from the archive of Big Bear Solar Observatory have been analyzed for the period of 1999 – 2003. The analysis shows the variety of crossing and interacting filaments. A number of examples of these filament patterns are compared with their photospheric magnetic field distributions. This reveals that all crossing filaments exhibit a quadrupolar magnetic configuration of the photospheric field, and presume the presence of null points in the corona that may be an important location of the energy release and MHD activities. [B. Filippov and **A. K. Srivastava**].



(a)



(b)

Figure 11. (a) Fragment of BBSO Hα filtergram on 17 October 2001 with overlaid ± 50 G magnetic field contours from SOHO/MDI magnetogram. Red areas represent negative polarity, while blue areas represent positive polarity. (Courtesy of Big Bear Solar Observatory and SOHO/MDI consortium.) (b) Four field lines representing four separate flux ropes within a quadrupole magnetic field configuration.

Deflection of Coronal Rays by Coronal Mass Ejections (CMEs):

Five events of the interaction of coronal mass ejections (CMEs) with the remote coronal rays located up to 90° away from the CME have been analyzed. These observations have been carried out by SOHO/LASCO C2 coronagraph. Using sequences of SOHO/LASCO C2 images, the estimated speed of the kink propagation in the coronal rays during their interaction with the corresponding CMEs has been found in the range from 180 to 920 km/s within the interval of radial distances 3 $R_{\odot}$-6 $R_{\odot}$. The all studied events do not correspond to the expected pattern of shock wave propagation in the corona as reported previously. The coronal ray deflection is interpreted as the influence of the magnetic field of a moving

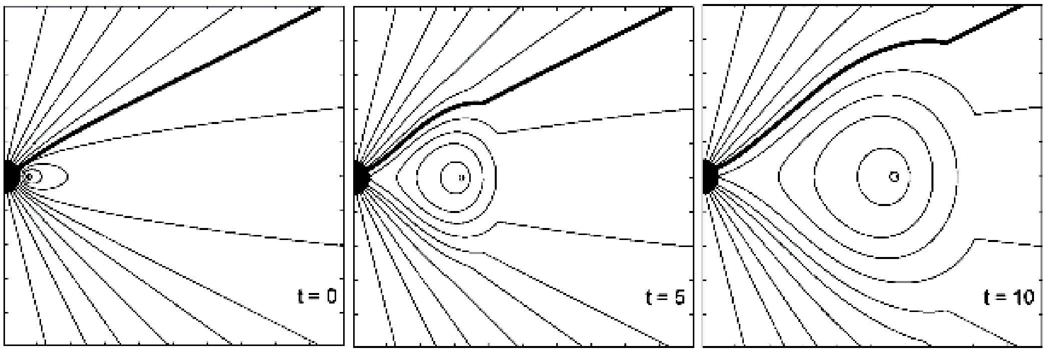


Figure 12. An example of the model output showing the interaction of the coronal rays with the expanding CME flux-rope and evolution of kinking in the coronal ray.

flux rope within the CME. The motion of a large-scale flux rope away from the Sun creates changes in the structure of surrounding field lines, which are similar to the kink propagation along coronal rays. [B. Filippov and **A. K. Srivastava**].

Homologous Flares and Magnetic Field Topology in Active Region NOAA 10501 on 20 November 2003:

The observations of two morphologically homologous flares that occurred in AR NOAA 10501 on 20 November 2003 have been carried out. Both flares displayed four homologous Hα ribbons and were both accompanied by coronal mass ejections (CMEs). The central flare ribbons were located at the site of an emerging bipole in the centre of the active region. The negative polarity of this bipole fragmented in two main pieces, one rotating around the positive polarity by ≈110° within 32 hours. Although several polarities were present in AR 10501, however, the global magnetic field topology corresponds to a quadrupolar magnetic field distribution without magnetic null points. For both the flares, the photospheric traces of quasi-seperatix layers (QSLs) were similar and matched well with the locations of the four Hα ribbons. This globally unchanged topology and the continuous shearing by the rotating bipole were two key factors responsible for the flare homology. However, the analyses also indicate that the different magnetic connectivity domains of the quadrupolar configuration became unstable during each flare, therefore, the magnetic reconnection proceeds differently in both events. [R. Chandra, et al. including **W. Uddin**].

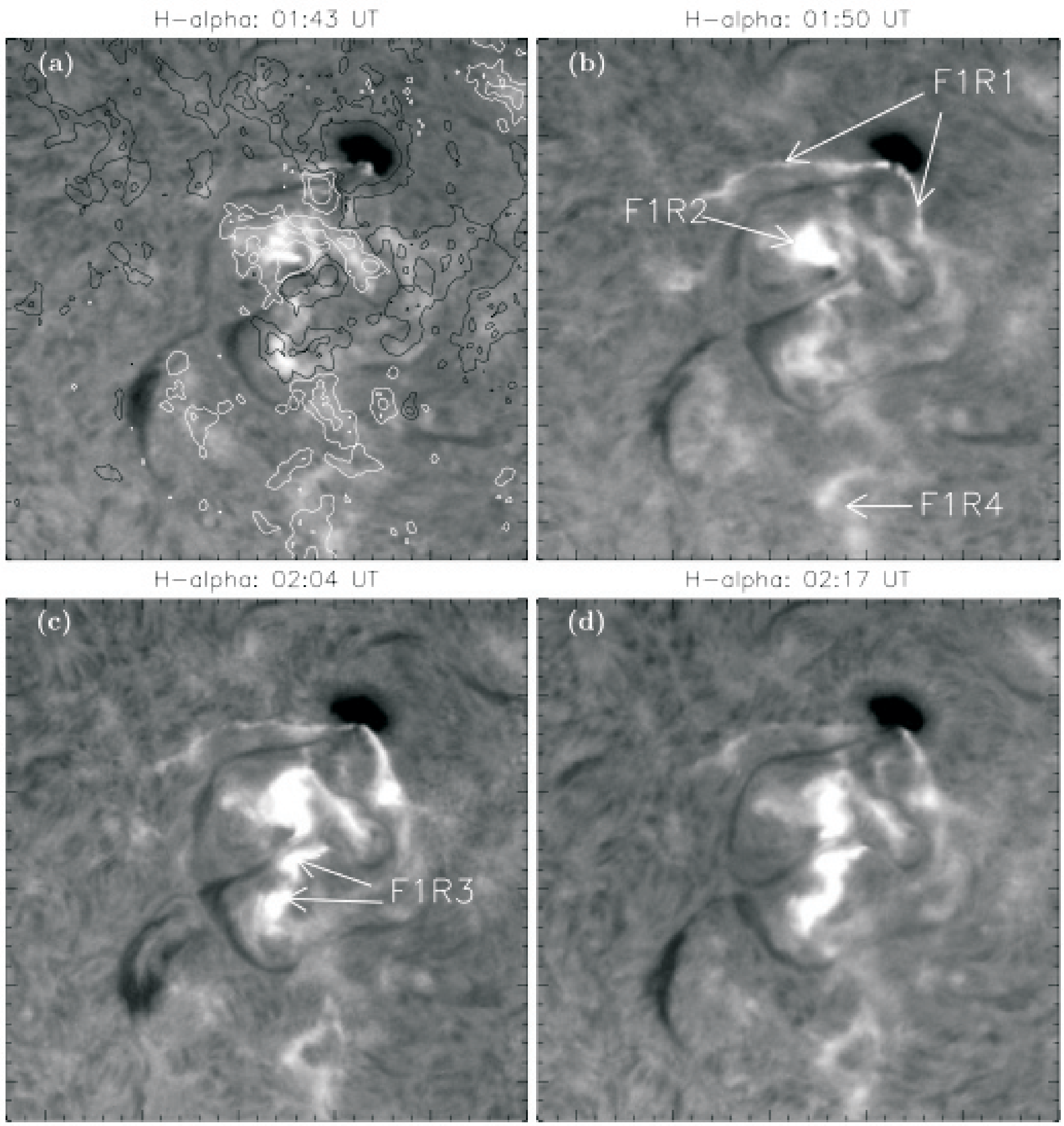


Figure 13. Hα evolution of the M1.4 flares in AR 10501 on 20th November 2003. The four flare ribbons are marked as F1R1, F1R2, F1R3, and F1R4, respectively. The top left panel shows overplotted contours of the photospheric line-of-sight (LOS) magnetic field at 01:39 UT. White (black) contours correspond to positive (negative) fields. Contour levels ± 100 and ± 500 G are used. The filaments are also interacting and changing the connectivity during the flare process. The H-alpha observations used in this study of homologous flares have been carried out by Solar Tower Telescope of the ARIES.

Statistical Analysis of Soft X-ray Solar Flares during Solar Cycles 21, 22 and 23:

The statistical analysis of Soft X-ray (SXR) flares during the period January 1976 to December 2007 covering solar cycles (SCs) 21, 22 and 23 have been carried out. The analyses of north–south (N–S) and east–west (E–W) asymmetry of SXR flares at total (1–90°), low (1–40°) and high (50–90°) latitudes and center meridian distances (CMDs) have been performed. The N–S and E–W asymmetry of different intensity classes (B, C, M and X) during the period of investigation have also been performed. A slight southern and eastern excess is found after analysis during solar cycles (SCs) 21, 22 and 23. N–S distribution shows that the SXR flare events are most prolific in the 11–20° latitude band in the northern and southern hemispheres whereas E–W distribution does not show any prolific band. The finding reveals that the N–S and E–W asymmetry which often peaks near the activity minimum is in agreement with the theoretical dynamo models. These results show that N–S asymmetry is statistically more significant than E–W asymmetry. It is revealed that the SXR flare activity (M and C class flares) during SC 23 is low as compared to the SC 22, indicating the violation of Gnevyshev-Ohl rule. The B class flare activity is higher for SC 23 whereas C, M and X class activities are higher for SC 21. The analyses of the flare evolution parameters, i.e. duration, rise time, decay time and event asymmetry for total SXR as well as for different classes during last three SCs have been done by statistical analyses. The duration, rise time and decay time increase with increasing intensity class. The increase is more pronounced for the duration and decay time than for the rise time for SCs 21 and 22 while for SC 23 it is the same for duration, rise time and decay time. On analyzing event asymmetry indices, it is found that more positive values during SC 21 (64.86 %) and SC 22 (54.31%), Whereas SC 23 has more negative values (48.08%). This study shows that during SC 23 more SXR flare events occurred with shorter decay time than the rise time as compared to SCs 21 and 22. [N. C. Joshi et al. including **W. Uddin**].

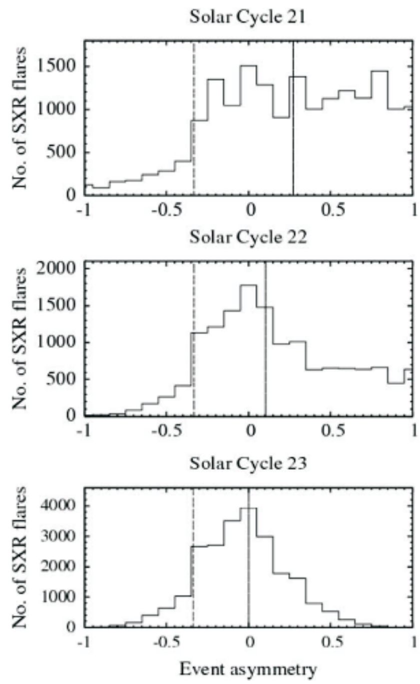


Figure 14. Histogram of the event (SXR flares) asymmetry as derived by statistical analyses for the solar cycle 21, 22, and 23. The solid line indicates the median of the distribution, while the dashed line the 10th percentile.

Impact of Boundary layer dynamics on black carbon variation over central Himalayas and its foothills:

In order to characterize the optical, physical and chemical properties of aerosols and trace gases measurements are carried out on routine basis at Manora Peak (29°.4 N; 79°.5 E; altitude:1950 m), Nainital in the central Himalayas. Being a high altitude observing site, these measurements have the importance of providing a sort of background level of aerosol parameters against which the impact of aerosol loading can be assessed to other low altitude regions. Further, to investigate the influence of evolving boundary layer on some aerosol-parameters, measurements of black carbon (BC), aerosol optical depth (AOD) and surface ozone were started in the campus of

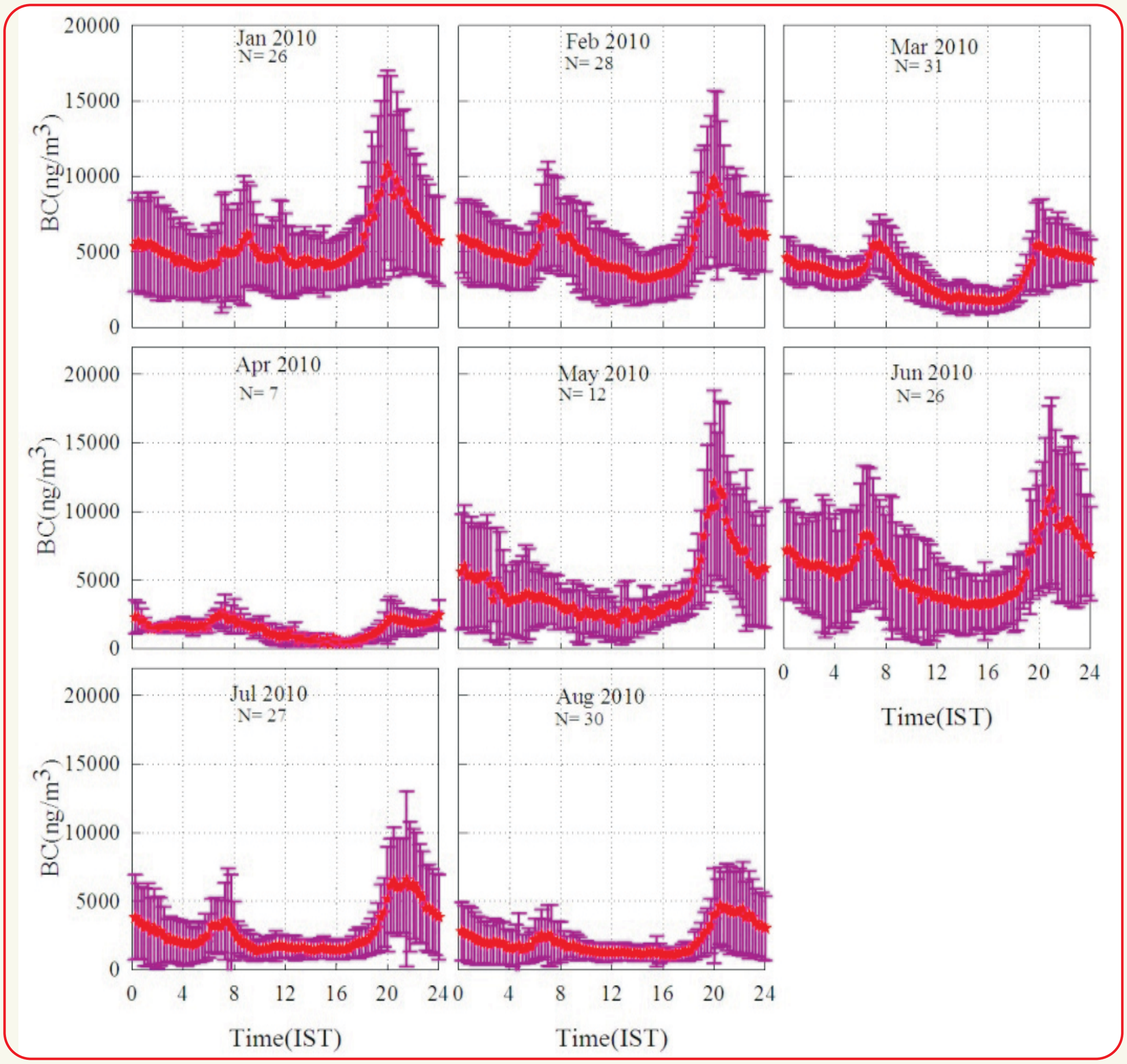


Figure 15. Monthly mean of diurnal variation of BC at Pantnagar from January to August for 2010, where N denotes the number of days for which observation was available.

G. B. Pant University of Agriculture & Technology, Pantnagar (29°.0 N; 79°.5 E; altitude: ~ 250 m), a semi urban location in the Terai belt of the Kumaon foothills in central Himalayas. In this perspective measurements are carried out in a coordinated manner from both places under ARFI, ABLN&C and AT-CTM projects, as a part of ISRO-GBP, in addition to other routine observations. The observations are mainly comprised of spectral AOD, BC mass concentration, number concentration (0.3 to 20 μm), mass loading (TSP) of composite aerosols, measurements of trace gases and meteorological parameters.

The first time measurements of AOD at Pantnagar show about 4 and 2.5 times increase during winter and spring seasons, respectively, in comparison to Nainital. Meanwhile the diurnal variation of BC aerosol at Pantnagar shows night time high with conspicuously enhanced values during morning and evening hours and low during noon period which eventually attains minimum in late afternoon hours. It is quite evident from the variations at both locations that the diurnal BC variation at Pantnagar is entirely opposite to what we observed at Naintal. The morning and evening hours peak at Pantnagar site are the manifestations of the corresponding hours rush owing to the high level of vehicular traffic and other fumigation practices. The discrepancy in the diurnal variation of near-surface measurements of the BC mass observed at a high (Nainital) and low (Pantnagar) altitude could be due to the geographical location of the observing sites. To the North-East of the Manora Peak, the hilly terrain of the Central Himalayas is prominently located where anthropogenic activities are absent or negligible. On the other hand the South-West is predominantly covered by the plain areas (<300m amsl), including Pantnagar which is merely at an aerial distance of about 20 km and having an abundance of anthropogenic sources. Strong convective eddies are generated with rising day temperature, consequently the BC aerosols as well as the trapped particles are lifted high in to the atmosphere, which facilitates the transport of pollutants from source regions (valley) to higher altitudes by convective mixing. [**H. Joshi, P. Pant, M. Naja,** M. Choudhary and K. P. Singh]**.**

Radiative effects of elevated aerosol layer in Central Himalayas:

Observations of vertical profiles of aerosols using micro pulsed lidar (MPL) system at ARIES during January – May 2008, show an elevated aerosol layer quite frequently in the altitude range of 2460–4460 meter having a width of ~ 2000 meter. These profiles are compared with the vertical profiles observed over Gadanki (13.5°N, 79.2°E; altitude: ~ 370) a tropical station, where no such elevated aerosol layer was found. Further, there is a steady increase in AOD from January (winter) to May (summer) from 0.043– 0.742 respectively at Nainital, indicating aerosol loading in the atmosphere.

Our observations show North-Westerly winds indicating the convective lifting of aerosols at far-off regions followed

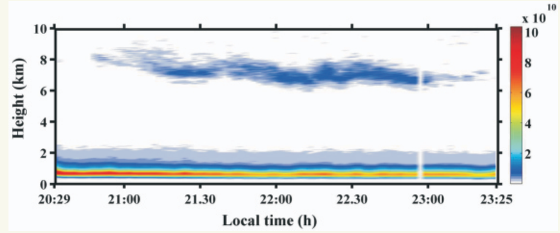
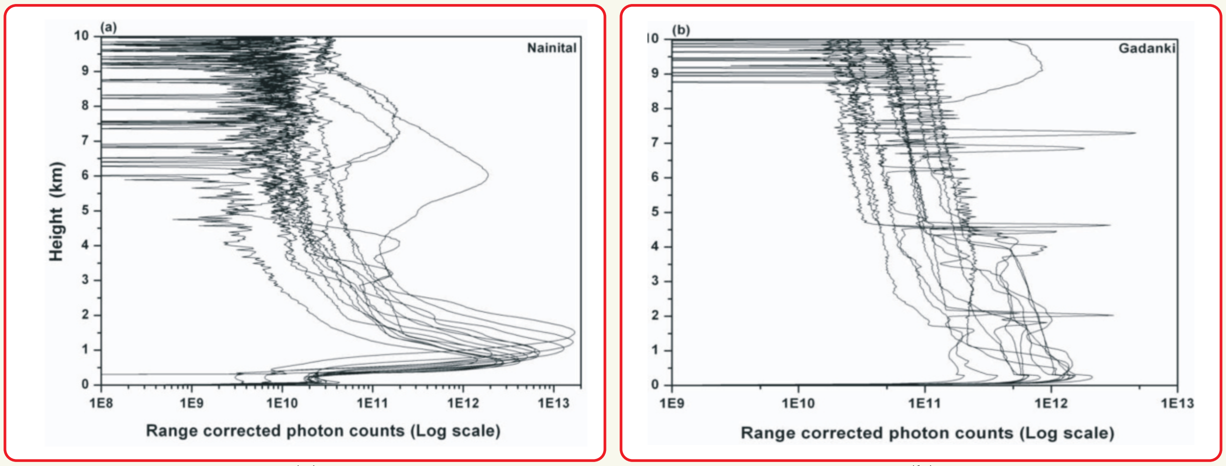


Figure 16. A typical example showing the temporal variation of range corrected signal (RCS) during 20:29 – 23:25 local time on 5th May 2008 over Manora Peak, Nainital.



(a) (b)

Figure 17. (a) Vertical profile of range corrected photon counts from the LIDAR system at Manora Peak (1960 m a.s.l) during Jan to May 2008 and (b) Vertical profile of range corrected photon counts from the LIDAR system at Gadanki (370 m a.s.l) during Jan to May 2008.

by the horizontal long-range transport. The presence of strongly absorbing and scattering aerosols in the elevated layer resulted to a relatively large daily mean aerosol surface radiative forcing efficiency of about -65 W m^{-2} and -63 W m^{-2} and corresponding mean reduction in the observed net solar flux at the surface (cooling effect) is as high as -22 Wm^{-2} and -30 Wm^{-2} for April and May 2008, respectively. The reduction of radiation will heat the lower atmosphere by redistributing the radiation with heating rate of 1.13 K day^{-1} and 1.3 K day^{-1} respectively. [K. Reddy, **P. Pant, D. V. Phanikumar, U. C. Dumka**, Y. B. Kumar, **N. Singh** and **H. Joshi**].

Influence of south Asian dust storm on aerosol radiative forcing at high-altitude station in central Himalayas:

The impact of long range transported dust aerosols, originating from the Thar Desert region, to a high-altitude location in the central Himalayas was studied using MPL observations. A drastic change in lidar backscatter profile was observed on dust day as compared to that on pre-dust day. The backscatter coefficient on dust day revealed the dust layer peaked at an altitude ~1300-meter above ground level (AGL) extending up to ~3000-meter AGL, with maximum value ~3×10^{-5} m^{-1} sr^{-1}. Aerosol index and airmass back-trajectory analysis substantiate the transport of dust aerosols from far-off Thar Desert region to the experimental site. Impact of dust aerosols on the measured spectral aerosol optical depths (AODs) using Microtops-II Sunphotometer, showed entirely different spectral behavior of aerosol optical depth on dust day as compared to that on pre-dust day. The Ångström exponent (α) showed a marked decrease from 0.42 to 0.04 during pre-dust to dust days respectively. The aerosol radiative forcing estimated using the Santa Barbara DISORT Atmospheric Radiative Transfer (SBDART) model in conjunction with Optical Properties of Aerosol and Cloud (OPAC) model, showed a value of about -30, -45, and +15 W m^{-2} at top-of-atmosphere (TOA), surface and in the atmosphere respectively, on dust day. The atmosphere forcing caused an estimated heating rate of the lower atmosphere by ~0.4 K day^{-1}. [**A. K. Srivastava, P. Pant,** P. Hegde, S. N. Singh, **U. C. Dumka, M. Naja, N. Singh** and Y. B. Kumar].

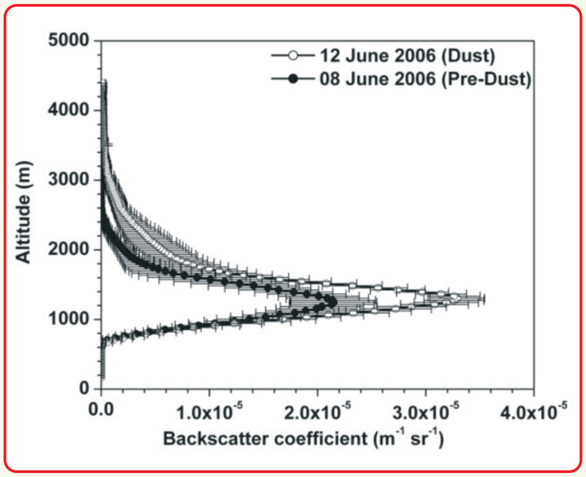


Figure 18. Average vertical profiles (AGL) of backscatter coefficient on dust day (12 June 2006) and pre-dust day (08 June 2006).

Estimation of D-region electron density using tweeks measurements at Nainital and Allahabad:

Lightning discharges from thunderstorms are nature's most significant source of electromagnetic radiation, the energy in these pulses vary over a wide frequency range from a few Hz to several megahertz, however, maximum energy radiation is contained in the ELF/VLF band. Continuous monitoring of these ELF/VLF waves provides a powerful remote sensing tool for understanding the processes in ionosphere and magnetosphere as well as to space weather. Since both the Earth and the ionosphere are good reflectors at these frequencies, the lightning radiated impulses travel thousands of kilometers in the so-called earth-ionosphere waveguide (EIWG) with little attenuation (~2–3 dB/1000 km). When this radiated energy is received at VLF/ELF bands, the received signals do not exhibit any dispersion, except near the cut-off frequency of the waveguide and are known as sferics/tweeks. In this perspective VLF receivers were set up at three sites (located at Geomagnetic Research Laboratory, Allahabad; ARIES, Nainital and BHU, Varanasi in 2007) by Indian Institute of Geomagnetism, Mumbai in collaboration with Stanford University, USA under IHY-2007 campaign. In order to estimate *D*-region electron densities at the ionospheric reflection heights, the dispersive property of tweeks observed at low latitude Indian stations Nainital (Geomag. Lat. 20.29^o N) and Allahabad (Geomag. Lat. 16.05^o N) was utilized. Direction finding technique has also been applied to determine the source locations of causative lightning discharge of tweeks. The evaluated geographic locations of causative lightening discharge are in good agreement with World Wide Lightning Location Network (WWLLN) data. The average *D*-region electron density along the propagation path varied in the range ~20-35 el/cc at ionospheric reflection heights of 70-90km. [**P. Pant**, A. K. Maurya, R. Singh, B. Veenadhari and A. K. Singh].

Influence of solar eclipse of 15 January 2010 on surface ozone:

Variations observed in the mixing ratios of surface ozone, its prominent precursor NOx* and the meteorological parameters (solar radiation, temperature, relative humidity and wind speed) during the annular solar eclipse on 15 January 2010 at Kannur (11^o.9N, 75^o.4E; altitude: 5 m) are studied. The solar eclipse started at 11:05 IST, reached to the maximum obscuration at 13:20 IST and ended at 15:05 IST. The observations show influences of the solar eclipse phenomenon on the surface ozone and NOx* mixing ratios. A sharp decline in the surface ozone was observed during the eclipse, due to the decreased efficiency of the photochemical ozone formation. The NO_2 levels were found to increase during the eclipse period while the NO levels remained unchanged. The eclipse induced reduction in surface ozone and enhancement in NOx* are estimated to be 57.5% and 62.5% respectively. Reductions in the air temperature, relative humidity and wind speed were also observed during the event of solar eclipse. Simulation from a chemical box model indicates about 94% reduction in the NO_2 photolysis rates during the eclipse period, which is leading to about 59% reduction in the surface ozone. Observations as well as model simulations indicate that the reduced photochemical ozone production from NO_2 photolysis is possibly the main driver of ozone reduction during the eclipse at this site. [T. Nishanth, **N. Ojha,** M. K. S. Kumar and **M. Naja].**

Stable carbon and nitrogen isotopic composition of bulk aerosols:

Atmospheric carbonaceous aerosols of South Asian origin have received immense concerns in the Anthropocene owing to their plausible role in the observed regional to inter-continental scale climate anomalies. Tracking plausible sources and alterations during their transport (secondary processes) are keys to understanding their net influence on regional climate. Here, elemental concentrations of C and N (TC and TN), their isotopes ($\delta^{13}C$, $\delta^{15}N$) and TC/TN ratios of bulk carbonaceous aerosol particles over northern Indian Ocean are studied. In order to understand typical sources, same parameters of (i) aerosols emitted from typical biomasses conventionally burnt in north and northeastern India and (ii) aerosols particles present in ambient air over selected Indian cities during pre-monsoon season are also measured. Bulk aerosols over AS are characterized by significantly higher TC/TN ratios (~50 ± 10) compared to aerosol over Indian cities (5.6 ± 2.6) as well as over BOB (6.8 ±12.5), most likely due to having significant inorganic carbon contributed by mineral dust. $\delta^{13}C$ of aerosols over AS and BOB do not show significant variation (-25.6‰ ± 0.6, -26.5‰ ± 0.8; n=24 and 21 respectively), however $\delta^{15}N$ values showed a conspicuous difference between the two braches of northern Indian Ocean (10.6‰ ± 2.7 over BOB and 1.4‰ ± 3.3 over the AS). Depleted $\delta^{15}N$ of aerosols over AS can be interpreted in terms of significant mixing of isotopically depleted nitrogenous compounds (NH_3 and NOxs) emitted from the underlying (denitrifying) waters. [R. Agnihotri, et al., including **M. Naja**].

Influences of biomass burning over the central Himalayas:

The influences of the springtime Northern Indian biomass burning are shown for the first time over the central Himalayas by using three years (2007-2009) of surface and space based observations along with a radiative transfer model. Near-surface ozone, black carbon (BC), spectral aerosol optical depths (AODs) and the meteorological parameters are measured at a high altitude site Nainital. The satellite observations include the MODIS derived fire counts and AOD (0.55 µm), and OMI derived tropospheric column NO_2, ultraviolet aerosol index and single scattering albedo. MODIS fire counts and BC observations are used to identify the fire-impacted periods (372 hours during 2007-2009) and the fire induced enhancements in surface BC, AOD (0.5 µm) and ozone are estimated to be 1802 ng m^{-3} (~145%), 0.3 (~150%) and 19 ppbv (~34%) respectively. Large enhancements (53-100%) are also seen in the satellite derived parameters over a 2°x2° region around Nainital. The present analysis highlights that the Northern Indian biomass burning can induce an additional cooling at the surface (-27 W m^{-2}) and top of the atmosphere (-8 W m^{-2}) in the lesser

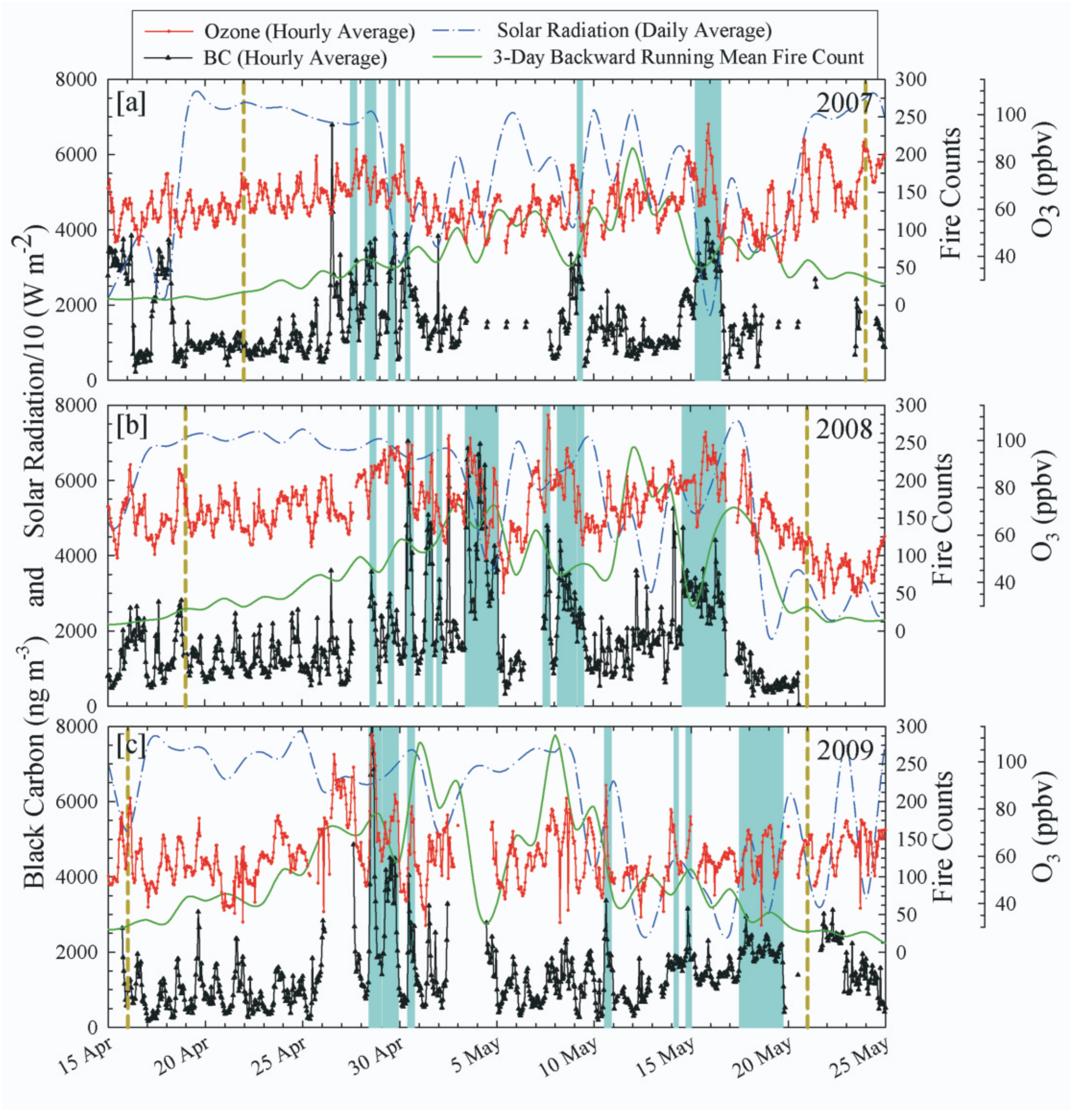


Figure 19. Variations in hourly average ozone and BC levels, daily daytime (0700-1700 hours) average solar radiation at Nainital and three day backward running mean fire counts during 15 April-25 May for [a] 2007, [b] 2008 and [c] 2009. Periods between two vertical dashed lines are high fire activity periods and shaded bars are fire-impacted periods.

polluted high altitude regions of the central Himalayas. This cooling leads to an additional atmospheric warming of 19 W m^{-2} and increases the lower atmospheric heating rate by 0.8 K day^{-1}. These biomass burning induced changes over the central Himalayan atmosphere during spring may also lead to enhanced short-wave absorption above clouds and might have important implications for the monsoonal rainfall. [**R. Kumar, M. Naja,** S. K. Satheesh, **N. Ojha, H. Joshi, T. Sarangi, P. Pant,** U. C. Dumka, P. Hegde and S. Venkataramani]**.**

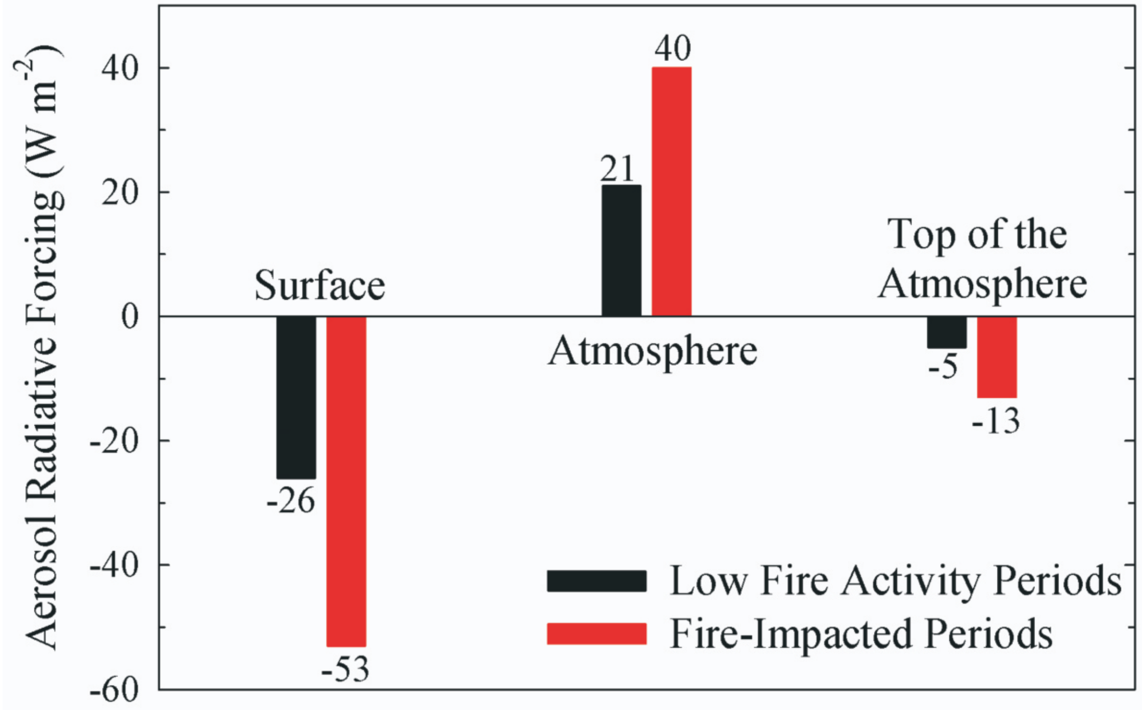


Figure 20. Diurnally averaged clear-sky shortwave (0.25-4.0 µm) direct aerosol radiative forcing (W m^{-2}) at the surface, in the atmosphere and at the top of the atmosphere during low fire activity and fire-impacted periods. Numbers along each bar are the radiative forcing for the respective cases.

Research Collaborations

The following activities are going on in collaboration between various institutions and ARIES:

- Wide field photometry is being pursued around star forming regions and open clusters using the 1.05-m Kiso Schmidt and 1.04-m ARIES telescope in collaboration with Prof. K. Ogura, Tokyo, Japan to study the mass function of low mass stars in the coronal regions of clusters.

- Multi-wavelength studies of star forming regions to study the global view of star formation in these regions, in collaboration with Prof. K. Ogura (Japan), Prof. W. P. Chen (Taiwan), Prof. S. K. Ghosh, Dr. D. K. Ojha (TIFR, Mumbai) are being carried out. Deep photometry of small clusters in HII regions with special focus on bright-rimmed clouds (BRCs) is also being carried out. The global distribution of young stellar objects manifests triggered star formation in the region.

- To search and study the pulsational variability in chemically peculiar stars, a program in collaboration with D. L. Mary of Labratoire Universitaire d'Astrophysique de Nice, France, Dr. Peter Martinez of South African Astronomical Observatory (SAAO), South Africa, Dr. T. Ryabchikova, M. Sachkov of Institute of Astronomy, Russian Academy of Science (INASAN), Russia and N. K. Chakradhari of School of Studies in Physics and Astrophysics, Pt. Ravishankar Shukla University, Raipur, India is being carried out.

- To study the morphology of extragalactic objects, a collaboration with Dr. Joydeep Bagchi of IUCAA, Pune and Prof. Gopal Krishna of NCRA, Pune, is being pursued.

- Studies of complex properties of Giant Radio Galaxies are being carried out in collaboration with Prof. D. J. Saikia of NCRA-TIFR, Pune, India and Prof. Oleg V. Verkhodanov of Special Astrophysical Observatory, Russian Academy of Sciences, Russia.

- Solar Physics group of ARIES is actively participating in the Indo-French Project on "Transient Phenomena in the Sun-Earth System" (Prof. P. Venkatkrishnan, USO, Udaipur is the PI from India, and Prof. G. Molodij, Observatory de Paris, Meudon is a PI from French side). Under this project, active collaboration is being pursued with Dr. Nandita Srivastava, Dr. Ashok Ambastha, Dr. S.K. Mathew, Dr. Sanjay Gosain (USO, Udaipur), Prof. P.K. Manoharan (RAC, Ooty). Collaborative project with Prof. Debi Prasad Choudhary, California State University, Northridge, USA on some major solar flares observed at ARIES in October-November 2003 to study energy build-up and energy release mechanisms is being carried out. The group is also a part of the (a) CAWSES India Project on " Space Weather Aspects of Active Region Vector Magnetic Fields", (b) X-ray Spectrometer (SOXS) project with Prof. Rajmal Jain (PRL, Ahmedabad) and Prof. A.R. Rao (TIFR, Mumbai), (c) "Indian Space Coronagraph Project", (d) "National Large Solar Telescope (NLST)" project of 2 meter class. The group is working in an Indo-Russian project entitled "Multiwavelength Observations and Modeling of Transients and Waves in the Solar Atmosphere" with B. P. Fillipov and his team from IZMIRAN, Russia, and is also collaborating with the solar scientists at Armagh Observatory, U.K.; Georgian National Astronomical

Observatory, Georgia; Space Research Institute, Austria; Sheffield and Warwick Universities, U.K.; SAI, Moscow State University, Russia and UMCS, Poland. The group is also participating in Indo-US project "Multiwavelength Study of Solar Eruptive phenomena and their Interplanetary Responses" with Prof. N. Gopalswamy, GSFC, NASA and Prof. D. P. Choudhary, California University. Prof. P. K. Manoharan, RAC, Ooty and Prof. R. Jain, PRL, Ahemdabad are also the participants from India. The solar-physics group of ARIES also collaborates with Dr. Syed Salman Ali, Aligarh Muslim University (AMU), Prof. Abdul Qaiyum (AMU), and Prof. B.N. Dwivedi, (I.T. BHU).

- Observations of trace gases and aerosols are being continued in collaboration with Prof. K. Krishnamoorthy, SPL, Trivandrum, Prof. Shyam Lal, PRL, Ahmedabad and Prof. S. K. Satheesh, IISc, Bangalore. Physical parameters of aerosols were measured at ARIES till February 2011 using AERONET Cimel-photometer in collaboration with NASA. Collaborative work with Dr. Yogesh Kant, IIRS and Dr. K. P. Singh, G. B. Pant University of Agriculture and Technology, Pantnagar is being continued for ozone and aerosols studies at Dehradun and Pantnagar, respectively. Research collaboration on modeling studies for tropospheric studies has been started with a group at the National Center for Atmospheric Research (NCAR), Boulder, USA. Collaborative works with Dr. H. Mukai and Dr. T. Machida, NIES, Tsukuba, Japan for greenhouse gas and VLF whistler studies in collaboration with IIG Mumbai and Stanford University, USA are being continued.

Facilities

1. Observing Facilities

1.1. Stellar Observing Facilities

The 104-cm Sampurnanand Telescope (ST) continued to be utilized as a main observing facility in the optical domain since 1972. The preventive maintainance and the telescope tests were carried out regularly by the scientists and the engineering staff of the ST. There was no major telescope problem encountered during the year 2010-2011. The students and scientists of the institute use this facility to carry out their research work. The total research output of the ST reaches nearly 320 scientific publications in different refereed journals so far.

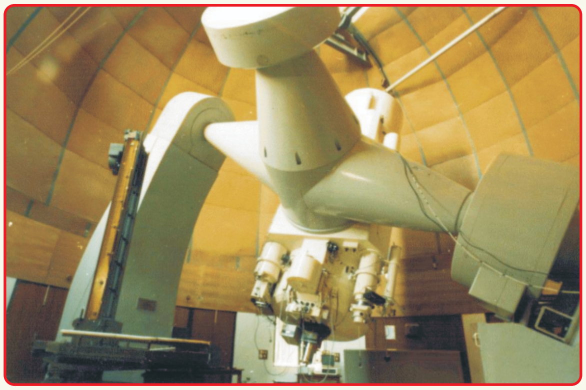


Figure 21. The optical 104-cm Sampurnanand telescope at ARIES.

The prime back-end instruments like, Wright 2K and Tek 1K CCD, ARIES Imaging Polarimeter(AIMPOL) and 3-Channel Fast Photometer are working well. The major scientific programs carried out with this observing facility includes study of star-clusters, young star-forming regions, HII regions, AGN and brown dwarfs, optical counterpart of Gamma-ray-brusts(GRBs), supernovae and X-ray sources, polarimetric studies of star-forming regions and late type stars.

Joint Time Allocation Committee (JTAC) alloted nearly 60% time for CCD imaging and nearly 20% time for imaging polarimetry and photometry each. Out of 273 alloted nights during the period of 2010 - 2011, we got nearly 150 clear nights. There were nine publications in refereed journals based on the data taken from ST.

1.2. Solar Observing Facilities

The main solar observing facility is 15-cm Coudé Solar Tower Telescope equipped with Bernhard Halle Hα filter, and ProEM 1024B (1KX1K, 13 μ^2, 16 bit A/D and 10 MHz read out rate) frame transfer fast imaging EMCCD cameras manufactured by Princeton Instruments Inc., USA. It is an automatic Hα flare patrolling system, which takes fast sequence of images in the flare mode

Figure 22. 15-cm Coude Solar tower telescope for solar observations.

observation. The main objective of the group is to observe the solar eruptive events (e.g., solar flares, filaments and prominences, surges etc.) in the Solar atmosphere. The CaII K 3933 Å and G-band 4305 Å observations are also being carried out to study the dynamics of lower solar atmosphere. The group also has FeX 6374 Å, FeXIV 5303 Å, FeXI 7892 Å filters to observe the corona during total solar eclipse. The space based advanced data acquisition and analysis environments are also available to pursue solar research.

1.3. Atmospheric Observing Facilities

Research in atmospheric science was initiated at ARIES, Nainital during January 2002 when a Multi-Wavelength solar Radiometer (MWR) was installed under Indian Space Research Organization – Geosphere Biosphere Program (ISRO-GBP). Soon after that various instruments like Microtops-II, GRIMM, Aethalometer, HVS and BLL were installed. Further, ARIES has acquired a battery of different analyzers for O_3, CO, NO, NO_y, SO_2 measurements under ISRO Environmental Observatory Project. Air samples are also being continued at ARIES to analyse other trace gases (e.g. CO, CH_4, SF_6, N_2O, NMHCs). Besides above, studies on VLF whistlers/tweeks are also being carried out at ARIES, in order to understand the processes in ionosphere and magnetosphere as well as to the space weather.

1.4. The 130-cm Telescope at Devasthal

The 130-cm telescope has been installed at Devasthal near Nainital. The telescope has been fabricated by DFM Engineering Inc. USA. The telescope uses a modified Ritchey-Chretien Cassegrain design which has three optical components, namely, primary mirror, secondary mirror, and a corrector or field flattener. The focal length to diameter ratio

Figure 23. 1.3-m Devasthal Optical Telescope.

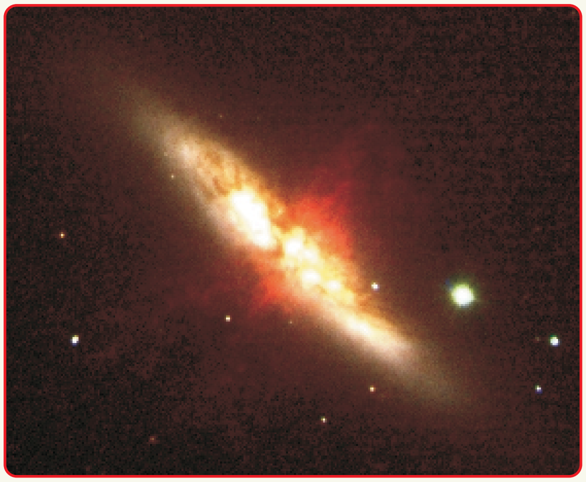
(focal-ratio) of the overall optics was kept at 4 making it a very fast system providing 40 arcsec view of the sky in 1 mm scale at the focal plane. A single element corrector provides a nearly flat field view of the sky up to 66 arcmin in diameter. The mirrors are made of Corning's Ultra Low Expansion (ULE) glass/ceramic material. The tube of the 130-cm telescope is of open truss allowing the telescope to cool faster in the ambient. The telescope mount is of fork-equatorial type which requires only one axis of rotation while tracking celestial sources. The mechanical structure of the telescope is made up of Steel and Aluminum. There is also a provision through Invar rods and bi-metallic materials for automatic compensation of focus variation brought from expansion or contraction of optical tube due to changes in the ambient temperature. The focus can be adjusted using a five-axis (tip, tilt, and 3-axis translation) controller on the secondary mirror. The telescope uses friction drives to control motions in right ascension and declination axes. The friction drives provide smooth and accurate pointing without any backlash. The encoders to register the position of the drives are absolute in 25-bit. A pointing accuracy better than 10″rms and a tracking accuracy of 0.5″ over 10 minutes has been achieved with the telescope. An autoguider has also been enabled. The telescope is controlled using dedicated softwares. The telescope control system is capable of operating the telescope automatically. The system can also be interfaced with the standard sky-viewing softwares such as The Sky, eliminating the need of any finding chart. The system maintains an accurate time standard using the Global Positioning System (GPS) satellites. There is also an onsite weather monitoring system to keep a watch on the outside weather. The telescope is housed in an open roll-of-roof type structure again to help the telescope to cool faster in the ambient. The roof is designed and constructed by the institute.

Three CCD cameras are currently available with the telescope for obtaining images of the celestial sky. The cameras are (1) 2048x2048 pixels, 13.5 micron pixel size conventional back-illuminated, deep thermoelectrically cooled (-80^0 C) CCD, (2) 512x512 pixels, 16 micron pixel size electron multiplying frame transfer back-illuminated deep thermoelectrically cooled (-90^0 C) CCD, (3) 3326x2504 pixels, 5.4 micron, front illuminated, thermoelectrically cooled (-30^0 C) conventional CCD. The first two cameras use high quantum efficiency E2V chip, assembled by ANDOR with low read noise electronics. The third camera is from SBIG using Kodak chip.

The telescope was inaugurated by Dr. T. Ramasami, Secretary, Department of Science & Technology, Govt. of India on December 19, 2010. The images obtained with the telescope show best FWHM at nearly 1 arcsec. The atmospheric extinction at Devasthal is measured as 0.24 mag in B (Blue), 0.14 mag in V (Visual), and 0.08 mag in R (Red) band on the first week of December, 2010. The sky brightness is measured as 21.2 mag/arcsec^2 in the V band in moonless night. The telescope is also equipped with a motorized filter changer, design and developed at the institute.

Figure 24. Inauguration of 1.3-m Optical telescope by Dr. T. Ramasami, Secretary, Department of Science & Technology, Govt. of India at Devasthal on December 19, 2010.

Currently, broad-band (BVRI), SDSS (u,g,r,i,z), and narrowband interference filters for O[III], S[II], and H-alpha line observations are available. The telescope is currently being used for photometric observations of star clusters, galaxies, and monitoring extrasolar planets, transients such as GRB and supernovae.



(a)

(b)

Figure 25. (a)H-alpha image of star burst galaxy M82 overlaid upon broadband VR image of the galaxy, (b) The BVR composite image of Orion star forming region.

Some of the first light images are shown in Figures 25. Figure 25 (a) brings out ionized gas seen in H-alpha (red color) in a starburst galaxy M82. The image in Figure 26 is a broad band BVR color composite image of the famous Orion star forming region, also known as *Mrigshirsha Nakshtra*.

Figure 26. The BVR color composite image of the central portion of the galaxy NGC598 imaged with the 130-cm telescope.

2. Support Facilities

ARIES has an aluminizing unit, a computer section, a civil works section, an electronics lab, a mechanical workshop, an optics laboratory, and a well equipped library as support facilities for the academic, research and developmental activities of the Institute. They are briefly described below:

2.1. Aluminizing Unit

Spherically concave 80-cm primary mirror was mounted in its mechanical cell with a desired accuracy and transferred to the Baker-Nunn Schmidt telescope house, followed by its successful assembly to the telescope tube. Similarly, the three element 50-cm air-spaced original corrector system got assembled and aligned in Optics laboratory before its assembly into B-N Schmidt telescope. Regular assistance continued to be provided to various projects, telescopes and labs, including the optomechanical alignment activities conducted initially in Schmidt telescope context. Two test mirrors [30 cm x 30 cm] aluminized in 3.7-m coating plant for Devasthal Observatory were received from M/s Hind High Vacuum Co., Bangalore. The mirrors passed the scotch tape test and visual tests at Optics laboratory. Routine jobs like evacuation of CCD dewars continued. The 106-cm primary mirror of Sampurnanand Telescope is planned to be aluminized during 2011-monsoon season after a gap of successful use for six continuous observing years.

2.2. Computer Centre

Thin client implemented for the administrative staff: The desktop PC management has always been a challenge to the computer section. It was a constant struggle to effectively manage the vast number of desktops installed in the ARIES office. We found that the Thin Client System can provide us with a solution to manage the desktops efficiently in a reasonable cost. Thin Client separates a desktop PC environment from a physical machine to a client-server computing model. That is, a users' desktop is hosted remotely and accessed via a thin client device over the Internet. A user no longer has a physical PC. Benefits of using thin clients instead of PCs are easier administration, enhanced data security, lower hardware cost, less energy consumption, and easier hardware failure management. Computer section successfully implemented this system for the ARIES administrative block.

Up-gradation of Institute Internet Facility: Internet is the main medium which serves as the backbone for our data and knowledge transfer. BSNL is providing ARIES with a lease line through which we are connected to the internet. In order to have a back-up arrangement incase of a failure, we made an alternate arrangement with Reliance for a 10 Mbps lease line. The installation of the same is completed. At the same time we could also get BSNL lease line upgraded from 10 Mbps to 16Mbps without any additional cost.

Annual Procurement and in-house training: We procured 22 desktops, 5 laptops and 2 work stations for the faculty members and research scholars. Training has been given to engineering and diploma students on various fields like high performance cluster development, web site management and networking.

2.3. Knowledge Resource Centre (KRC) / Library

The mark of a progressive institution is judged by the strength of its library. Ever since the inception of the Observatory in 1954, its library has been steadily building up through the years. The ARIES Library is now known as **Knowledge Resource Centre (KRC)**. The KRC continued with its basic activities of information resources development by collecting, processing, organizing, storage and retrieval of information; maintaining liaison with other related institute libraries for resource sharing and for exchange of information; providing need based current awareness, reference and bibliographic services; and facilitating on-line access to wide range of information resources in print and electronic versions. The number of Institutions, both from the country and abroad, on exchange list is about 100. The KRC acquires books and journals mainly related to Astronomy & Astrophysics and Atmospheric Sciences. The KRC also acquires reference books time to time.

KRC Resource Development

During the period 2010 - 2011, the following information resources were added:-

Books	:	265
Bound Volumes of Journals	:	100
Subscription to Journals (Print + Online)	:	96
ARIES Publications	:	52
ARIES Theses	:	7

The collection at the end of the period is

Books	:	Around 10,310
Bound volumes of Journals	:	Over 11,000

Apart from books and journals, non-book materials such as slides, charts, maps, diskettes, CD-ROMs, etc. are also available in the KRC.

Modernization

During 2010 – 11, the LIBSYS software of the KRC was upgraded. The new features of Online Catalogue are available at Web-OPAC on ARIES home page as well as ARIES Intranet. **DSpace** open source software has been installed successfully for digital repository of ARIES and available at ARIES KRC home page. The subscribed e-journals, online journals / databases through National Knowledge Resource Consortium, ARIES academic reports and updated list of Publications are also available at ARIES KRC home page.

Consortia

The ARIES KRC is a member of FORSA (Forum for Resource Sharing in Astronomy and Astrophysics), which has been established by Indian Astronomy Librarians in 1979. The ARIES KRC is also a member of National Knowledge Resource Consortium. E-Journals of American Institute of Physics, Annual Reviews, CSIRO Publishing, Emerald, IEEE, Indian Journals.com, IOP Science, J-Gate, Nature, Nature Photonics, Nature Physics, Optical Society of America, Science, Springer, Taylor & Francis, ISI Web of Knowledge and Wiley Online Library, etc. are available through National Knowledge Resource Consortium (NKRC).

2.4. Civil Works Section

The civil work section supervises the new upcoming buildings, routine maintenance and modifications/ renovation of the ARIES office, residence buildings and roads. The works supervised by the section at Manora Peak and Devasthal campuses during 2010 – 2011 are as follows:

At Manora Peak

Construction of 10 units of Lab (Residences) Blocks and ST Radar Building is in progress.

At Devasthal

1. **Guest House** : Upcoming Guest House has 5 rooms with the necessary facilities. It has dining area with a sitting capacity of about 15 persons. Final painting and site development work are in progress.

2. **Construction of water tanks and installation of pump –** Construction of water tanks including laying of pipe line and installation of pump etc. has been completed. Water supply has already reached Devasthal top and the water supply lines have been connected to 130-cm telescope building and solar telescope site. Installation of 2nd pump is in progress.

3. **3.6-m Optical Telescope Building** – Civil works up to plinth level have been started. Foundation work of basement and retaining walls is in progress.

2.5. Electronics Section

Electronics and Electrical section caters to the overall electronics and electrical aspects related to instrumentation and infrastructure. In this section a group of engineers and engineering assistants are actively involved in design, development, upgradation and maintenance activities. The section comprises of different electronics labs and related facilities to support the above activities. Since electronics has become a vital part of advanced instruments, the section plays an important role in all the new projects and installation of new instruments. The section is responsible for installation and maintenance of facilities vital for effective functioning of the organization like strong communication setup, electric substation, centralized UPS and other useful appliances.

During the year 2010 - 2011 the section was involved in the following activities:

a. 1.3-m telescope

- Actively participated in the installation of 1.3-m telescope and its enclosure at Devasthal. Necessary documents of electrical and electronics system associated with the telescope were prepared for regular maintenance.
- Installed roll of roof and shutter control panel for 1.3-m telescope and also interfaced with DFM controller. Interlocking arrangement between roll of roof and shutter was additionally incorporated.
- Developed motorized filter wheel controller for 1.3-m telescope.

b. Schmidt telescope

- Actively participated in the installation of dome and slit control panel for Schmidt telescope.
- Developed micro-controller based PWM close loop controller for Schmidt telescope drive system. Its testing and fine tuning is under progress.

c. 3.6-m DOT

- Soil resistivity measurement was carried out at 3.6-m telescope site.
- Participated in finalization of the tender specification for the 3.6-m telescope enclosure.

d. LIDAR

- Offline data analysis software for Mie LIDAR was developed to obtain different important parameters like AOD, extinctions, cloud thickness etc. from the backscattered photon profile. The same software will be upgraded for Rayleigh mode.

e. ST Radar

- Actively participated in the developmental and testing process of the Transmit Receive Module (TRM) to get T & E committee clearance for the mass production. The committee cleared the production of TRM after critically analyzing the performance.
- Yagi-Uda antenna of the radar got clearance for mass production. The engineers from the section were actively involved during the T & E process of the antenna.
- Actively participated in the development and testing process of the DSP sub system.
- Section also contributed significantly in the civil work of the ST radar building particularly in the finalization of the electrical aspects.

f. Maintenance and Other activities

- Maintaining both sub stations at

Manora peak and Devasthal, existing infrastructure and routine electrical and electronics activities of the Institute.

- UPS and telephone facility was also maintained by the section.
- Maintained the electrical and electronics activities of the telescopes and their back-end instruments.
- Maintained all the electronics instruments of atmospheric section.
- Installed survey equipments and telescope for NLST project and its electrification works.
- Section engineers are actively participating in the GVAX project.
- Actively participated in the installation and operation of the Radionsonde balloon flight.

2.6. Mechanical Section

The new building of the mechanical section was inaugurated by Prof. P. C. Agrawal, senior member of the Governing Council of ARIES on 17th June, 2010. The section is equipped with machine shop, welding shop and carpentry shop along with design section and stores.

Figure 27. Inaugration of mechanical section by Prof. P. C. Agrawal, senior member of the Governing Council of ARIES on 17th June, 2010.

Mechanical section provides mechanical engineering support to almost all departments of ARIES through development of instruments, infrastructure and maintenance of existing facilities. The section was actively involved and contributed significantly in design and developmental works of on going and upcoming projects through out the year.

1. Projects activities

a) The section provided constant support in transportation, storage, assembly, installation and commissioning of 1.3-m telescope at Devasthal. Design and manufacture of backend instrument interface for 1.3-m telescope with provision for mounting three CCDs (ANDOR 2K x 2K, ANDOR 512 x 512 and SBIG ST-8300) was carried out and tested successfully. It has provision for mounting six filters. Two sizes of filters viz. 50 mm and 75 mm can be accommodated in the filter disc. Maximum parts were manufactured from aluminium to reduce the instrument weight. Automation of filter

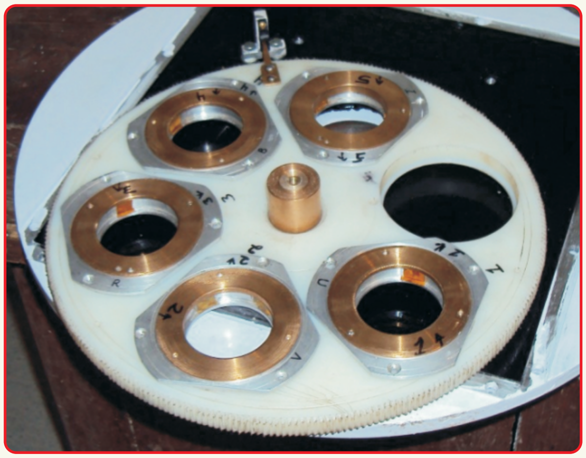


Figure 28. Filter disc of backend instrument interface for 1.3-m telescope.

disc with stepper motor and position sensor was accomplished with support from electronics section.

b) The dummy steel mirror from primary mirror cell of Schmidt telescope was replaced with 796 mm diameter primary mirror with support from optics section. Mirror was assembled in the cell to achieve floating condition with eighteen axial and twelve radial supports. Radial defining support was assembled in the central hole of primary mirror to locate it

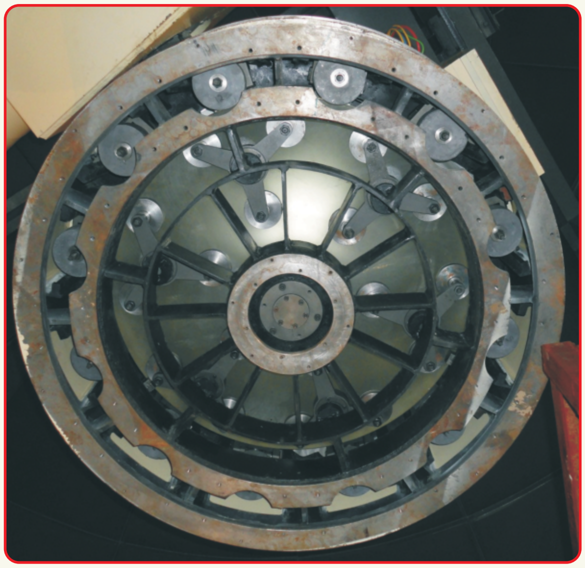


Figure 29. View from bottom of primary mirror cell of Schmidt telescope containing primary mirror floating on axial and radial supports.

in the radial direction. Three defining axial supports, provided with micrometer-controlled motion, were also assembled to exactly position the mirror when it was supported by the axial supports. Three elements of the corrector were assembled in the optics section and dummy steel corrector was replaced from top of the telescope tube with corrector assembly. Fine balancing of the telescope was done by monitoring the motor currents. Jigs and fixtures for optical alignment of the telescope as per the optical section requirement were designed and manufactured.

c) Preliminary design of modular scaffolding with pipes, z-stairs, hand rails, ladder beam and jacks at base has been prepared for proposed assembly of 3.6-m telescope at Devasthal.

d) Mechanical workshop took initiative to refurbish the existing 3.35-m dome to host a new 35.5-cm telescope at science centre.

e) The Mie LIDAR system has been made operational and night observations have been carried out

2. Upgradation and maintenance activities:

The workshop was upgraded with inspection instruments, material handling equipments and cutting tools etc. The workshop carried out preventive and breakdown maintenance in 40” telescope, solar telescopes, generator, office buildings, Devasthal and ARIES campus. The section also planned the activities related to upcoming projects.

3. Other Project activities

The tender document for construction of 3.6-m DOT enclosure was prepared to identify the vendor. Tender documents for 3.6-m enclosure cranes and International Liquid Mirror Telescope (ILMT) enclosure design were also prepared. ADFOSC preliminary design review was accomplished. Technical inputs for upcoming mirror aluminizing plant of 3.6-m telescope were also provided.

2.7. Optics Laboratory

The optics laboratory carried out routine maintenance activities of the optical telescope and the back end instruments at the institute. The laboratory is actively involved in developmental activities such as LIDAR project, B-N Schmidt telescope, 130-cm and 360-cm Devesthal optical telescopes.

The optical design analysis of 130-cm, 360-cm telescope and other small telescopes were carried out. A new design for the autoguider for 130-cm telescope was also prepared. The laboratory is equipped for making small optics characterization and analysis. The modern equipments such as sensitive spectrograph and CCD camera are available.

The laboratory is acquiring new vibration isolation tables, fibre optics, LASERS, wavefront sensor, seeing monitor etc for enhancing optical testing capabilities of the institute for astronomy and atmospheric sciences. Modern softwares like Zemax and powerful workstations are available in the lab for optical system analysis.

3. Upcoming Facilities

A few years ago, ARIES started several major projects with an aim to establish world-class research facilities in the area of Astronomy & Astrophysics at Devasthal and Atmospheric Sciences at Manora Peak. Following are the description about these ongoing projects.

3.1. Devasthal Site

Devasthal (latitude 29°22'26'' North; longitude 79°40'57'' East, Altitude: 2500 meter) is being developed as an astronomical site. The site is far from any urban development and is the most suitable for astronomical observations. A 1.3-m optical telescope has already been installed and 3.6-m DOT is expcted to be ready by December 2012 for observations of celestial sources at optical and near infrared wave lengths.

About 3-km long road connecting the state highway, from Jarapani junction to Devasthal site has been constructed. The 150 kW hydroelectric power transmission line laid down by Uttarakhand power corporation has been energized. The water requirement has been met successfully by installing a bore well. The bore well is located at the base of the Devasthal site. Further, there is a plan to recharge the water level around the bore-well by rain-water harvesting. A plan for tapping roof water is also under progress. Optical fiber cables have been installed between the base camp to the proposed telescope site to enable the transfer of electronic data.

3.1.1. 3.6-m Devasthal Optical Telescope (DOT Project)

The ARIES is establishing a national facility in optical astronomy at Devasthal to fulfill the major aspirations of the Indian astronomical community. This facility consists of a modern 3.6 meter optical new technology telescope, a suite of instruments, an observatory with a coating plant, a control room and a data center. The 3.6-m Devasthal Optical Telescope (DOT) will have a number of instruments providing high resolution spectral and imaging capabilities at visible and near-infrared bands. In addition to optical studies of a wide variety of astronomical topics, it will be used for follow-up studies of sources identified in the radio region by GMRT and UV/X-ray by ASTROSAT.

The telescope manufacturing is being

done by AMOS Belgium. The design of the enclosure and building has been prepared by M/s PPS, Pune. The coating plant is being manufactured by M/s HHV, Bangalore. The development of infrastructure (road, power, internet, water), instruments (a faint object spectrograph and camera, a high resolution spectrograph), observatory control and data center is being developed in-house at ARIES. The project is monitored and advised periodically by a 9-member Project Management Board (PMB) chaired by Professor P.C. Agrawal. The PMB met thrice during the period. The day-to-day activities related to scientific, technical and financial aspect of the project is executed by a project implementation team (PIT) and eight project working groups (PWG) under the guidance of the project director and project manager. The PIT and PWGs met at more than a dozen occasions to monitor the activities. A progress review meeting took place during 17-18 January 2011 at AMOS Belgium to discuss issues related to various interfaces of the telescope and the observatory. During April 2010 – March 2011, most of the scheduled project activities were carried out successfully.

The manufacturing of primary mirror is in progress at LZOS Russia. The final aspherization was achieved in April 2010 and after that the preliminary polishing continued till August 2010. Gluing of lateral pads was performed in February 2011. The wavefront error has progressed from 1300 nm RMS (11000 nm PV) in October 2010 to 495 nm RMS (4884 nm PV) in February 2011, to 223 nm RMS (2314 nm PV) in March 2011. The M1 specification for WFE is 40 nm RMS and it is planned to be ready for acceptance by June 2011. The polishing of Astrositall M2 mirror was completed in March 2010 with RMS WFE of 18 nm and the M2 mirror was delivered at AMOS workshop in the month of October 2010.

A key contract milestone - the assembly and integration of the telescope with dummy mirrors has been completed in February 2011. Figure 30 shows the picture of fully assembled telescope at the AMOS workshop. Now, the testing and fine tuning of the telescope is in progress and it is scheduled to be completed by March 2012.

The design of the civil work up to plinth level of the telescope site was done by M/s PPS Limited, Pune. After completing a third party (M/s TRFI, Delhi) check and approval of the design, a contract for the civil work up to plinth level has been awarded to M/s Vidyawati construction company, Allahabad. M/s Vidyawati started excavation at site in December 2010 and the

Figure 30. Fully assembled 3.6-m telescope with dummy mirrors at AMOS workshop.

civil work upto plinth level, i.e. pier and retaining wall is in progress. A contract agreement has been signed with M/s Pedvak Cranes Pvt Ltd., Hyderabad in February 2011 to manufacture, supply, erection and commissioning of the telescope enclosure structure and equipments for the 3.6-m Devasthal Optical Telescope.

The first aluminization of the primary mirror shall be done at Devasthal before final performance test of the telescope. After a global tendering process, the contract to design, manufacture, and commission an aluminuinm coating plant for 3.7-m primary mirrors has been awarded to M/s HHV, Bangalore in July 2009. The design phase was over by June 2010. The assembly and integration of the coating plant has been also completed. The coating plant was inspected by a team of three members (R. Sagar, A. C. Gupta and Vishal Shukla) from ARIES on 29th December 2010. M/s HHV has submitted a detailed test report to ARIES. A pre-shipment review meeting was planned in March 2011.

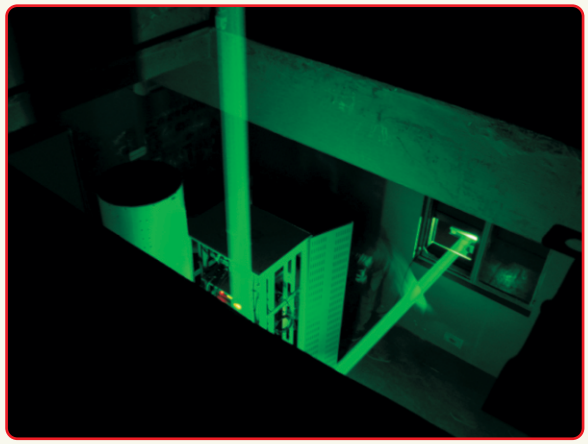
The ADFOSC (ARIES Devasthal Faint Object Spectrograph and Camera) will be one of the first light instruments to be mounted at the axial port of the Cassegrain focus of the 3.6 meter DOT. The instrument well cover the wavelength range 350-1000 nm and it will have two distinct mode of operation; (1) Direct broad and narrow-band imaging capabilities with spatial resolution of less than 0.2 arcsec in 10 arcmin field of view. (2) Low-to-medium resolution spectroscopy with spectral resolution (250-4000) covering the optical wavelengths 360-1000 nm. The design of the ADFOSC is in advanced stage and a critical design review meeting is scheduled to take place in July 2011.

3.2. Projects at Manora Peak

At Manora campus of ARIES, a few Atmospheric Science projects are also shaping up apart from the ones in the area of Astronomy & Astrophysics. They are described below in brief.

3.2.1. High Energy Pulse LIDAR System

The Mie lidar system, a part of high energy pulse Lidar system, developed at Manora peak consists of three subsystems namely transmitter, receiver and a data acquisition system. A Q-switched Nd:YAG laser operating at 532 nm wavelength along with a 10X beam expander is used as the transmitter. The laser beam after expansion through the beam expander falls on to the LASER steering mirror oriented at 45^0 to the LASER beam.



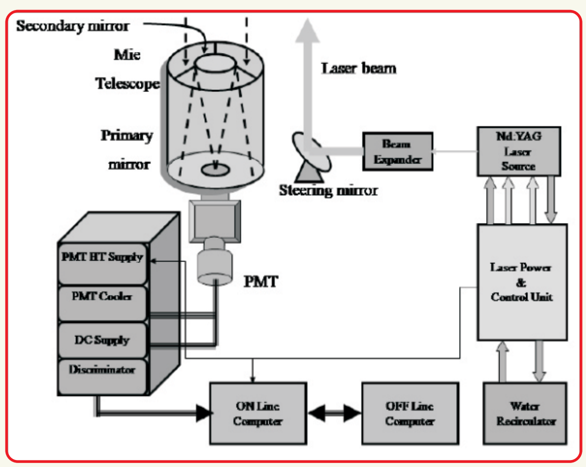


Figure 31. Mie LIDAR system at ARIES, Nainital.

Indigenously developed precise mechanical mount having 5-axis motion holds the 250-mm diameter laser steering mirror which directs the beam vertically up into the atmosphere. The receiver system consists of a 38 cm Cassegrain telescope and indigenously developed mechanical mounts for detection optics.

The LIDAR system in Mie mode was made operational in January 2010. In order to study aerosols profiles over the site, the system was operated during the month of January and March 2010, corresponding to local winter and spring season, respectively. Presently only clear night data sets are taken into account for the reliability of the analysis avoiding any perplexity in the interpretation of the results.

3.2.2. Stratosphere Troposphere Radar

Clearance for the mass production of antenna and TR module has been given to the ECIL, Hyderabad. There will be 588 antenna and TRM modules in the upcoming ST Radar and mass production will be in the batches of 50-100 numbers. The test & evaluation (T&E) committee has evaluated the test results and recommended for their mass production. There have been four meetings of PMRC and three meetings of the PMC to review the progress of the ST Radar during last year. Now, integration work of the mini profiler (49 arrays) is in progress at ECIL, Hyderabad.

IIGM team has carried out geomagnetic survey to establish the magnetic meridian at the ST Radar site. A civil meeting was held at NARL on 7th Jan 2011 to discuss the TRMs installation methodology and antenna mounting procedure. Different options were discussed during this meeting and it was proposed to implement some of them in the 49 array at ECIL that will provide experience before actual set-up at ARIES, Nainital.

Civil work related to ST Radar building is in progress. The slab for the ground floor's top has been completed and work for top floor slab is in progress. Action has been taken to get approval for 400 KVA sub-station from Uttarakhand Power

Figure 32. Work is in progress for the mini profiler (49 subarray) at ECIL, Hyderabad.

Corporation Ltd (UPCL) required to run the radar.

3.2.3. ARFI and ABLN&C projects under ISRO-GBP

Regular observations of AOD, BC, number concentration of composite aerosols (in 0.3 to 20 µm range), composite mass using high volume sampler and meteorological parameters are made at ARIES, as a part of ISRO-GBP. Observations of BC and AOD were also started at Pantnagar site in order to study the influence of boundary layer dynamics on the aerosol characteristics in different environment. The first time measurements of AOD at Pantnagar show about 4 and 2.5 times increase during winter and spring seasons, respectively, in comparison to Nainital. Meanwhile the diurnal variation of BC aerosol at Pantnagar shows night time high with conspicuously enhanced values during morning and evening hours and low during noon period which eventually attains minimum in late afternoon hours. Thus the diurnal variations of BC at Pantnagar are found to be almost opposite to that at Naintal.

3.2.4. Environmental Observatory (AT-CTM) under ISRO-GBP

Continuous in-situ observations of ozone and related gases like CO, NO, NO_y, and SO_2 are being made under AT-CTM project of ISRO-GBP. The influences of the springtime Northern Indian biomass burning are shown for the first time over the central Himalayas by using three years (2007-2009) observations. Fire induced enhancement in surface ozone is estimated to be 19 ppbv (~34%). Observations are also initiated at Pantnagar under this project. In contrast to Nainital, ozone variations at Pantnagar show a clear ozone buildup in daytime. This is mainly due to photochemical ozone production, involving its precursor gases. Average ozone levels observed at Nainital are generally higher than those at Pantnagar. The noontime (1300-1500) ozone levels at Nainital and Pantnagar exhibit strong positive correlation indicating the transport of pollutants from Indo-Gangetic Plain to central Himalayan region. These results suggest that observations at Nainital are representative of a larger region while those at Pantnagar provide information about the local emissions.

3.2.5. 50/80-cm Baker - Nunn Schmidt Telescope Project (B N S T P)

The dome and building construction of the B N Schmidt telescope project is completed. The mechanical alignment of the telescope with the North celestial pole has been done. The preliminary optical alignment has been done using the laser alignment telescope. Several additional tools were fabricated to facilitate the alignment. The laser spot was found to be off from the center which will be corrected by performing the optical alignment further. The final optical alignment of the telescope optics will be done using the CCD.

The linear controller which was earlier planned for the drives of the telescope is not functioning properly. Currently a microprocessor controlled pulse width modulator has been used which gives a better performance. Further tests are in progress. Once the proper functioning of the mechanical drives is achieved, final optical alignment of the optics system will be initiated. Our aim is to perform actual tests with the star in next observing season (October – December, 2011).

Figure 33. 50-cm B-N Schmidt telescope at ARIES, Nainital.

Other Activities

1. Conferences/Workshops

A Workshop on Need for Large Optical and Infrared Astronomy Facilities in India organized at ARIES during December 18 – 19, 2011

A two day workshop was organized by ARIES, Nainital on "Need for Large Optical and Infrared Astronomy facilities in India" at ARIES during December 18-19, 2010. The workshop was well received by astrophysicists in the country including those from IIA-Bangalore, TIFR-Mumbai, NCRA-Pune, IUCAA-Pune and RRI-Bangalore. The total participants were nearly 35 including astronomers from ARIES. The meeting was well represented by young astronomers and students. A total of 15 scientific and technical presentations were made emphasizing the need for large observing facilities in the country such as building a 10-meter telescope in the country and participating in instrumentation for existing and upcoming telescopes such as 3.6-meter Devasthal telescope and Thirty Meter Telescope at USA. It was confidently felt by the participants that India is in a stage to participate in large telescope project particularly in the area of instrumentation. The current efforts from Indian astronomers on Active and Adaptive optics were presented. The scientific programs proposed with the telescopes were varying from exoplanets detection to distant galaxies and transient events like Gamma Ray Bursts and supernova. Many astronomers were in favour of developing techniques for high spectral resolution spectrograph and advanced techniques for high angular resolution imaging through Adaptive optics or similar methods. The astronomers were also willing to develop instruments specifically for the upcoming 3.6-meter telescope at Devasthal.

Figure 34. Inaugural ceremony of Workshop on 'Need for Large Optical and Infrared Astronomy Facilities in India' organized at ARIES during December 18 – 19, 2011

Figure 35. Participants of Workshop on Need for Large Optical and Infrared Astronomy Facilities in India organized at ARIES during December 18 – 19, 2010.

Indo-Russian Bi-lateral Workshop held at ARIES during March 02 – 04, 2011

Indo-Russian bilateral workshop titled "Gamma-ray bursts, evolution of massive stars and star formation at high redshifts" was successfully hosted at ARIES, Nainital during March 02-04, 2011. The workshop was jointly funded by the Department of Science and Technology (DST), India and Russian Foundation of Basic Research (RFBR), Russia. Apart from Russian delegates, many other Indian scientists from various research institutes, universities also participated in the workshop. During the workshop, many scientific results were presented by the participants and new collaborative projects were also discussed.

Figure 36. Inauguration of Indo-Russian Bi-lateral Workshop held at ARIES during March 02–04, 2011.

Figure 37. Participants of Indo-Russian Bi-lateral Workshop held at ARIES during March 02 – 04, 2011.

2. Pedagogical Activities

ARIES Graduate School

ARIES conducted graduate school for the first year research students which consisted of two teaching terms and one-research project. The lectures were delivered by ARIES staff as well as guests scientists from other institutes. The first term was started from August 1st and continued till November 30; the second term was started from December 15 which was continued till April 15. The projects were carried out during April 15 to July 15, 2011.

Weekly Seminars and Special Talks

Weekly seminars and special talks were organized regularly at the Institute to increase the academic interactions amongst the researchers. About 20 seminars and 40 special talks were delivered during the period April, 2010 to March, 2011 by the Institute's students, scientists, engineers and eminent scholars from India and abroad.

Public Outreach

Public outreach is an ongoing program at ARIES. The Department of Science and Technology (DST) also supports these activities to increase general awareness about astronomy and basic sciences among the common people. For the purpose ARIES has developed a science center which has a lecture hall equipped with projector and sitting capacity for about 40 persons. The centre also has an exhibition hall to display the science models and posters. In addition a small 6-inch telescope is being installed to display the live night sky in the lecture hall for general public. The dome of the telescope is almost near completion and the telescope installation is under progress.

People visit ARIES regularly as well as on the occasions of popular astronomical events like eclipses and other planetary occultations. On these occasions special arrangements are made to provide related information to the visitors and the sky-watching programs using the telescopes. Apart from this, we also make use of print and electronic media to communicate information related to astronomical events as and when required as a part of the activities. Popular talks in the nearby schools and collages are also arranged as a part of the programs. The popular talks, science popularization programs are also organized by ARIES on the special occasions e.g. National Science Day.

In addition, summer program for school students was held from 15 May to 30 June. Nineteen students of class VIII to X participated in various projects at ARIES under the guidance of scientists and research scholars. These students were given access to the library, computer center and science centre. A report was submitted by each student at the end of the programme. Scientists also delivered popular talks to the groups of students visiting the Institute.

ARIES Training School in Observational Astronomy – 2011 (March 07-11, 2011):

The growth of our current understanding of the Universe depends not only on the growth of observational facilities but also on the number of people utilizing them. A number of new national (e.g. 3.6-m DOT) and international (TMT) observational facilities are coming up, which will need more researchers to use them efficiently. In this context ARIES organized "ARIES training school in Observational Astronomy (ATSOA)" to provide the necessary expertise and skill to M. Sc. final year or fresh Ph.D. students to enable them to analyze the observational data.

The *1st annual ATSOA* was held during March 07 – 11, 2011 at ARIES, Manora Peak, Nainital. About 30 participants from various universities and institutes participated in the school. The focus was on hand-on experience of observational astronomy using 1-m ARIES telescope.

Figure 38. The participants of ARIES traning school on observational sciences-2011 (ATSOA-2011) engaged in their projects works.

Figure 39. The lecture session in ATSOA-2011.

Figure 40. ATSOA-2011 participants on solar telscope visits.

Figure 41. Participants of ATSOA-2011 held at ARIES, Nainital during March 07-11, 2011.

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