ARYABHATTA RESEARCH INSTITUTE OF OBSERVATIONAL SCIENCES

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

MANORA PEAK, NAINITAL (INDIA)

ACADEMIC REPORT

2011 – 2012

ARYABHATTA RESEARCH INSTITUTE OF OBSERVATIONAL SCIENCES

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

Manora Peak, Nainital - 263 129, India

ACADEMIC REPORT

2011 - 2012

(1st April, 2011 to 31st March, 2012)

ARIES, 2012, Academic Report: 2011 - 2012
No. 7, 63 pages

Editor: Dr. M. Singh

Editorial Assistance: Mr. Prashant Kumar
Mr. Arjun Singh

Phone	:	+91 (5942) 235136
EPABX	:	+91 (5942) 233727, 233734, 233735, 232655
Fax	:	+91 (5942) 233439
E-mail	:	library@aries.res.in
URL	:	http://www.aries.res.in/

ISSN : 0974-679X

September, 2012

CONTENTS

GOVERNING COUNCIL

Prof. K. Kasturirangan — **Chairperson**
Member, Planning Comission,
Room. No. – 119, Yojana Bhavan, Parliament Street,
New Delhi – 110 001

Dr. T. Ramasami — **Member**
Secretary, Ministry of Science and Technology,
Department of Science and Technology, Govt. of India,
New Delhi - 110 016

Mr. S. Kumar — **Member**
Chief Secretary, Govt. of Uttarakhand,
Dehradun - 248 001

Ms. A. Mitra — **Member**
Joint Secretary and Financial Advisor,
Ministry of Science and Technology,
Department of Science and Technology, Govt. of India,
New Delhi - 110 016

Prof. J. V. Narlikar — **Member**
Emeritus Professor, Inter University Centre for Astronomy
and Astrophysics, Pune University Campus, Ganeshkhind,
Pune - 411 007

Prof. P. C. Agrawal — **Member**
405, Vigyan, Scientists CHS,
Plot no.- 23, Sector – 17, Vashi
Navi Mumbai – 400 703

Prof. S. Hasan — **Member**
Director, Indian Institute of Astrophysics,
Sarjapur Road, Bangalore - 560 034

Prof. S. K. Ghosh — **Member**
Director, National Centre for Radio Astrophysics,
Pune University Campus, Ganeshkhind, Pune - 411 007

Prof. D. Bhattacharya — **Member**
Inter University Centre for Astronomy and Astrophysics,
Pune University Campus, Ganeshkhind,
Pune - 411 007

Prof. Ram Sagar **Member**
Director, ARIES, Manora Peak, Nainital – 263 129

Mr. T. Bhattacharyya **Non – Member Secretary**
Registrar, ARIES, Manora Peak, Nainital - 263 129

FINANCE COMMITTEE

Prof. Ram Sagar — **Chairperson**
Director, ARIES, Manora Peak, Nainital - 263 129

Ms. A. Mitra — **Member**
Additional Secretary and Financial Advisor,
Ministry of Science and Technology, Department of Science
and Technology, Govt. of India, New Delhi - 110 016

Prof. P. C. Agrawal — **Member**
405, Vigyan, Scientists CHS,
Plot no.- 23, Sector – 17, Vashi
Navi Mumbai – 400 703

Dr. W. Uddin — **Member**
Scientist, ARIES, Manora Peak, Nainital - 263 129

Mr. T. Bhattacharyya — **Member Secretary**
Registrar, ARIES, Manora Peak, Nainital - 263 129

ABBREVIATIONS

ABLN&C	Atmospheric Boundary Layer Network and Characterization
ADFOSC	ARIES Devasthal Faint Object Spectrograph and Camera
AERONET	Aerosol Robotic Network
AGN	Active Galactic Nuclei
AIA	Atmospheric Imaging Assembly
AIMPOL	ARIES Imaging Polarimeter
AMOS	Advanced Mechanical and Optical Systems
AOD	Aerosols Optical Depth
AR	Active Region
ASAS	All Sky Automated Survey
ASTROSAT	Indian Satellite Mission for Multiwavelength Astronomy
AT – CTM	Atmospheric Trace Gases – Chemistry, Transport and Modeling
ATSOA	ARIES Training school in Observational Astronomy
BAL	Broad Absorption Line
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
BVR	Blue-Violet-Red
BVRC	Blue Violet Red Continuum
CCD	Charged Coupled Device
CME	Coronal Mass Ejection
CTTS	Classical T Tauri Stars
DOT	Devasthal Optical Telescope
DRF	Direct Radiative Forcing
DST	Department of Science and Technology
EARLINET	European Aerosol Research Lidar Network
ECIL	Electronics Corporation of India Limited
EIWG	Earth - Ionosphere Wavelngth
ELF	Extremely Low Frequency
EM	Emission Measure
EMCCD	Electron Multiplying Charge Coupled Device
EW	Equivalent Length
FWHM	Full Width at Half Maximum
GALEX	Galaxy Evolution Explorer
GATE	Graduate Aptitude test in Engineering
GMRT	Giant Meterwave Radio telescope
GOES	Geostationary Operational Environmental Satellite
GRB	Gamma-Ray Burst
GVAX	Ganga Valley Aerosol Experiment
HVS	High Volume Sampler

HYMORS	HYbride MOrphology Radio Sources
IDV	Intra-Day Variability
IGO	IUCAA Girawali Observatory
ILMT	International Liquid Mirror Telescope
IMF	Interplanetary Magnetic Field
INOV	Intranight Optical Variability
IRAC	Infrared Array Camera
IRAS	Infrared Astronomical Satellite
ISRO-GBP	Indian Space Research Organization – Geosphere Biosphere Programme
JEST	Joint Entrance Screening Test
KRC	Knowledge Resource Centre
LAMP	Lidar for Atmospheric Measurements and Probing
LBLs	Low Energy Peaked Blazers
LIDAR	Light Detection and Ranging
LZOS	Lytkarino Optical Glass Factory
MAXI	Monitor of All-sky X-ray Image
MCs	Magnetic Clouds
MDI	Michelson Doppler Imager
MERLIN	Multi-Element Radio Linked Interferometer Network
MHD	Magnetohydrodynamic
MHOs	Molecular Hydrogen emission-line Objects
MIR	Mid Infra Red
NKN	National Knowledge Network
MLS	Microwave Limb Sounder
Mpc	Megaparsec
MPLNET	Micro Pulsed Lidar Network
MSX	Midcourse Space Experiment
MWR	Multi-Wavelength solar Radiometer
NARL	National Atmospheric Research Laboratory
NASA	National Aeronautics and Space Administration
NET	National Eligibility Test
NGC	New General Catalog
NIR	Near Infra Red
NKRC	National Knowledge Resource Consortium
NLST	National Large Solar Telescope
NOAA	National Observatory of Astronomy and Astrophysics
NPCH	North Polar Coronal Hole
NVSS	NRAO VLA Sky Survey
OPAC	Online Public Access Catalogue
PAHAL	People's Association of Hill Area Launchers
PFL	Post-Flare Loop
PIL	Polarity Inversion Line
PIT	Project Implementation Team
PMB	Project Management Board
PWG	Project Working Groups

QPOs	Quasi Periodic Oscillations
QSO	Quasi-Stellar Object
RAWEX	Regional Aerosol Warming Experiment
REALM	Regional East Atmospheric Lidar Mesonet
RHESSI	Ramaty High Energy Solar Spectroscopic Imager
RMS	Root-mean-Square
RQQSOs	Radio-Quiet Quasi-Stellar Objects
SAP	Solar Active Prominence
SDO	Solar Dynamics Observatory
SED	Spectral Energy Distribution
SMM	Solar Maximum Mission
SN	Supernovae
SNe	Supernovae Explosion
SOHO	Solar and Heliospheric Observatory
ST	Sampurnanand Telescope
STA	Semiconductor Technology Associates
STEREO	Solar TErrestrial RElations Observatory
ST Radar	Stratosphere Troposphere Radar
STV	Short-Term Variability
SXI	Soft X-Ray Imager
TRACE	Transition Region and Coronal Explorer
UBVRI	Ultraviolet-Blue-Visual-Red-Infrared
UCOST	Uttarakhand State Council for Science and Technology
UFK	Ultra-Fast Kelvin
UPS	Uninterruptible Power Supply
UT	Universal Time
VDSL	Very-high-bit-rate Digital Subscriber Line
VLA	Very Large Array
VLF	Very Low Frequency
WFE	Wavefront Error
XBP	X-ray Bright Points
XRT	X-Ray Telescope
YSO	Young Stellar Object

DIRECTOR'S FOREWORD

Director

The main goal of the institute is to make important contributions in some front-line areas of astronomy & astrophysics and atmospheric sciences. The Academic Report for the year 2011-2012 presents the ongoing activities pertaining to knowledge creation as well as developments of the Institute. The major academic and developmental activities carried out during 2011-2012 are summarized below:

- The 130 cm telescope is in full operation for making observations. A number of front-line observing programmes have been taken up by scientists from ARIES as well as from other institutions.

- The activities related to the 3.6 meter Devasthal optical telescope (DOT) has been in full swing. The telescope was fully integrated with the real optics and the factory acceptance tests were done at AMOS workshop in Belgium. Preliminary results from the sky tests done in March 2012 indicate that the telescope optics is capable of producing stellar image as good as 0.3 arcsec FWHM. Although the wavefront error of 223 nm RMS (2314 nm PV) had already been achieved in March 2011, the required specification (40 nm RMS) was achieved in June 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 and transportation of the plant to the actual site at Devasthal has been done by HHV, Bangalore.

- The ARIES Devasthal Faint Object Spectrograph and Camera (ADFOSC) has been planned to 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 optical and mechanical design of the ADFOSC has been completed and tenders for procuring the optical components and its manufacturing were floated.

- The mechanical alignment of the Baker-Nunn Schmidt Telescope with the North pole has been done. The optical alignment of the telescope is in full progress.

- The project management committee has evaluated the antenna and TR modules for the upcoming 206.5 MHz 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.

- The construction of a guest house at

Devasthal was completed. It was inaugurated by Prof. G. Srinivasan of Bangalore on 09, May 2011.

- Academic staff members vigorously pursued the research work in their respective fields. They published 88 (including 13 in press) research papers in peer reviewed journals of National and International repute. Another six papers were published as circulars and conference proceedings. Six Ph. D. theses have been awarded and another two have been submitted. Academic and technical interactions with various institutions and universities were continued actively.

- The Institute has a vibrant graduate studies programme with more than 25 research students. The institute continued to host a variety of programme 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 students programme.

- Several public outreach activities took place during the year including a summer program for school students and workshops on Planetary Science, Observing techniques and data analysis etc.

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

A number of young and meritorious scientists and engineers joined ARIES. Faculty members are actively collaborating with scientists and engineers of other institutes in India and abroad. The details of scientific, developmental and other activities of the institute are given in the next chapters. The continued developments in infrastructure and academic activities indicate a very bright future and prospect of the institute.

ARIES, Nainital — RAM SAGAR
Director

THE INSTITUTE

ARIES (Aryabhatta Research Institute of observational sciencES), came into existence in the year 2004 (formerly 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 a 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 to its unique position (79°.5 East), almost in the middle of 180° wide longitude band between Canary Island (20° West) and Eastern Australia (157° 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 26 core academic faculty members, 16 engineering staff, 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, radio galaxies, quasars absorption and emission line studies and inherently transient events like supernovae and highly energetic gamma-ray bursts. Moreover, to strengthen the scientific contributions, the Institute has extended its horizon to theoretical and numerical studies in Relativistic Astrophysics. Research focus in Atmospheric Science division is mainly in the lower part of the atmosphere which 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 programme 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 16 engineers, 50 technical & 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 last years. The telescope is equipped with a 512 x 512 electronically cooled CCD camera and standard astronomical filters. Setting up 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 undertaken by IIA, Bangalore.

The atmospheric 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 at 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 and engineering 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.

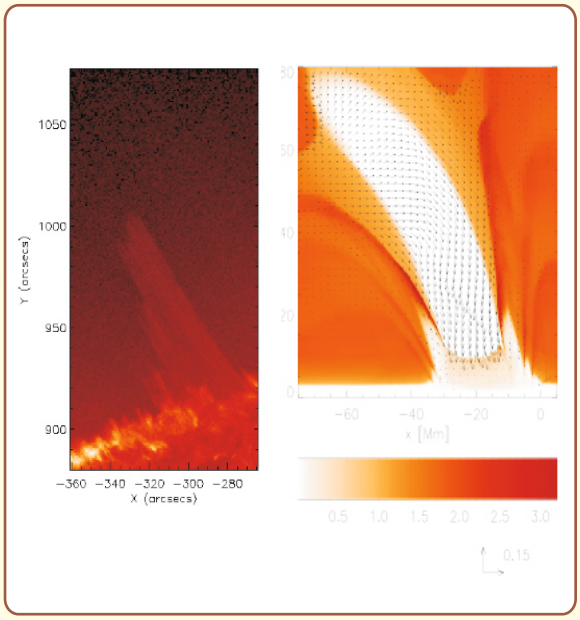
Ph. D./PDF Program: ARIES offers Ph. D. program in the field of Astronomy & Astrophysics and Atmospheric Sciences. The minimum qualification for a research scholar is M. Sc. degree in Physics/Astronomy/Astrophysics/Atmospheric Sciences and they should be JEST/NET/GATE qualified. The students can register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

1. SUN AND SOLAR ACTIVITY

Observations and Modelling of a MHD Pulse-driven Cool Polar Jet by Solar Dynamics Observatory/Atmospheric Imaging Assembly (AIA):

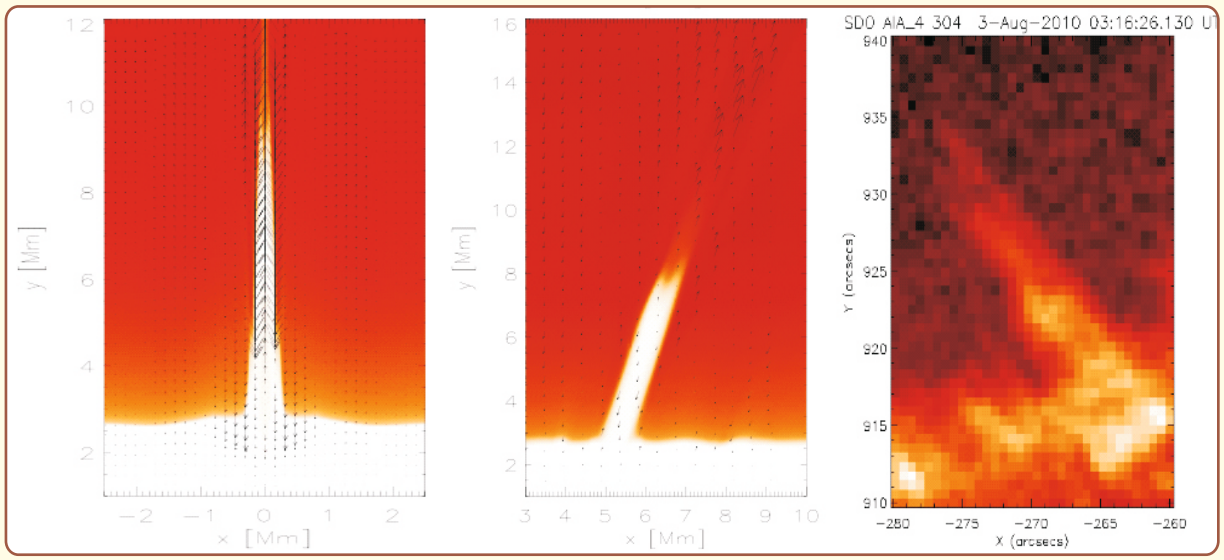
Observations of a solar jet at north polar coronal hole (NPCH) in SDO AIA 304 Å channel on 3 August 2010 have been analyzed. The jet rises obliquely above the solar limb and then retraces its propagation path to fall back. Numerical modelling of this solar jet by implementing a realistic (VAL-C) model of solar temperature as an initial atmospheric condition, has been performed. For solving two-dimensional ideal magnetohydrodynamic equations numerically to simulate the solar jet, a localized velocity pulse that is essentially parallel to the background magnetic field lines and initially launched at the top of the solar photosphere, has been implemented in the numerical domain. The pulse steepens into a shock at higher altitudes, which triggers plasma perturbations that exhibit the observed features of the jet. The numerical simulations reveal that a large amplitude initial velocity pulse launched at the top of the solar photosphere in general produces the observed properties of the jet, e.g., upward and backward average velocities, height, width, life-time, and its ballistic nature. The close match between the jet observations and numerical simulations provides a first strong evidence that this jet is formed by a single velocity pulse. The strong velocity pulse is most likely generated by the low-atmospheric reconnection in the polar region, which triggers the jet. The down-flowing material of the jet most likely is absorbed in the next upcoming velocity pulses from the lower solar atmosphere, and because of that only a single jet is evident moving upward in the solar atmosphere. [**Srivastava, A. K.** and Murawski, K.].



The left panel shows the observed polar jet on 03 August 2010, while the right panel describes the simulated jet. The background is the temperature map in MK units and the velocity arrows are drawn in units of 150 km/s (Credit : **Srivastava** & Murawski, 2010, A&A, 534, A62).

Observations and Numerical Simulation of the Solar Macrospicules:

A stringent 2-D numerical simulation has been carried out to study the giant spicules known as solar macrospicules, which are important candidates to locally supply the mass and energy in the lower solar atmosphere. A localized magneto pulse in the component of velocity parallel to the ambient magnetic field lines is initially launched in the solar chromosphere as a driver of the spicules in a VAL-C model of solar temperature. With the use of the code FLASH, the two-dimensional ideal magnetohydrodynamic equations have been solved numerically to simulate the solar macrospicules. The numerical results reveal that the pulse located below the transition region triggers plasma perturbations, which

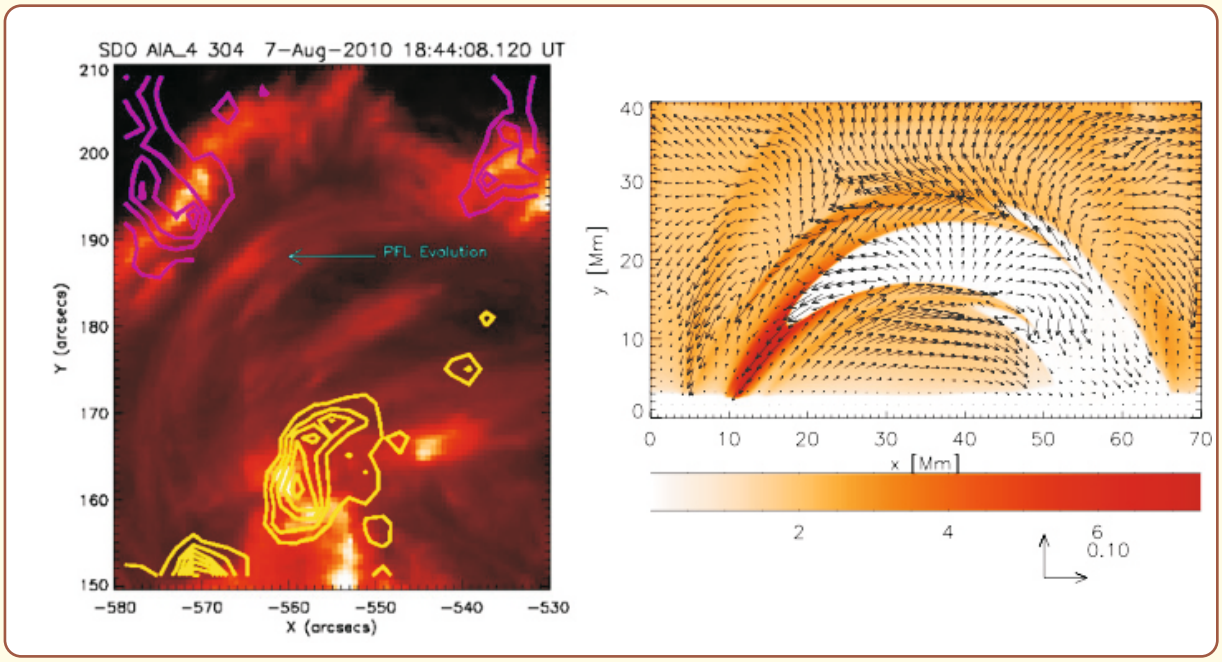


The left panel shows the simulated vertical solar macrospicule, middle panel shows the simulate oblique macrospicule, and the right panel shows the observed macrospicule. The background is the temperature map in MK units and the velocity arrows are drawn in units of 100 km/s in simulation snapshots (Credit : Murawski, Srivastava, and Zaqarashvili, A&A, 2011, 535, A58).

exhibit many features of observed macrospicules. The observed (SDO/AIA 304 Å) macrospicule approximately mimics simulation results. In the frame of the model devised, the solar macrospicules can be triggered by velocity pulses launched from the chromospheres. [Murawski, K., **Srivastava, A. K.** and Zaqarashvili, T.V.].

Observations and Modelling of Confined Plasma Dynamics in Post Flare Loops:

The motion of cool and hot plasma in a multi-stranded post-flare loop (PFL) system that evolved in the decay phase of a two-ribbon M1.0 class flare in AR 11093 on 2010 August 7, has been observed using the Solar Dynamics Observatory/Atmospheric Imaging Assembly 304 Å and 171 Å filters. The moving intensity feature and its reflected counterpart are observed in the loop system at multiple temperatures. The observed hot counterpart of the plasma probably envelopes the cool confined plasma and moves comparatively faster (~34 km s^{-1}) than the latter (29 km s^{-1}) in the form of a spreading intensity feature. The propagating confined plasma and intensity reflect from the region of another footpoint of the post flare loop. The subsonic speed of the moving plasma and associated intensity feature may be the most likely evolved in the PFL system through impulsive flare heating processes. Complementing the observations of moving multi-temperature intensity features in the PFL system and its reflection, a numerical model of two-dimensional ideal magnetohydrodynamic equations using the VAL-IIIC atmosphere as an initial condition has been performed to simulate the observed plasma dynamics. The consideration of a localized thermal pulse impulsively generated near one footpoint of the loop system during the flare processes, which is launched along the magnetic field lines at the solar chromosphere. The pulse steepens into a slow shock at higher altitudes while moving along this loop system, which triggers plasma perturbations that closely exhibit the observed confined plasma



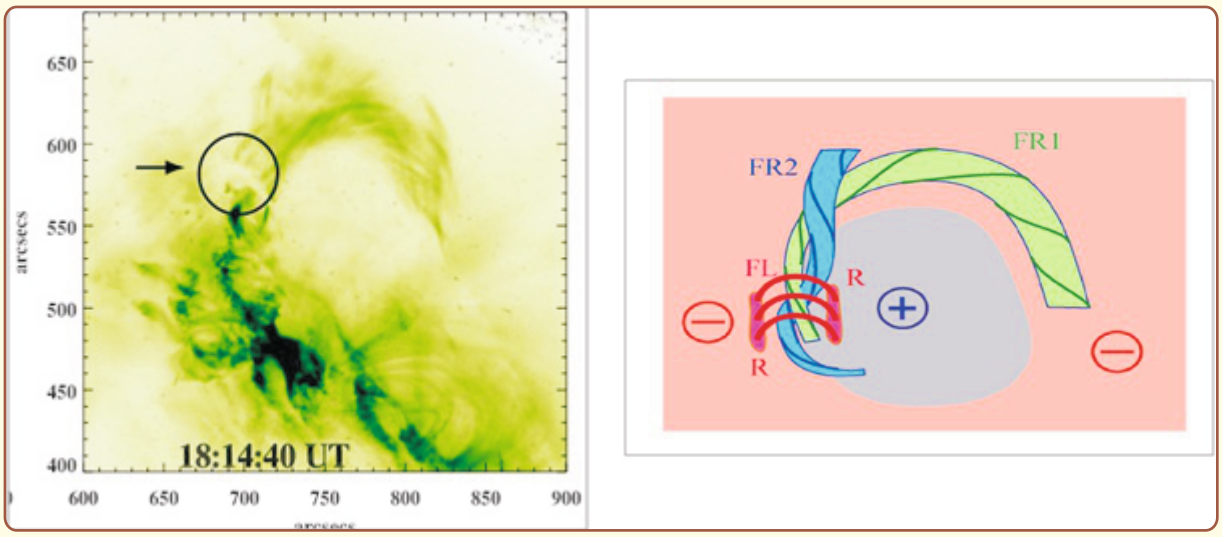
The left panel show the moving intensity features in the post flare loop as observed by SDO/AIA 304 Å filter, while the right most image describes the simulated loop with moving and reflected plasma and their interaction (Credit : Srivastava & Murawski, 2012, ApJ, 744, 173).

dynamics of the post flare loop systems. [**Srivastava, A. K.** and Murawski, K.].

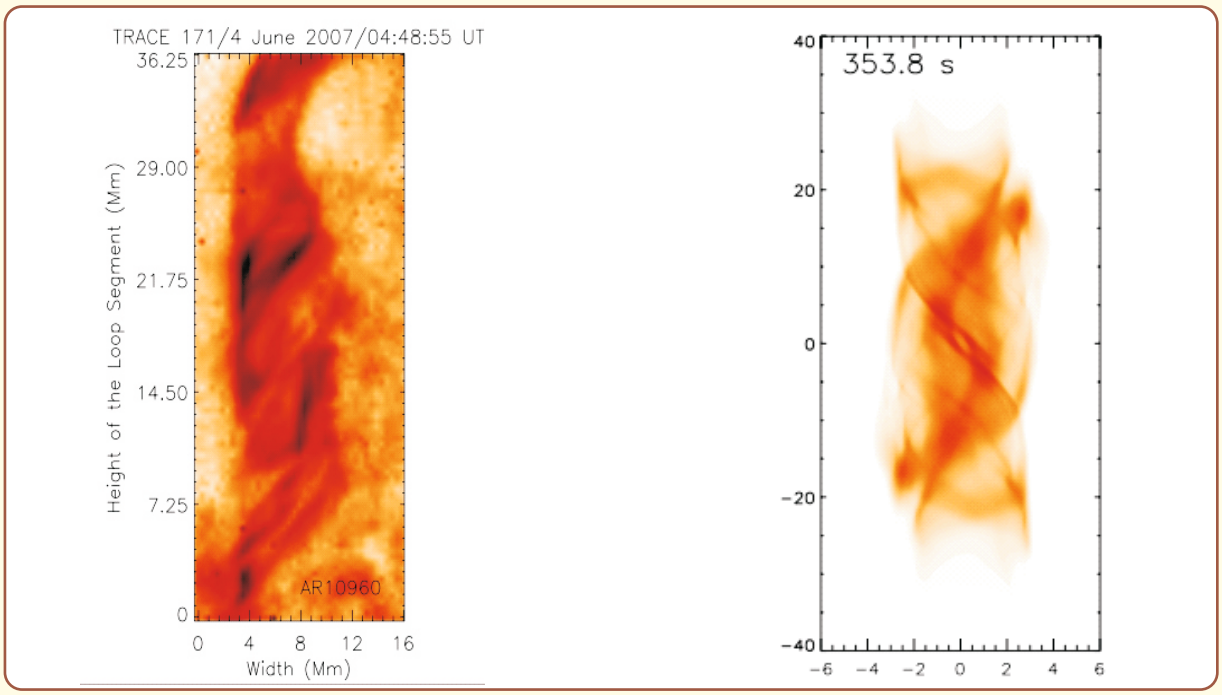
Observations of failed flux rope in the Eruption and Associated M-Class Flare from NOAA AR 11045:

The multiwavelength observations of a flux rope that was trying to erupt from NOAA AR 11045 and the associated M-class solar flare on 12 February 2010 using space-based and ground-based observations from TRACE, STEREO, SOHO/MDI, Hinode/XRT, and BBSO, have been carried out. While the flux rope was rising from the active region, an M1.1/2F class flare was triggered near one of its footpoints. Suggest have been made that the flare triggering was due to the reconnection of a rising flux rope with the surrounding low-lying magnetic loops. The flux rope reached a projected height of $\approx 0.15\ R_{sun}$ with a speed of ≈ 90 km s^{-1} while the soft X-ray flux enhanced gradually during its rise. The flux rope was suppressed by an overlying field, and the filled plasma moved towards the negative polarity field to the west of its activation site. The first observational evidence of the initial suppression of a flux rope due to a remnant filament visible both at chromospheric and coronal temperatures that evolved a couple of days earlier at the same location in the active region is the major finding of the present work. SOHO/MDI magnetograms show the emergence of a bipole ≈ 12 h prior to the flare initiation. The emerged negative polarity moved towards the flux rope activation site, and flare triggering near the photospheric polarity inversion line (PIL) took place. The motion of the negative polarity region towards the PIL helped in the build-up of magnetic energy at the flare and flux rope activation site. This study provides unique observational evidence of a rising flux rope that failed to erupt due to a

remnant filament and overlying magnetic field, as well as associated triggering of an M-class flare. [Kumar, P., **Srivastava, A. K.,** Filippov, B., Erdelyi, R. and **Uddin, W.**].



The left panel shows the rising of a twisted and kinked flux-rope, which is failed in the eruption due to overlying filament remnant as well as coronal magnetic field. The right panel displays the schematics of the observations. FL, R, FR1, FR2 respectively stand for flaring post flare loops, ribbons, the overlying remanant filament , and emerging twisted flux-rope (Credit, Kumar, P., **Srivastava, A.K.,** Filippov, Boris, Erdelyi, R., Uddi, Wahab, 2010, Solar Physics, 272, 301.).



The left panel shows the twisted and kink unstable flux-tube as observed by Transition Region and Coronal Explorer (TRACE). Using the initial conditions of the observed twisted loop, the simulation is performed (right-panel) in the full magnetohydrodynamic regime to study the evolution of kink instability in coronal loops (Credit : Botha, G.J.J., Arber, T.D., **Srivastava, A.K.,** 2012, ApJ, 745, 53).

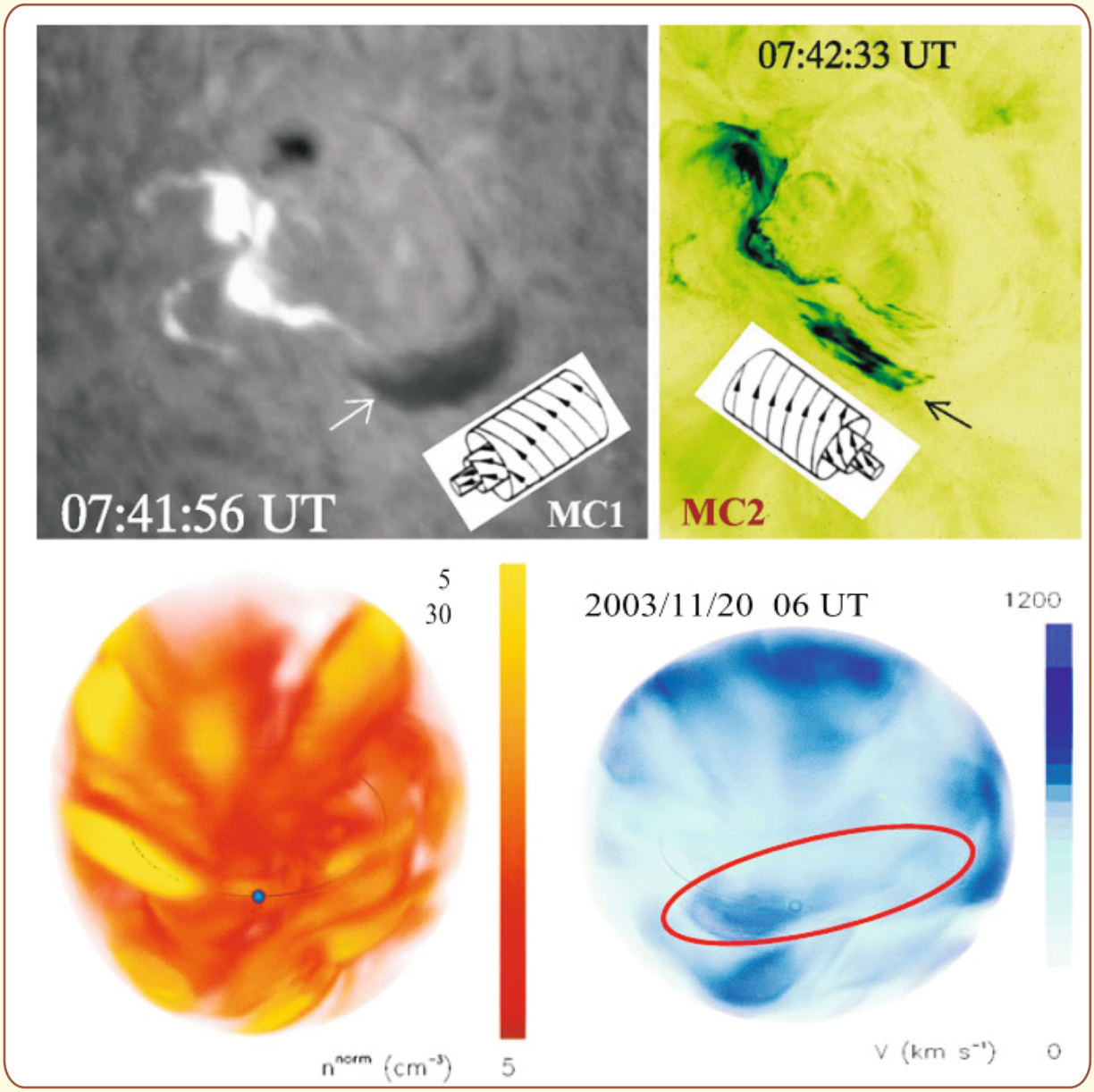
Signatures of the Coronal Kink Instability with Thermal Conduction in the Solar Corona:

It is known from the present numerical simulations that thermal conduction along magnetic field lines plays an important role in the evolution of the kink instability in coronal loops. This study presents the observational signatures of the kink instability in long coronal loops when parallel thermal conduction is included in the numerical modelling implemented. The three-dimensional nonlinear magnetohydrodynamic equations are solved numerically using LARE3D code to simulate the evolution of a coronal loop that is initially in an unstable equilibrium. The loop has length 80 Mm, width 8 Mm, and an initial maximum twist of $\Phi = 11.5\pi$, where Φ is a function of the radius. The initial loop parameters are obtained from a highly twisted loop observed in the Transition Region and Coronal Explorer (TRACE) 171 Å wave band. Synthetic observables are generated from the data. These observables include spatial and temporal averaging to account for the resolution and exposure times of TRACE images. Parallel thermal conduction reduces the maximum local temperature by an order of magnitude that means that different spectral lines are formed and different internal loop structures are visible with or without the inclusion of thermal conduction. The major result is that the inclusion of parallel thermal conductivity does not have as large an impact on observational signatures as the order of magnitude reduction in the maximum temperature would suggest, i.e., the net effect is a blurring of internal features of the observed loop structure. The more realistic numerical model of coronal kink instability will be useful for the future observations of coronal kink instability using various filters of SDO/AIA. [Botha, G. J. J., Arber, T. D. and **Srivastava, A. K.**].

Study on Solar and Interplanetary Origins of the Strongest Geomagnetic Storm of Solar Cycle 23:

Study of the solar sources of an intense geomagnetic storm of solar cycle 23 that occurred on 20 November 2003, based on ground- and space-based multiwavelength observations, has been performed. The coronal mass ejections (CMEs) responsible for this geomagnetic storm was originated from the super-active region NOAA 10501. Investigation of the Hα observations of the flare events was made with a 15 cm solar tower telescope at ARIES, Nainital, India. The propagation characteristics of the CMEs have been derived from the three-dimensional images of the solar wind (i.e., density and speed) obtained from the interplanetary scintillation data, supplemented with other ground- and space-based measurements. The TRACE, SXI and Hα observations revealed two successive ejections (of speeds $\approx$ 350 and $\approx$ 100 km s^{-1}), originating from the same filament channel, which were associated with two high speed CMEs ($\approx$ 1223 and $\approx$ 1660 km s^{-1}, respectively). These two ejections generated propagating fast shock waves (i.e., fast-drifting type II radio bursts) in the corona. The interaction of these CMEs along the Sun-Earth line has led to the severity of the storm. According to this investigation, the interplanetary medium consisted of two merging magnetic clouds (MCs) that preserved their identity during their propagation. These magnetic clouds made the interplanetary magnetic field (IMF) southward for a long time, which reconnected with the geomagnetic field,

resulting the super-storm (Dst $_{peak}$=-472 nT) on the Earth. [Kumar, P., Manoharan, P. K. and **Uddin, W.**].



The top panel shows the ARIES H-alpha (top-left), and TRACE (top-right) observations of the filament eruption that further leads the Earth directed CME and the strongest Geomagnetic storm of solar cycle 23. The bottom-left panel shows the density measurement at 1 A.U, while the bottom-right panel shows the velocity distribution of the CME at the same point. [Kumar, P., Manoharan, P. K., **Uddin, W.**].

Asymmetric Behavior of Different Solar Activity Features Over Solar Cycles 20-23:

The study of normalized north–south asymmetry, cumulative normalized north–south asymmetry and cumulative difference indices of sunspot areas, solar active prominences (at total, low (⩽40°) and high (⩾50°) latitudes) and H*a* solar flares from 1964 to 2008 spanning the solar cycles 20–23, have been carried out. Hemispherical distribution of activity features shows the dominance of activities in northern hemisphere for solar cycle 20 and in southern hemisphere for solar cycles 21–23 excluding solar active prominences at high latitudes. Cumulative difference index of solar activity features in each solar cycle is observed at the maximum of the respective solar cycle suggesting a cyclic behavior of approximately one solar cycle length. Asymmetric behavior of all activity features except solar active prominences at high latitudes hints at the long term periodic trend of eight solar cycles. North–south asymmetries of SAP (H) express the specific behavior of solar activity at high solar latitudes and its behavior in long-time scale is distinctly opposite to those of other activity features. [Bankoti, N., Joshi, N. C., Pandey, B., Pandey, S. and **Uddin, W.].**

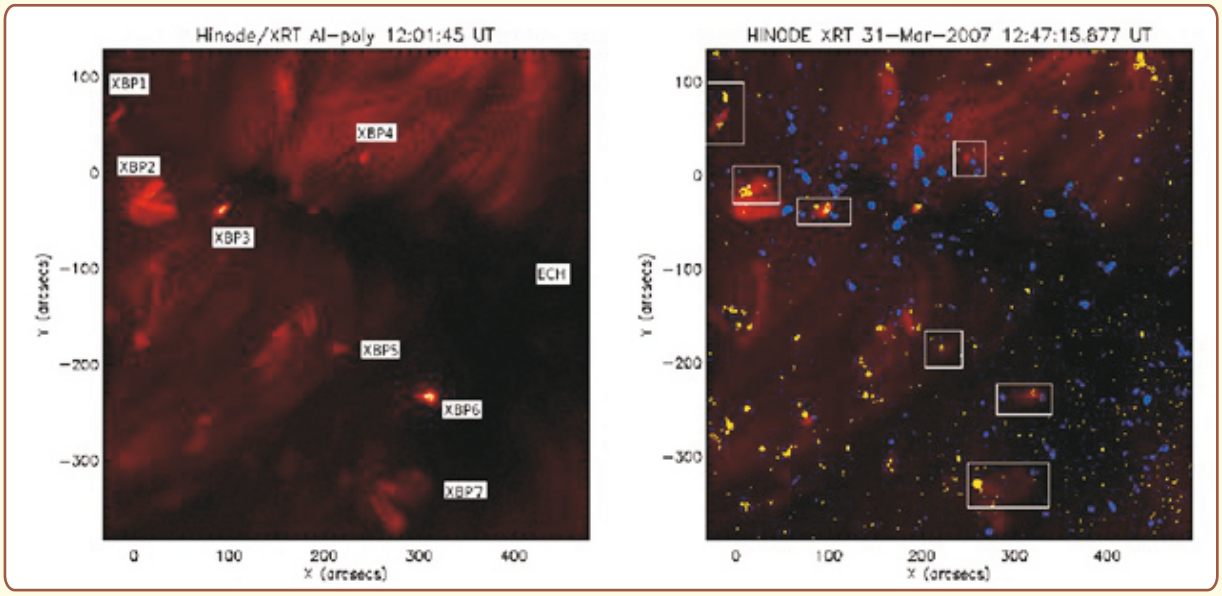
Highly significant, significant and insignificant values of yearly normalized N–S asymmetry and cumulative normalized N–S asymmetry (in parenthesis) indices of different solar activity features.

Solar activity features	Highly significant	Significant	Insignificant
SA	36 (42)	4 (1)	5 (2)
SAP	32 (45)	6 (0)	7 (0)
SAP (L)	34 (45)	4 (0)	7 (0)
SAP (H)	10 (45)	21 (0)	14 (0)
SF	38 (45)	3 (0)	4 (0)

Conclusion of the presented statistical study is summarized in the table. SA=Sunspot Area; SAP= Solar Active Prominence; SAP (H) Solar Active Prominence at High Latitude; SAP (L)= Solar Active Prominence at Low Latitude; SF= H-alpha Solar Flares. The significant North-South Asymmetry is evident during solar cycle 20-24.

MHD Oscillations in the X-ray Bright Points:

Analyse the temporal image data of the quiet Sun observed by the X-ray Telescope (XRT) onboard the Hinode spacecraft and Al-poly filter on 2007 March 31, has been carried out. These temporal image data of 30 s cadence have been selected from 11:34:48 UT to 14:19:35 UT to study intensity oscillations above seven selected X-ray bright points (XBPs) with an exposure time 8.193 s of each XRT image. Using the standard wavelet software, the power spectra of the reconstructed light curves, which are generated by filtering the original X-ray time-series at the Fourier scale (54.55 min) outside the COI period (60.18 min) free from the edge effect and inappropriate long-term periodicities, have been derived. Statistically significant observed periodicities (two or three) for XBP1, XBP2, XBP4, XBP5, XBP6 and XBP7, respectively, to be (28, 15) min, (50, 20) min, (60, 20, 12) min, (51, 23) min, (35, 23, 13) min, (49, 20) min and (35, 19) min. These observed periodicities have been interpreted in terms of the leakage of various harmonics of magnetoacoustic waves into the higher corona. Some BPs (XBP1, XBP3, XBP5 and XBP7) show the shift in the period ratio either as $(P_1/P_2) < 2.0$ or as $(P_1/P_3) < 3.0$. This period ratio shift provides the first most likely observational signature of the density stratification in these XBPs. Other BPs (XBP2, XBP4 and XBP6) show the shift in the period ratio $(P_1/P_2) > 2.0$, which may serve as evidence for magnetic field divergence with a significant effect on the various harmonics of magnetoacoustic waves. [Kumar, M., **Srivastava, A. K.** and Dwivedi, B.N.].



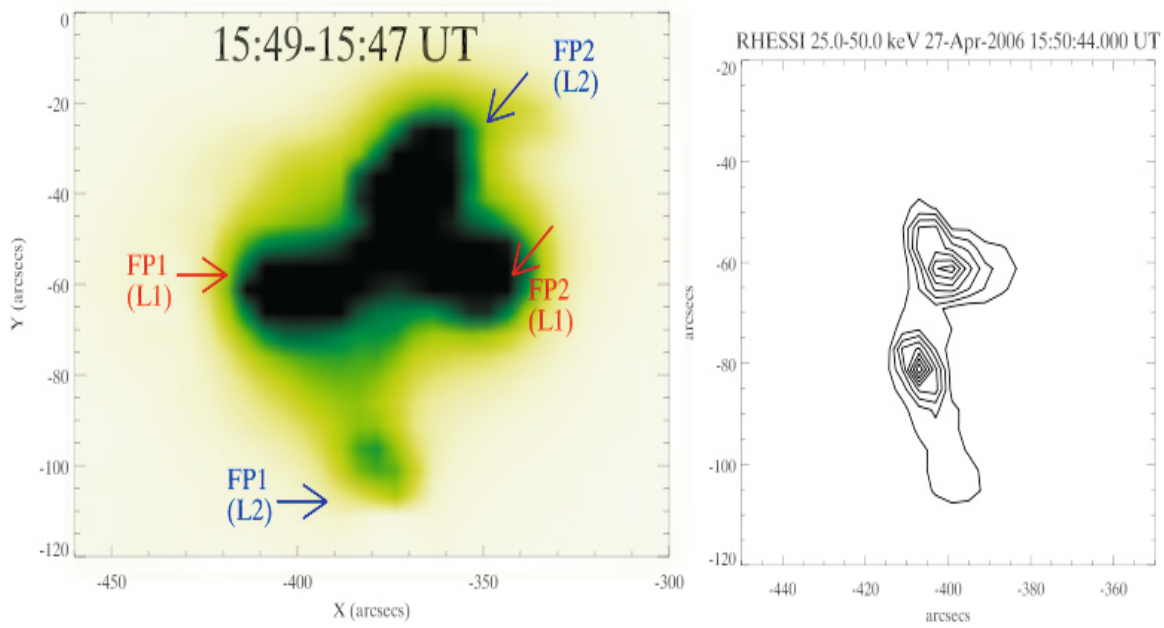
The top-left panel shows the seven X-ray bright points in the solar atmosphere, while the right panel shows their magnetic field distribution. It is clear from right panel (yellow=+ve, blue=-ve magnetic polarities) that the selected XBPs are made by small-scale loops, which may serve as MHD resonators. The bottom table shows the statistics of the observed periodicities, and their physical consequences.

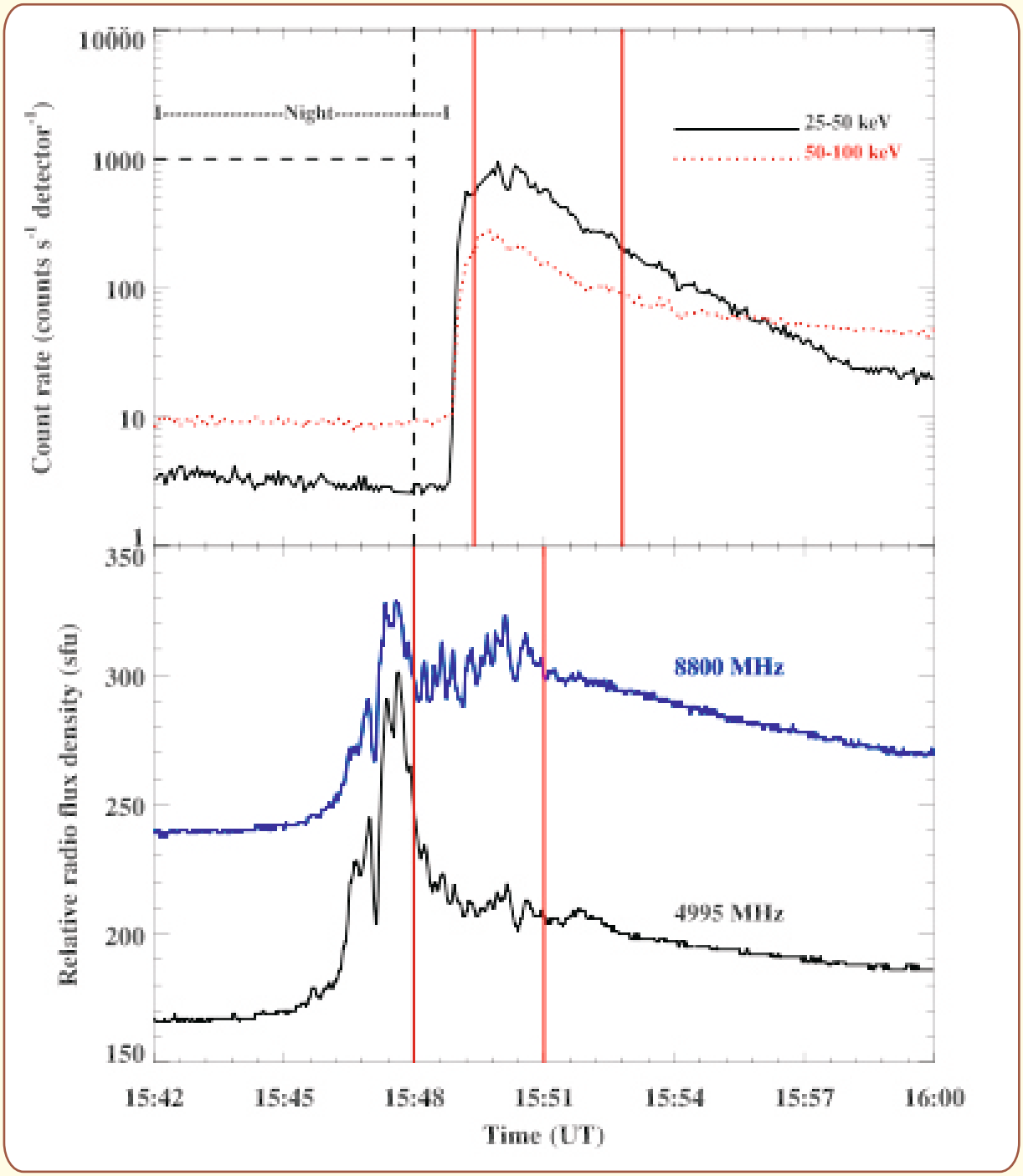
Table 1. Periodicities detected in XBPs from periodograms close to corresponding wavelets and their consequences.

Coronal structures	Pixel location (x, y)	First period (min)	Second period (min)	Third period (min)	Probability (per cent)	P_1/P_2	P_1/P_3	Seismological information from the wave period ratio
XBP1	(16, 444)	~28	~15	–	>99	1.86	–	Density stratification
XBP2	(51, 364)	~50	~20	–	>99	2.50	–	Magnetic field divergence
XBP3	(127, 346)	~60	~20	~12	>99	–	3.00	No density stratification, higher order periodicities
XBP4	(274, 399)	~51	~24	–	>99	2.12	–	Magnetic field divergence
XBP5	(248, 198)	~35	~23	~13	>99	1.52	2.69	Density stratification
XBP6	(343, 147)	~49	~20	–	>99	2.45	–	Magnetic field divergence
XBP7	(312, 51)	~35	~19	–	>99	1.84	–	Density stratification

Observations of Quasi-periodic Oscillations due to Loop-Loop Interaction in the Solar Corona:

Solar transients and eruptive phenomena which are ubiquitous in the solar atmosphere, can shed new light to the understanding of the outstanding problems like coronal heating and the solar wind acceleration. Observations in the entire electromagnetic spectrum of such dynamical processes of large and small-scale transient/eruptive events, with highly dynamic magnetic field configuration, and energetic particles, provide crucial information about the plasma processes at mega-Kelvin temperature embedded in a complex magnetic field, and also energy build-up/energy-release processes, taking place in such events. One of the most important phenomenological aspects of solar eruptive phenomena is the induced magnetohydrodynamic (MHD) waves generated during these energetic processes, which carry a potential signature to probing the solar active regions. One of such phenomenological observational clue has been obtained in terms of the evolution of quasi-periodic oscillations in the radio as well as Hard X-ray light curves during the M7.9 class solar flare in AR10875 on 27 April 2006. The QPOs evolved due to the loop-loop interaction and the generation of coalescence instability in the flaring region, which is observed firstly during the flare process. [**Srivastava, A. K.**, Nakariakov, V. M., Kumar, P. and Dwivedi, B. N.].



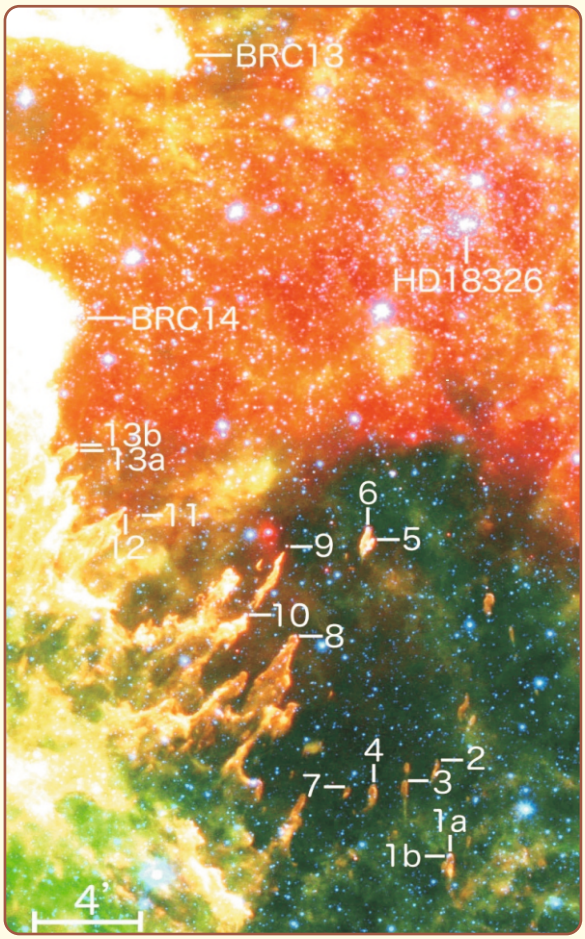


The loop-loop interaction as visible in GOES/SXI, and reconstructed RHESSI Hard X-ray images (top-panel). The evolved QPOs are clearly evident for ~3 min duration in the decay phase of flare in radio as well as HXR light curves (bottom panel) (Credit : Srivastava, A.K., Nakariakov, V.M., Kumar, Pankaj, Dwivedi, B.N., AsInC, 2, 271).

a. Star Formation

Stars at the Tip of Peculiar Elephant Trunk-Like Clouds in IC 1848E:A Possible Third Mechanism of Triggered Star Formation:

The HII region IC 1848 contains several thin and long elephant trunk-like structures in the southeastern part of IC 1848E. Some of them have an apparently associated star or two stars at their very tip. Their positions on the V /(V − Ic) color-magnitude diagram as well as



Contrast-enhanced Spitzer pseudo-color image of part of IC 1848E taken from the NASA Spitzer Space Telescope website. Stars at the tip of elephant trunk-like structures are marked together with two bright-rimmed clouds and the exciting star of IC 1848E. The scale is shown. North is up, east to the left.

the physical parameters obtained by SED fittings indicate that they are low-mass pre-main sequence stars of ages of mostly one Myr or less. This strongly suggests that they formed from the elongated, elephant trunk-like clouds. We presume that such elephant trunk- like structures are genetically different from BRCs, on the basis of the differences in morphology, size distributions, and the ages of the associated young stars. We suspect that those clouds have been caused by hydro-dynamical instability of the ionization/shock front of the expanding HII region. Similar structures often show up in recent numerical simulations of the evolution of HII regions. We further hypothesize that this mechanism makes a third mode of triggered star formation associated with HII regions, in addition to the two known mechanisms, i.e., collect-and-collapse of the shell accumulated around an expanding HII region and radiation-driven implosion of BRCs originated from pre-existing cloud clumps. [**Chauhan, N.**, Ogura, K., **Pandey, A. K., Samal, M. R.** and Bhatt, B. C.].

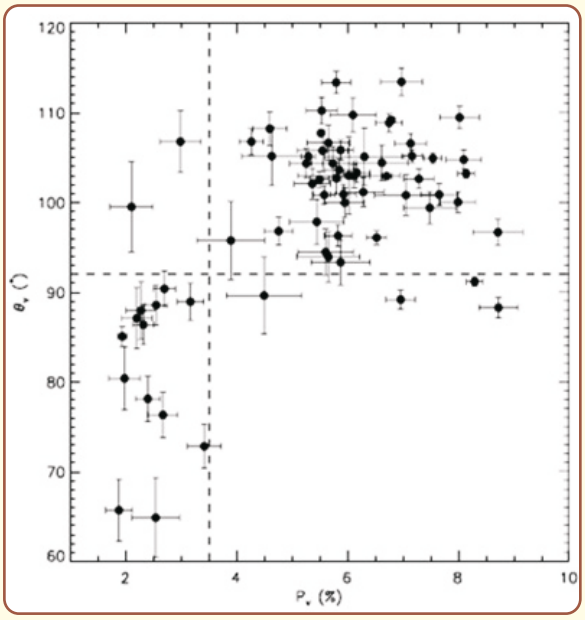
Stellar Content and Star formation in the young cluster stock 18:

An attempt has been made to understand the basic parameters and the implications of star formation processes in the cluster Stock 18 from multiwavelength study. Deep optical UBVRI data along with archival data from the surveys such as 2MASS, MSX, IRAS, AKARI and 12CO are used to understand the global scenario of star formation in and around the cluster region. Reddening, E(B-V), in the direction of cluster is found to be normal but varying between 0.7 and 0.9 mag. The post-main-sequence age and distance to the cluster are found to be 6 ± 2 Myr and 2.8 ± 0.2 kpc, respectively. The slope of the MF is found to be 1.37 ± 0.27 for the mass range 1.0 <

M/M⊙<11.9. The effect of mass segregation is not seen in the MS stars. A population of PMS YSOs in the cluster region having masses 0.8–2 M⊙ have been found within the cluster. The position of the YSOs on the CMDs indicates that these stars have age between 1 and 2 Myr. However, this age spread is affected with observational errors and limitations of theoretical models. Further, the present data sets are not enough to explain the ongoing star formation. [**Bhatt, H., Sagar, R.** and **Pandey, J. C.**].

Broad-band optical polarimetric studies towards the Galactic young star cluster Berkeley 59:

Multiwavelength optical linear polarimetric observations of 69 stars towards the young open cluster Berkeley 59 were carried out. The observations reveal the presence of three dust layers located at distances of ~300, ~500 and ~700 pc. The dust layers produce a total polarization PV ~5.5 per cent. The mean values of polarization and polarization angles due to the dust layers are found to increase systematically with distance. We show that polarimetry in combination with the (U-B)-(B-V) colour-colour diagram yields a better identification of cluster members. The polarization measurements suggest that the polarization due the intracluster medium is ~2.2 per cent. An anomalous reddening law exists for the cluster region, indicating a relatively larger grain size than that in the diffuse interstellar medium. The spatial variation of polarization and colour excess E(B-V) are found to increase with radial distance from the cluster centre, whereas θV and λmax are found to decrease with increasing radial distance from the cluster centre. About 40 per cent of cluster members show the signatures of either intrinsic polarization or rotation in their polarization angles. There is an indication that the starlight of the cluster members might have been depolarized because of non-uniform alignment of dust grains in the foreground dust layers and in the intracluster medium. [**Eswaraiah, C., Pandey, A. K., Maheswar, G.,** Chen, W. P., Ojha, D. K. and Chandola, H. C.].



Polarization angle versus polarization in the V band for 69 stars towards Be 59. The dashed lines are drawn to show the two clearly separated groupings among the observed sample.

Star Formation Activity in the Galactic H II Complex S255-S257:

We studied the star formation activity of an optically obscured region containing an embedded cluster (S255-IR) and molecular gas between two evolved H II regions, S255 and S257. We have studied the complex using optical and near-infrared (NIR) imaging, optical spectroscopy, and radio continuum mapping at 15 GHz, along with Spitzer-IRAC results. We found that the main exciting sources of the evolved H II regions S255 and S257 and the compact H II regions associated with S255-IR are of O9.5-B3 V nature, consistent with previous observations. Our NIR observations reveal 109 likely young

stellar object (YSO) candidates in an area of ~4 arcm × 4 arcm centered on S255-IR, which include 69 new YSO candidates. To see the global star formation, we constructed the V - I/V diagram for 51 optically identified IRAC YSOs in an area of ~13' × 13' centered on S255-IR. We suggest that these YSOs have an approximate age between 0.1 and 4 Myr, indicating a non-coeval star formation. Using spectral energy distribution models, we constrained physical properties and evolutionary status of 31 and 16 YSO candidates outside and inside the gas ridge, respectively. The models suggest that the sources associated with the gas ridge are younger (mean age ~1.2 Myr) than the sources outside the gas ridge (mean age ~2.5 Myr). The positions of the young sources inside the gas ridge at the interface of the H II regions S255 and S257 favor a site of induced star formation. [Ojha, D. K., **Samal, M. R., Pandey, A. K.,** Bhatt, B. C., Ghosh, S. K., **Sharma, S.,** Tamura, M., Mohan, V. and Zinchenko, I.].

b. Variable Stars

Search and Study for the Variability in Chemically Peculiar Stars

A survey project, the ``Nainital-Cape Survey'' was initiated in 1997 between the Aryabhatta Research Institute of Observational Sciences (ARIES), Nainital, and the South African Astronomical Observatory, Capetown. The objective of the survey was to search for such chemically peculiar stars that are pulsationally unstable. Under this programme, the fast photometric observations of the samples were obtained in high-speed photometric mode using a three-channel fast photometer attached to the 1.04-m Sampurnanand telescope at ARIES. Till now a total of about 260 stars have been observed and out of these nine stars were turned up pulsating variables. In the context of stellar-seismology, we have briefly review the results of our survey project in a review article [**Joshi, S.** and Chakradhari, N. K.].

Search for the Photometric Variability in Open Star Clusters:

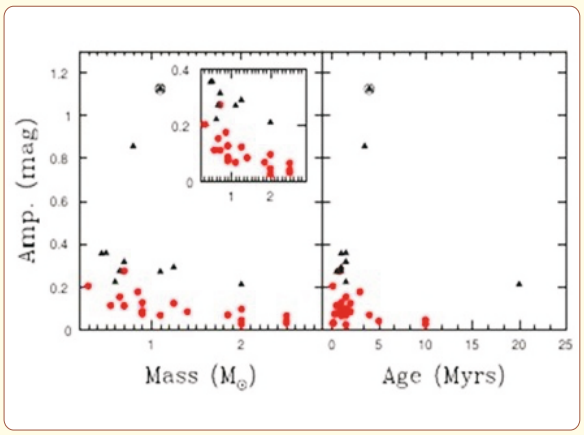
In order to investigate the occurrence of pulsation in A-type stars in different galactic environments, recently a survey program was initiated to search for the photometric variability in the young and intermediate age open star clusters. For this survey a sample of clusters having different age (young to intermediate of age range 10 to 100 Myrs), metallicity and galactocentric position where probability of finding A-type pulsators is high were selected. The preliminary results on the survey resulted 18 new variables in an open star cluster NGC6866. [**Joshi, Y. C., Joshi, S., Kumar, B**., Mondal, S. and Balona, L. A.].

c. Star clusters

Photometric search for variable stars in the young open cluster Berkeley 59:

The time series photometry of stars located in the extremely young open cluster Berkeley 59. Using the 1.04-m telescope at Aryabhatta Research Institute of Observational Sciences (ARIES), Nainital, we identified 42 variables in a field of ~13 × 13 arcmin^2 around the cluster were studied. The probable members of the cluster have been identified using a (V, V-I) colour-magnitude diagram and a (J-H, H-K) colour-colour diagram. 31 variables have been found to be pre-main-sequence stars associated with the cluster. The ages and masses of the pre-main-sequence stars have been derived from the colour-magnitude diagram by fitting theoretical models to the observed data points. The ages of the majority of the probable pre-main-sequence

variable candidates range from 1 to 5 Myr. The masses of these pre-main-sequence variable stars have been found to be in the range of ~0.3 to ~3.5 Msun, and these could be T Tauri stars. The present statistics reveal that about 90 per cent T Tauri stars have period <15 d. The classical T Tauri stars are found to have a larger amplitude than the weak-line T Tauri stars. There is an indication that the amplitude decreases with an increase in mass, which could be due to the dispersal of the discs of relatively massive stars. [**Lata, S., Pandey, A. K., Maheswar, G.,** Mondal, S. and **Kumar, B.**].

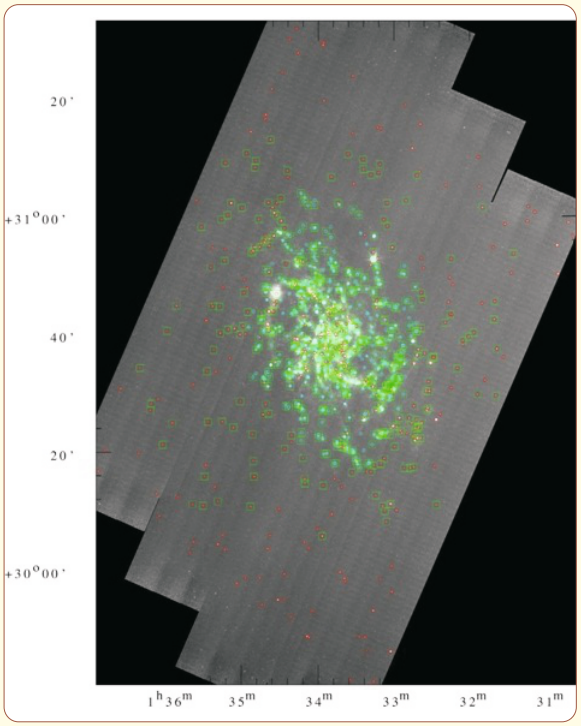


Amplitude as a function of mass and age of CTTSs and WTTSs. Inset in the left-hand panel shows a magnified view of amplitude variation.

The population of young stellar clusters throughout the disk of M 33:

915 MIR sources in M33 have been extracted from the Spitzer 24 μm image. Upon inspection of Hα and GALEX images and exclusion of evolved AGB stars, a sample of 648 objects is selected as candidate YSCs and their luminosity function is examined. The spectral energy distribution of each object, based on aperture photometry, is compared with Starburst99 models to derive age, mass and A_V of individual clusters. In the analysis we allow for different values of the upper mass cutoff of the stellar initial mass function (IMF), the porosity of the ISM, and the dustiness of HII regions. We also examine the influence of different dust models and include corrections for incompleteness of the IMF.

We find discrete MIR sources as far as the extent of the warped HI disk, i.e. 16 kpc from the galaxy center. Their surface density has a steep radial decline beyond 4.5 kpc, and flattens out beyond the optical radius at 8.5 kpc. We are able to identify YSCs out to 12 kpc. At large galactocentric radii, the paucity of luminous clusters and the relevance of hot dust emission become evident from the analysis of the bolometric and MIR luminosity functions. The YSC mass and size

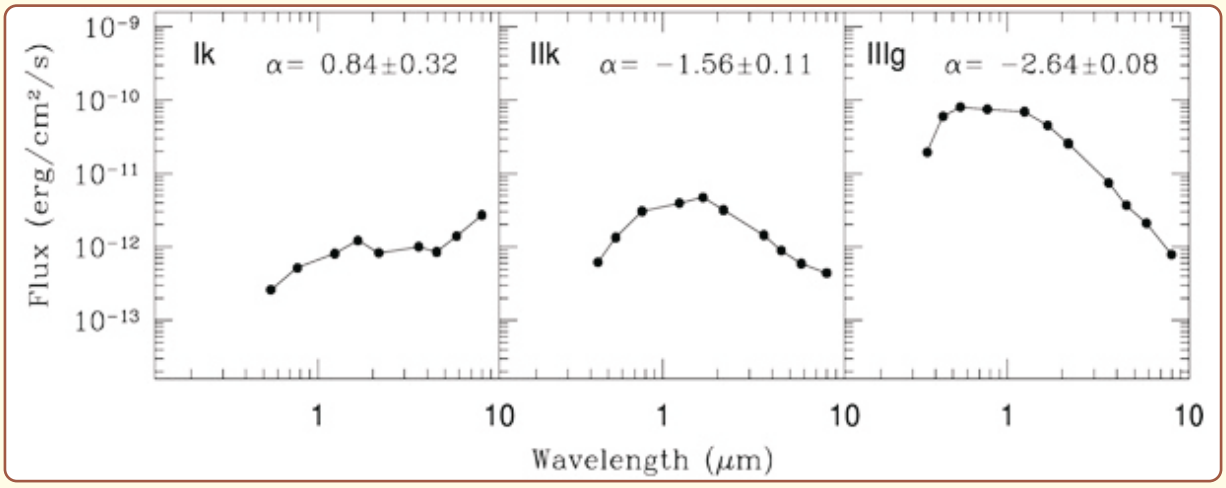


Spatial distributions of 915 Mid-IR sources (circles) and 648 young stellar clusters (squares) overlaid on the 24mm Spitzer image. The blue and red circles in the on-line version represent IR sources from the Verley et al. 2007, A&A...476.1161V catalog and from the present study respectively.

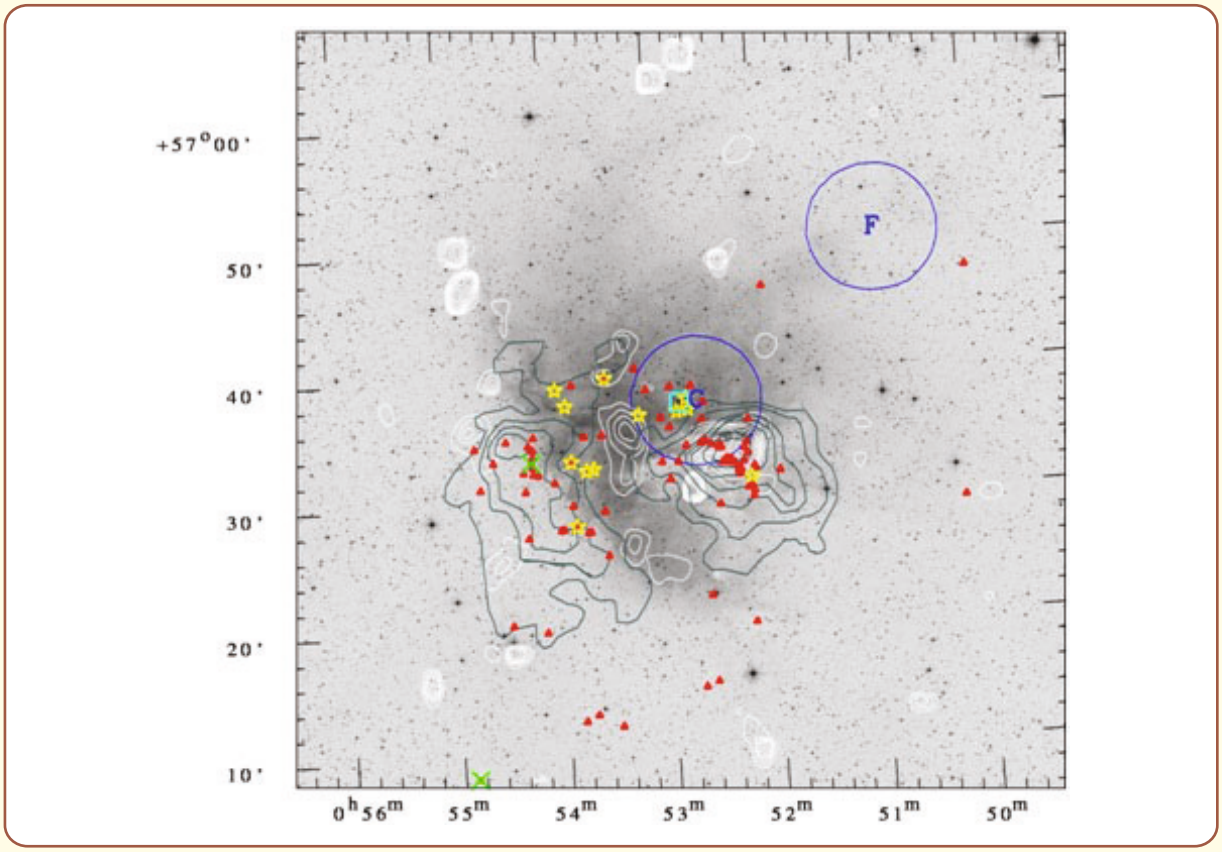
are correlated with a log-log slope of 2.09 ± 0.01, similar to that measured for giant molecular clouds in M 33 and the Milky Way, which represent the protocluster environment. Most of the YSCs in our sample have A_V ~ 0-1 mag and ages between 3 and 10 Myr. In the inner regions of M 33 the clusters span a wide range of mass ($10^2 < M < 3 \times 10^5$ M_{sun}) and luminosity ($10^{38} < L_{bol} < 3 \times 10^{41}$ erg s^{-1}), while at galactocentric radii larger than ~4 kpc we find a deficiency of massive clusters. Beyond 7 kpc, where the Hα surface brightness drops significantly, the dominant YSC population has $M < 10^3$ M_{sun} and a slightly older age (10 Myr). This implies the occurrence of star formation events about 10 Myr ago as far as 10-12 kpc from the center of M 33. The cluster L_{FUV} vs. $L_{Hα}$ relation is non-linear for $L_{FUV} < 10^{39}$ erg s^{-1}, in agreement with randomly sampled models of the IMF which, furthermore, shows no appreciable variation throughout the M 33 disk. **[Sharma, S.**, Corbelli, E., Giovanardi, C., Hunt, L. K. and Palla, F.].

Multiwavelength Study of NGC 281 Region:

We have done a multiwavelength study of the NGC 281 complex which contains the young cluster IC 1590 at the center, using deep wide-field optical UBVI_c photometry, slitless spectroscopy along with archival data sets in the near-infrared (NIR) and X-ray. The cluster region shows a relatively small amount of differential reddening. The majority of the identified young stellar objects (YSOs) are low mass PMS stars having age <1-2 Myr and mass 0.5-3.5 M_\odot. The slope (\Gamma) of the mass function for IC 1590, in the mass range 2 < M/M_\odot \le 54, is found to be -1.11+-0.15. The slope of the K-band luminosity function (0.37+-0.07) is similar to the average value (~0.4) reported for young clusters. The distribution of gas and dust obtained from the IRAS, CO and radio maps indicates clumpy structures around the central cluster. The radial distribution of the young stellar objects, their ages, \Delta(H-K) NIR-excess, and the fraction of classical T Tauri stars suggest triggered star formation at the periphery of the cluster region. However, deeper optical, NIR and MIR observations are needed to have a conclusive view of star formation scenario in the region. The properties of the Class 0/I and Class II sources detected by using the Spitzer mid-infrared observations indicate that a majority of the Class II sources are X-ray emitting stars, whereas X-ray



The sample SEDs obtained by using the optical, NIR and MIR observations. Stars Ik, IIk and IIIg represent Class 0/1, Class II and Class III sources, respectively, classified according to the MIR TCDs.

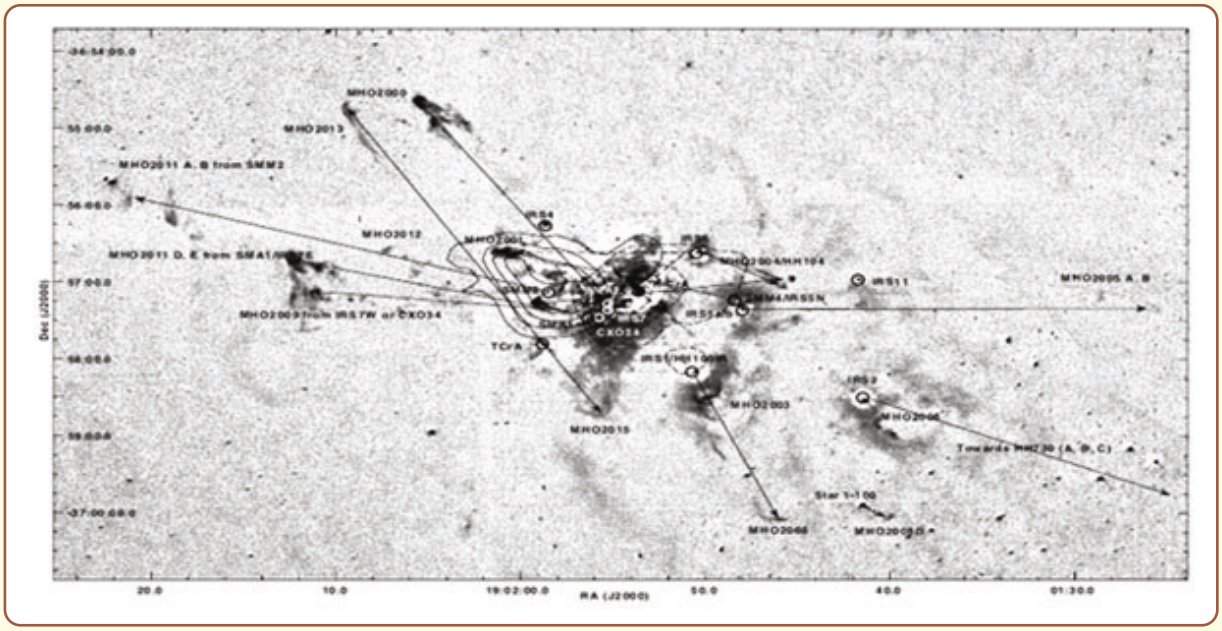


Spatial distributions of IR-excess sources (probable CTTSs, triangles), H\alpha stars (star symbols), IRAS point sources (cross), O-type star (open square), are overlaid on DSS-2 R band image. The cluster and field regions are represented by circles. The CO contours taken from Henning et al. (1994) are shown by black contours and NVSS (1.4~GHz) radio contours by white contours. The radio contours are 5, 10, 15, 20, 30, 40, 60, 80 % of the peak value 0.04 Jy/Beam.

emission is absent from the Class 0/I sources. The spatial distribution of Class 0/I and Class II sources reveals the presence of three sub-clusters in the NGC 281 West region. **[Sharma, S., Pandey, A. K., Pandey, J. C., Chauhan, N.**, Ogura, K., Ojha, D. K., Borrissova, J., Mito, H., Verdugo, T. and Bhatt, B. C.].

H_2 flows in the Corona Australis cloud and their driving sources:

A deep, near-infrared H_2v = 1-0 S(1), 2.122 μm-line, narrow-band imaging survey of the R CrA cloud core was carried out. The nature of all candidate-driving sources in the region was evaluated using data available from the literature and also by fitting the spectral energy distributions (SED) of each source either with an extincted photosphere or YSO model. Archival Spitzer-IRAC and MIPS data was used to obtain photometry, which was combined with USNO, 2MASS catalogs and millimeter photometry from the literature, to build the SEDs. We identify the best candidate-driving source for each outflow by comparing the flow properties, available proper motions, and the known/estimated properties of the driving sources. We also adopted the thumbrule of



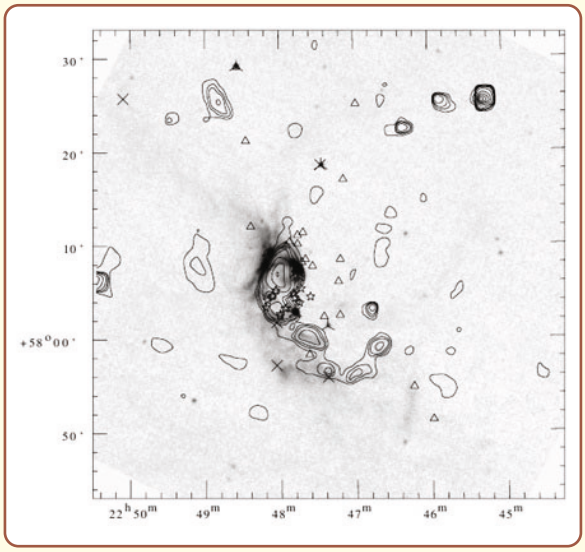
Continuum-subtracted H2 image of the Coronet subregion displayed using a logarithmic scaling. The circular symbols show all sources detected by the Spitzer IRAC images. The identifications are reproduced from Wilking et al. (1997) (IRS), Groppi et al. (2007) (SMA), and Nutter et al. (2005) (SMM). The arrows join the probable driving source with the corresponding MHO. When two arrows originate in the same source, it implies both outflow lobes are visible. The CO bipolar outflow mapped by Groppi et al. (2004) is shown by solid (blue lobe) and dotted (red lobe) contours For the sake of clarity, MHO 2000, which is situated close to SMM2, is not marked in this figure.

outflow power as proportional to source luminosity and inversely proportional to the source age to reach a consensus.

Continuum-subtracted, narrow-band images reveal several new Molecular Hydrogen emission-line Objects (MHOs). Together with previously known MHOs and Herbig-Haro objects we catalog at least 14 individual flow components of which 11 appear to be driven by the R CrA aggregate members. The flows originating in the Coronet cluster have lengths of ~0.1-0.2 pc. Eight out of nine submillimeter cores mapped in the Coronet cluster region display embedded stars driving an outflow component. Roughly 80% of the youngest objects in the Coronet are associated with outflows. The MHO flows to the west of the Coronet display lobes moving to the west and vice-versa, resulting in nondetections of the counter lobe in our deep imaging. We speculate that these counter flows may be experiencing a stunting effect in penetrating the dense central core. Conclusions: Although this work has reduced the ambiguities for many flows in the Coronet region, one of the brightest H_2 feature (MHO2014) and a few fainter features in the region remain unassociated with a clear driving source. The flows from Coronet, therefore, continue to be interesting targets for future studies. **[**Kumar, M. S. N., **Sharma, S.,** Davis, C. J., Borissova, J. and Grave, J. M. C.].

A Kinematic and Photometric Study of the Galactic Young Star Cluster NGC 7380:

We did the proper motions, radial velocities,

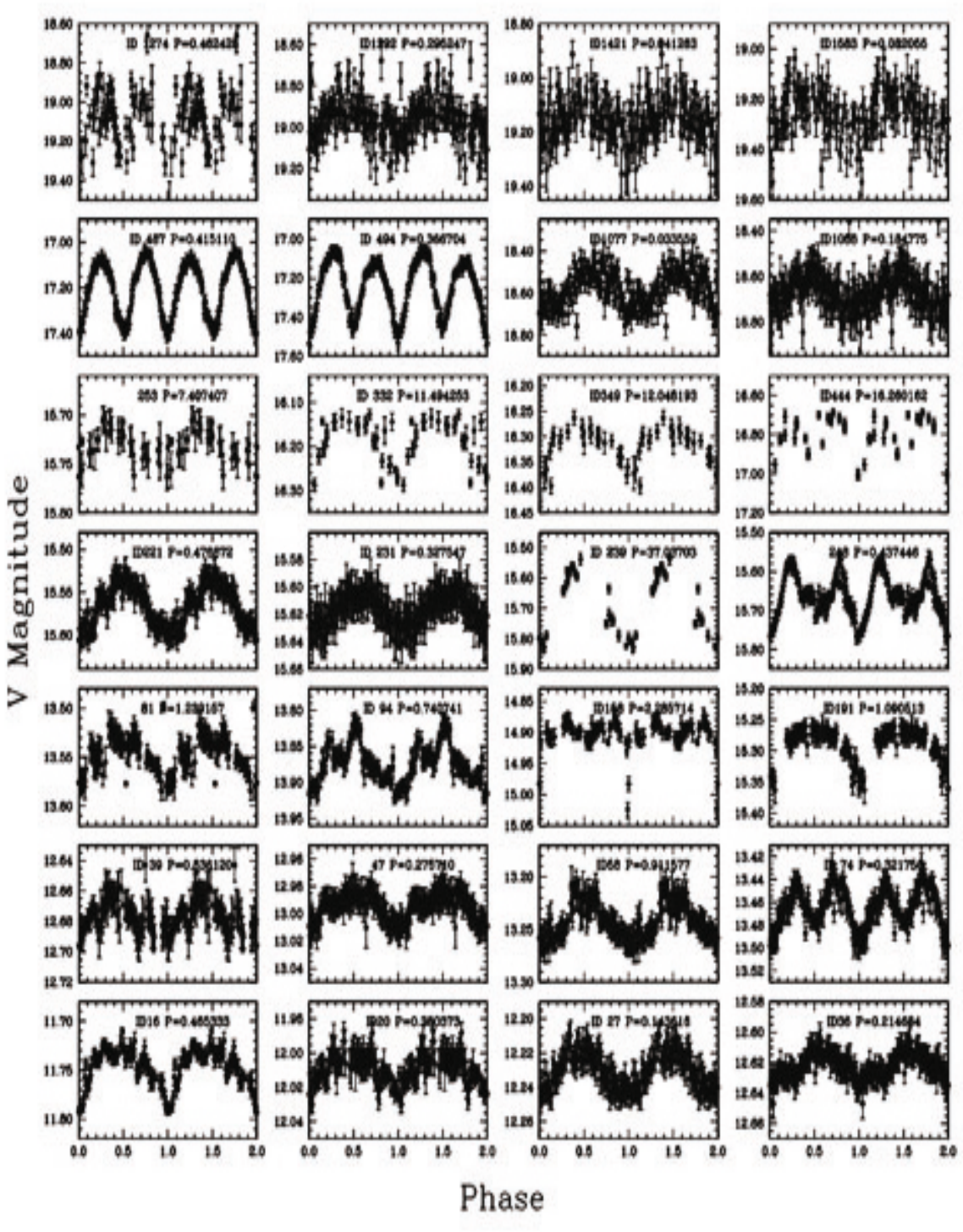


NVSS (1.4 GHz) radio emission, shown as contours at 1%, 2%, 3%, 5%, 10%, 20%, 30%, 40%, 50%, 60%, 70%, 80%, and 90% of the peak value of 0.1613 Jy Beam^{-1}, is superimposed on the MSX A-band emission, shown as gray scales. Known YSOs or candidates are marked: IR-excess sources (probable T-Tauri-type stars, open triangles), Hα stars (asterisks), IRAS point sources (crosses), MSX point sources (three-pointed stars), O-type stars (open squares), and X-ray stars (open circles).

and a photometric study of the Galactic open cluster NGC 7380, which is associated with prominent emission nebulosity and dark molecular clouds. On the basis of the sample of highly probable member stars, the star cluster is found to be at a distance of 2.6 ± 0.4 kpc, has an age of around 4 Myr, and a physical size of ~6 pc across with a tidal structure. The binary O-type star DH Cep is a member of the cluster in its late stage of clearing the surrounding material, and may have triggered the ongoing star formation in neighboring molecular clouds which harbor young stars that are coeval and comoving with, but not gravitationally bound by, the star cluster. [Chen, W. P., **Pandey, A. K.**, **Sharma, S.**, Chen, C. W., Chen, L., Sperauskas, J., Ogura, K., Chuang, R. J. and Boyle, R. P.].

Photometric study and detection of variable stars in the open clusters NGC 6866:

The study of Galactic open clusters is important for understanding the history of star formation and the nature of the parent star clusters. These systems are used to test stellar models and are vital for our understanding of stellar evolution. At Nainital, we have undertaken a long-term observational survey program to detect variable stars in some unstudied or poorly studied young and intermediate-age open star clusters. The purpose of this survey is to search and characterize the variable star content of these clusters and to determine their fundamental parameters. During 2008-2011, we observed one intermediate-age open cluster NGC 6866 on 29 nights from 1-m Sampurnanand Telescope. Our study revealed 28 periodic variables, of which 19 were newly identified. The periods of these variables, which have mean V magnitudes in the range of 11.5 to 19.3 mag, lie within ~ 48 minutes to 37 days. We detected several delta-Scuti stars, some of which are of high amplitude, as well as gamma-Doradus, rotational variables and eclipsing binaries. In order to study the physical properties of the cluster, we obtained UBVRI photometry of all the stars on a good photometric night. The radial distribution of the stellar surface density shows that the cluster has a radial extent of about 7 arcmin (~ 3 pc) with a peak density of 5.7+/-0.7 stars arcmin^{-2} at the cluster center. The colour-colour diagram indicates a reddening of E(B-V) = 0.10 mag towards NGC 6866. A distance of about 1.47 kpc and an age of about 630 Myr was estimated from the colour-magnitude diagram using the theoretical isochrones of solar metallicity. We also provided calibrated UBVRI photometry of 2473 stars down to V=21.5 mag. [**Joshi, Y. C.**, **Joshi, S.**, **Kumar, B.**, Mondal, S. and Balona, L. A.].

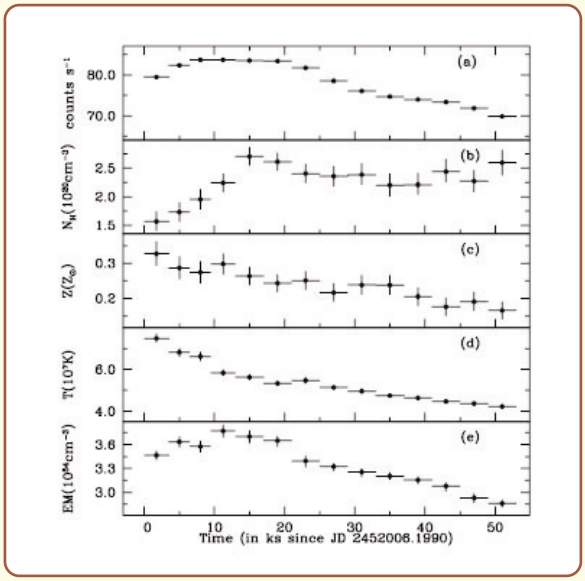


V band phase light curve for the 28 variable stars identified in the open cluster NGC 6866. Phase is plotted twice and shifted in such a way that the light minimum falls near to zero phase.

d. X-ray Astronomy

X-ray flares from RS Cvn binaries:

Seven flares detected from five RS CVn-type binaries (UZ Lib, σ Gem, λ And, V711 Tau and EI Eri) observed with XMM–Newton observatory were studied with the aim to extend the understanding of the spectral and the temporal characteristics of X-ray flares in them. The quiescent state X-ray luminosities in the energy band of 0.3–10.0 keV of these stars were found to be $10^{30.7\text{-}30.9}$ erg s^{-1} . The exponential decay time in all the sample of flares range from ~ 1 to 8h. The luminosity at peak of the flares in the energy band of 0.3–10.0 keV was found to be in the range of $10^{30.8\text{-}31.8}$ erg s^{-1} . The great sensitivity of the XMM -European Photon Imaging Camera instrument allowed us to perform time resolved spectral analysis during the flares and also in the subsequent quiescent phases.



Variation of (a) count rate, (b) hydrogen column density (NH), (c) abundance (Z), (d) temperature (T) and (e) emission measure (EM) during the XMM–Newton observations during the flare from σ Gem. The temperature and emission measure are corresponding to the hottest component of the best-fitting 3T-plasma model.

The derived metal abundances of coronal plasma were found to vary during the flares observed from σ Gem, V771 Tau and EI Eri. In these flares elemental abundances found to be enhanced by factors of ~ 1.3–1.5 to the quiescent states. In most of the flares, the peak temperature was found to be more than 100 MK, whereas emission measure increased by factors of 1.5–5.5. Significant sustained heating was present in the majority of flares. The loop lengths (L) derived for flaring structure were found to be in the order of 10^{10-11} cm and are smaller than the stellar radii (R), i.e. L /R. The flare from σ Gem showed a high and variable absorption column density during the flare. [**Pandey, J. C.** and Singh, K. P.].

Photometric, Spectroscopic and Polarimetric study of active star FR Cnc:

This work is part of a multiwavelength study programme aimed at using complementary photometric, polarimetric and spectroscopic data to achieve an understanding of the activity process in late-type stars are presented. Here, we present the study of FR Cnc, a young, active and spotted star. The analysis of All Sky Automated Survey 3 (ASAS-3) data for the years 2002–2008 and amended the value of the rotational period to be 0.826518 d. The amplitude of photometric variations decreased abruptly in the year 2005, while the mean brightness remained the same, which was interpreted as a quick redistribution of spots. BVRC and IC broad-band photometric calibration was performed for 166 stars in FR Cnc vicinity. The photometry at Terskol Observatory shows two brightening episodes, one of which occurred at the same phase as the flare of 2006 November 23. Polarimetric BVR observations indicate the probable presence of a supplementary source of polarization. FR Cnc was spectroscopically monitored

during the years 2004–2008. It is concluded that the radial velocity changes cannot be explained by the binary nature of FR Cnc. The spectral type of FR Cnc as K7V was determined. Calculated galactic space-velocity components (U,V ,W) indicate that FR Cnc belongs to the young disc population and might also belong to the IC 2391 moving group. Based on Li I λ 6707.8 measurement, The age of FR Cnc was estimated to be between 10 and 120 Myr. Doppler tomography was applied to create a starspot image of FR Cnc. The goodness of fit was optimized to the deconvolved profiles for axial inclination, equivalent width and v sin i , finding v sin i = 46. 2 km s^{-1} and i = 55° . A synthetic V -band light curve based on Doppler imaging generated that makes simultaneous use of spectroscopic and photometric data (see Fig.1). This synthetic light curve displays the same morphology and amplitude as the observed one. The starspot distribution of FR Cnc is also of interest since it is one of the latest spectral types to have been imaged. No polar spot was detected on FR Cnc. [Golovin, A. et al. (Including **Pandey, J. C.** and **Medhi, B. J.**)].

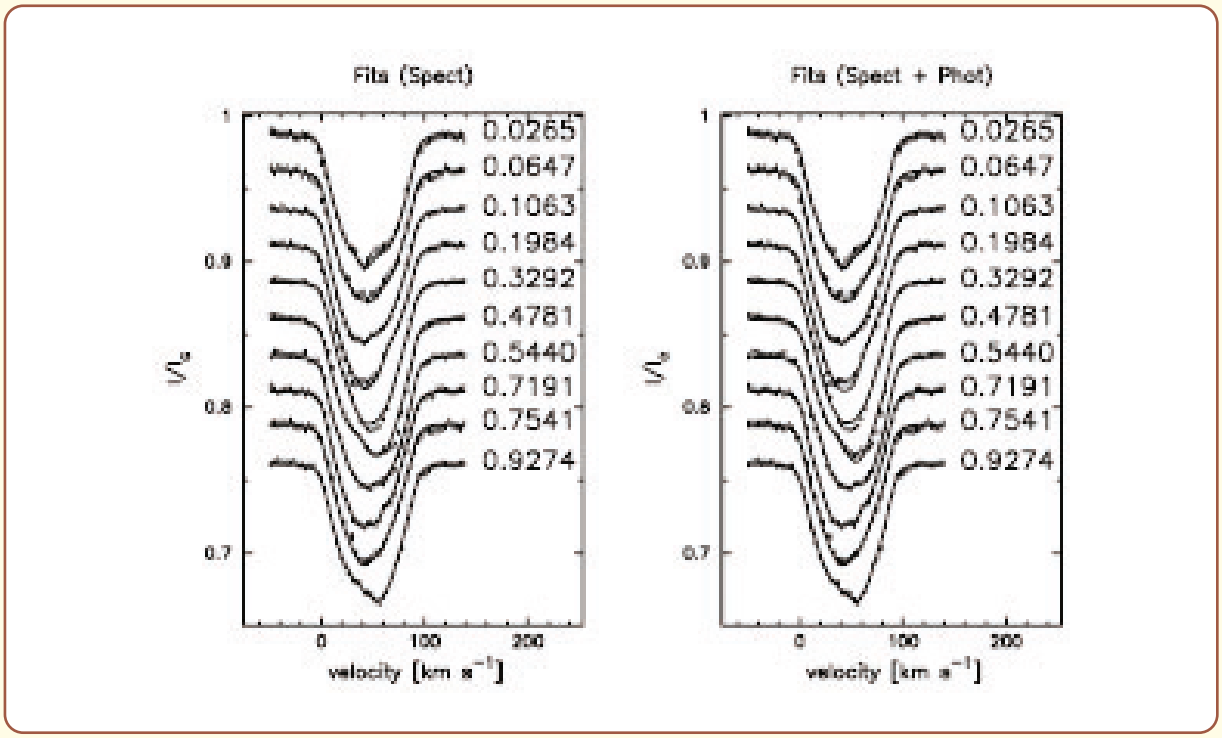


Figure 1. The figure shows the deconvolved profiles, with the phases of observation. The variation of the profile shape, due to starspots rotating into and out of view, is clearly seen.

3. EXTRA GALATIC ASTRONOMY

a. Supernovae/GRBs

Supernovae, one of the most energetic cosmic explosions in the universe, cause a sudden burst of radiation that often outshines an entire galaxy. The Sne mark the violent death of a massive star more massive than eight solar masses. Despite studies of several SNe, many questions remain fairly uncertain, i.e. underlying explosion mechanism and the nature of possible progenitors. The study of optical emission of SNe are important to study and test the theories massive stellar evolution and mechanism of stellar explosions. A team of astronomers at ARIES have used the optical borad-band UBVRI photometric data from 104-cm Sampurnanand Telescope and optical low-resolution spectroscopic data from 2m IGO telescope to study three SNe events – Sn 2008gz, SN 2008in and CSS100217:102913.

The SN 2008gz was discovered on 2008 November 5.83 UT by Koichi Itagaki using a 0.6m telescope in the spiral galaxy NGC 3672 at an unfiltered magnitude of 16.2. Photometric observations were done using 104-cm telescope at Manora Peak, Nainital. As the SN location was very close to the center of galaxy, a template subtraction technique was used to extract the true flux of SN (see Fig. 1). A detailed investigation of its light curves and spectra spanning 200 d suggest that it is an event of Type IIP similar to the archetypal SNe 2004et and 1999em. However, in contrast to other events of its class, SN 2008gz exhibits a rarely observed V magnitude drop of 1.5 over the period of a month during the plateau to nebular phase. Using an AV of 0.21 mag as a lower limit and a distance of 25.5 Mpc, we estimate a synthesized 56 Ni mass of 0.05 ± 0.01 M , a mid-plateau MV of −16.6 ± 0.2 mag and a total radiant energy of $\sim 10^{49}$ erg. The photospheric velocity is observed to be higher than observed for SN 2004et at similar epochs, indicating that the explosion energy was comparable to or higher than that of SN 2004et. A similar trend was also seen for the expansion velocity of H envelopes. By comparing the properties of SN 2008gz with other well-studied events, as well as by using a simulation results for pre-SN models, we infer an explosion energy range of 2.3×10^{51} erg, and this coupled with the observed width of the forbidden [O I] 6300–6364 Å line at 275 d after the explosion gives an upper limit for the main-sequence (non-rotating, solar metallicity) progenitor mass of 17 solar masses.

The observations of an optical transient CSS100217:102913+404220, revealed that it is an extremely luminous (Mv = -22.7) event in a galaxy with a redshift z = 0.147. Over a period of 287 rest-frame days, this event had an integrated bolo-metric luminosity of 1.3×10^{52} erg. We explored the proposition of the event being an extremely luminous supernova, the tidal disruption of a star by the massive nuclear black hole, and variability of the central active galactic nucleus (AGN) and We found that CSS100217 was likely an extremely luminous Type IIn supernova and occurred within the range of the narrow-line region of an AGN. The SN 2008in was discovered in the outskirts of the nearly face-on spiral galaxy M61 (Fig 2). The spectra of Sn2008in has striking resemblance to those of the archetypal low-luminosity IIP SNe 1997D and 1999br. However, the light curve (Fig 3) indicates that the production of radioactive 56 Ni is significantly higher than that in the low-luminosity Sne. The Sn2008in seems to an unique event bridging the gap beteen characteristics of normal and faint supernovae of type IIP. [**Roy, R., Kumar, B.** and **Pandey, S. B.**].

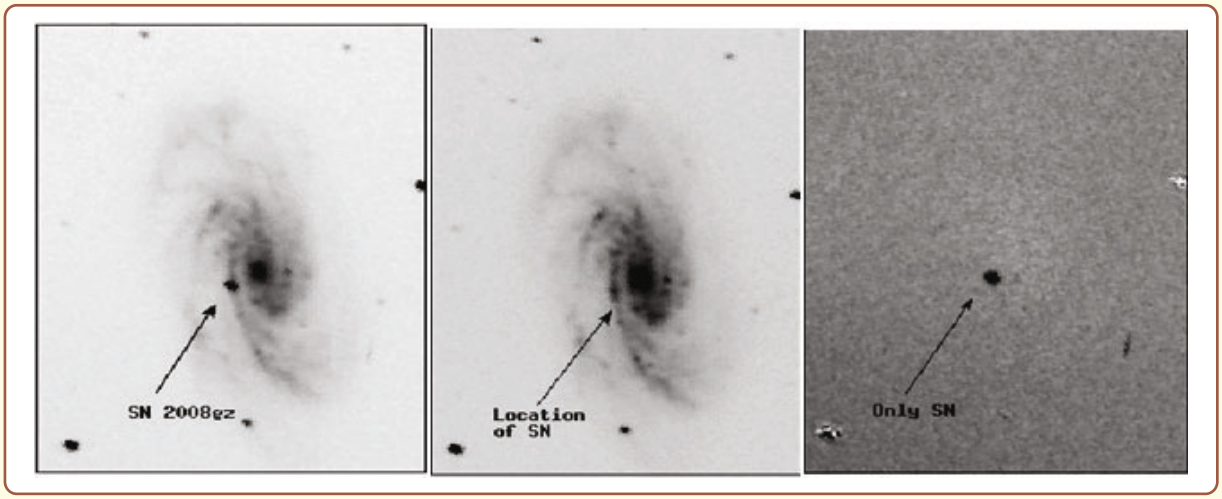


Figure 1. The galaxy template subtraction method for SN 2008gz. V-band image of SN (117 day old) is shown in leftmost panel, the galaxy template taken 548 day after burst is shown in middle, while the rightmost panel shows the template subtracted image. All the images are around 3x4.5 arcmin. North is up and East is to left.

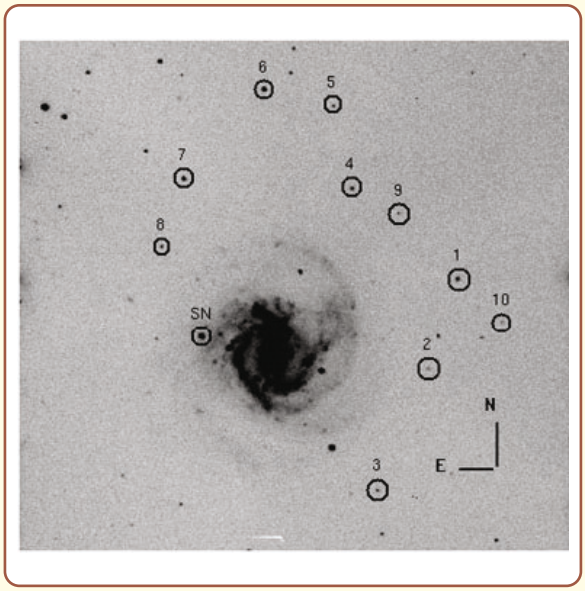


Figure 2. The Supernova 2008in in the galaxy M 61. A 600 s V-band image taken 32 days after the supernova burst from the 104-cm Sampurnanand Telescope at ARIES, India. The image covers an area of about 10 x 10 arcmin on the sky. The location of supernova as well as the local photometric standard stars are marked with circles. North is to up and east is to the left.

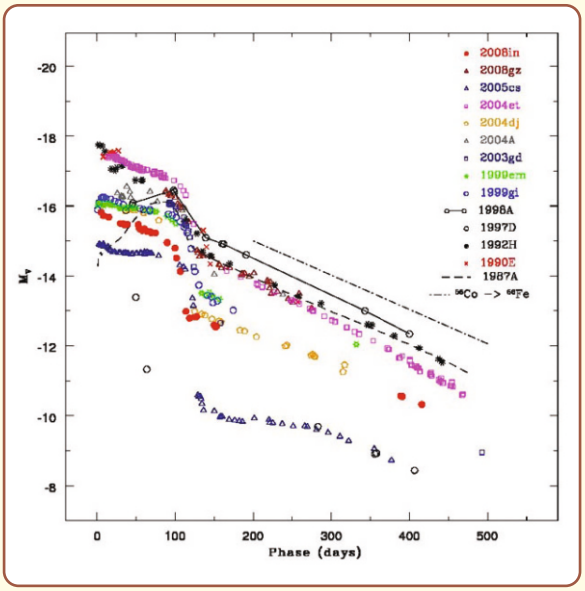


Figure 3. A comparison of the absolute V-band light curve of SN 2008in with the low-luminosity SNe 1997D, 2005cs; the normal SNe 1999em, 2004et, 2008gz, 2004dj, 2004A, 2003gd, 19992H, 1999E, 1999gi; and the peculiar Type II SNe 1987A, 1998A. The decline rate of emission expected from radioactive decay of Ni^{56} to Co^{56} to Fe^{56} is shown with dot-dashed line.

b. Radio Galaxies

A low-frequency study of two asymmetric large radio galaxies:

Studies of asymmetries in luminous extragalactic radio sources have provided valuable insights towards understanding a number of important aspects of these sources. The possibility of the environment playing an important role in the observed asymmetries is consistent with a slow velocity of propagation of the jet head suggested by Scheuer (1995; see also O'Dea et al. 2009; Konar et al. 2009). Structural asymmetries of the oppositely-directed components have been used to probe the `flip-flop' model for radio sources, where energy supply from the nucleus is one-sided at a time, but the source appears reasonably symmetric averaged over its life time (e.g. Saikia & Wiita 1982; Rudnick & Edgar 1984). Effects of orientation and relativistic motion on the spectra of the hot-spots or lobes have also been studied (see Garrington, Conway & Leahy 1991; Dennett-Thorpe et al. 1997, 1999; Ishwara-Chandra & Saikia 2000; Mullin et al. 2008). While the high-brightness regions appear to have flatter spectra on the side facing the jet, consistent with mild relativistic beaming, the spectral asymmetries of the extended regions appear to depend on the lobe length (Dennett-Thorpe et al. 1999).

While most structural asymmetries can be understood by taking into account the effects of both an asymmetric, inhomogeneous environment and relativistic motion (e.g. Jeyakumar et al. 2005; see Gaibler, Khochfar & Krause 2011 for results of recent simulations of jet-disk interaction), MERLIN (Multi-Element Radio Linked Interferometer Network) and VLA (Very Large Array) observations of one-sided radio sources revealed a possible class of weak-cored, one-sided sources which were difficult to understand in the simple relativistic beaming scenario (e.g. Saikia et al. 1989, 1990). Saikia et al. (1996) also highlighted the very asymmetric radio galaxy B0500+630, where one component had an FRII structure (Fanaroff & Riley 1974) while the other one appeared to be of FRI type. It was difficult to understand its asymmetries in the relativistic beaming scenario. Gopal-Krishna & Wiita (2000) examined the detailed structure of a large number of sources and identified several with FRI and FRII structures on opposite sides, and christened these as HYMORS (HYbrid MOrphology Radio Sources). They inferred that such sources indicate that the FR dichotomy is due to interaction with the external medium rather than differences in the central engine.

To further explore the asymmetries and low-frequency spectra and structure of Mpc-scale radio galaxies, the results of Giant Metrewave Radio Telescope (GMRT) and VLA observations of two large asymmetric radio sources, J1211+743 and J1918+742, which have an FRII-like component containing a hot-spot on one side and a diffuse lobe on the opposite side are presented here. In the case of J1211+743 a well-collimated radio jet faces the diffuse lobe . These two sources are both associated with galaxies and have been selected from the sample of large sources compiled by Lara et al. (2001).

J1211+743 (4CT 74.17.01):

The radio galaxy J1211+743 with a projected linear size of ~846 kpc, has been observed by a number of observers over the years (e.g. Rudnick & Owen 1977; van Breugel & Willis 1981; Fanti et al. 1983; Jagers 1986; Zhao et al.

1989; Schoenmakers et al. 2000, 2001; Lara et al. 2001). Rudnick & Owen (1977) and identified the source with the south-west member of a pair of bright galaxies in Abell 1500. The nearby companion galaxy is ~7.5 arcsec away (Lara et al. 2001). The radio structure shows a prominent hot-spot in the southern component while the northern component appears as a diffuse lobe (Figs. 1 and 2). The maximum value of the peak brightness ratio in the oppositely-directed components is ~6.5. The source has a wiggling jet towards the north with the magnetic field lines along the direction of the jet (van Breugel & Willis 1981). A weak counter-jet has been reported by Lara et al. (2001).

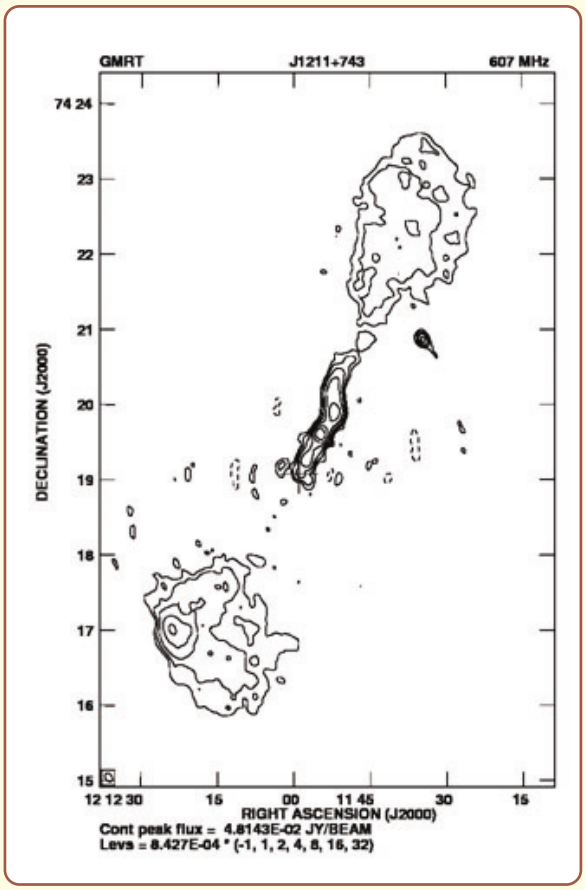


Figure 1. GMRT Full resolution image of J1211+743

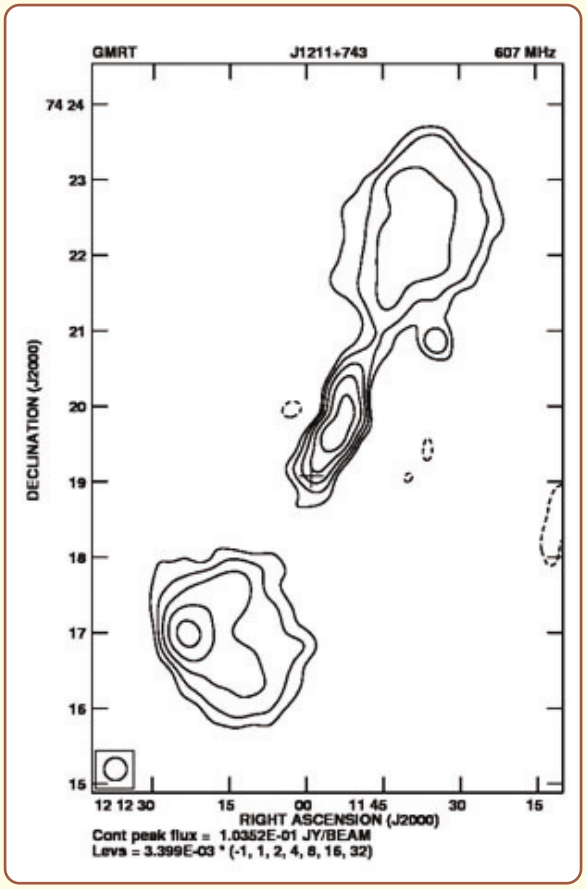


Figure 2. GMRT Low resolution image of J1211+743.

J1918+742:

The giant radio galaxy J1918+742 with a projected linear size of ~1.3 Mpc (Figs. 3 and 4) has been imaged earlier at 1.4 and 4.9 GHz with the VLA by Lara et al. (2001). It has a prominent hot-spot on the western component while the eastern component is diffuse without a significant hot-spot. The maximum ratio of the peaks of emission in the oppositely-directed components is ~13.

Although the radio luminosity of these sources is in the FRII category, one of the components in these two sources is diffuse with no significant hot-spot at its outer edge. Although the diffuse lobes are reminiscent

of those in FRI radio galaxies, the radio jet in J1211+743 is well-collimated (see Fig. 1) with the magnetic field lines following the bends in the jet (van Breugel & Willis 1981). This is similar to what is usually seen in jets in FRII radio sources (e.g. Bridle & Perley 1984), suggesting that one needs to examine the jet and magnetic field structures as well as the structure of the lobes before classifying these sources as being of hybrid FRI/FRII morphology.

Asymmetries in the peak brightness of the lobes could be due to either relativistic motion of the hot-spots or intrinsic asymmetries in the sources or their environments. However, since these are all large Mpc-scale sources associated with galaxies, relativistic motion is not likely to be a dominant factor. The fraction of emissions from the cores at an emitted frequency of 8 GHz, which is a statistical indicator of orientation of the jet axis to the line of sight is ~0.08 and 0.05 for J1211+743 and J1918+742 respectively. Spectra and spectral profiles of both the sources are shown in figure 5 and 6. [**Pirya, A., Nandi, S.,** Saikia, D. J., **Singh, M.,** and Konar, C.]

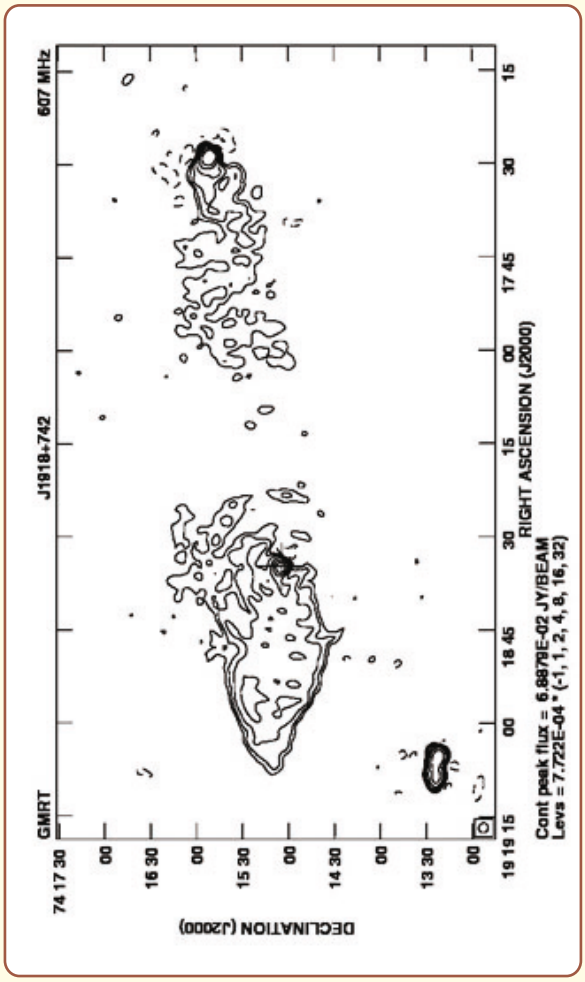


Figure 3. GMRT Full Resolution image of J1918+742

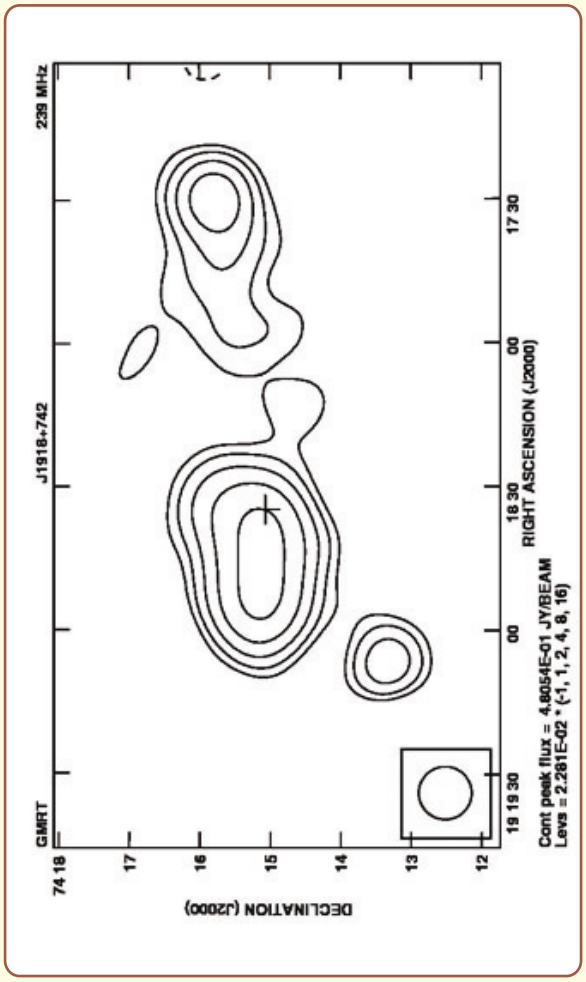


Figure 4. GMRT Low resolution image of J1918+742.

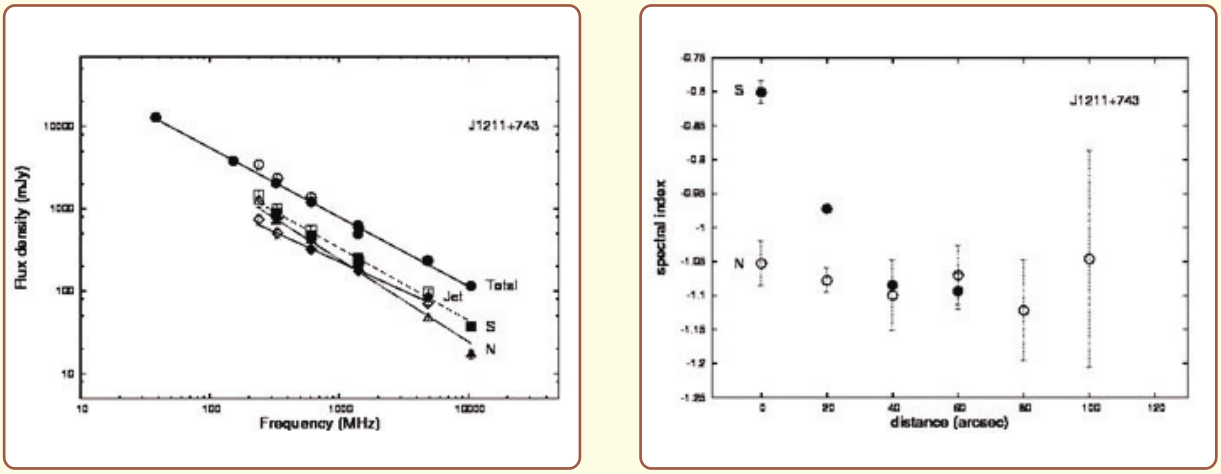


Figure 5. Spectra and spectral index profile for J1211+743.

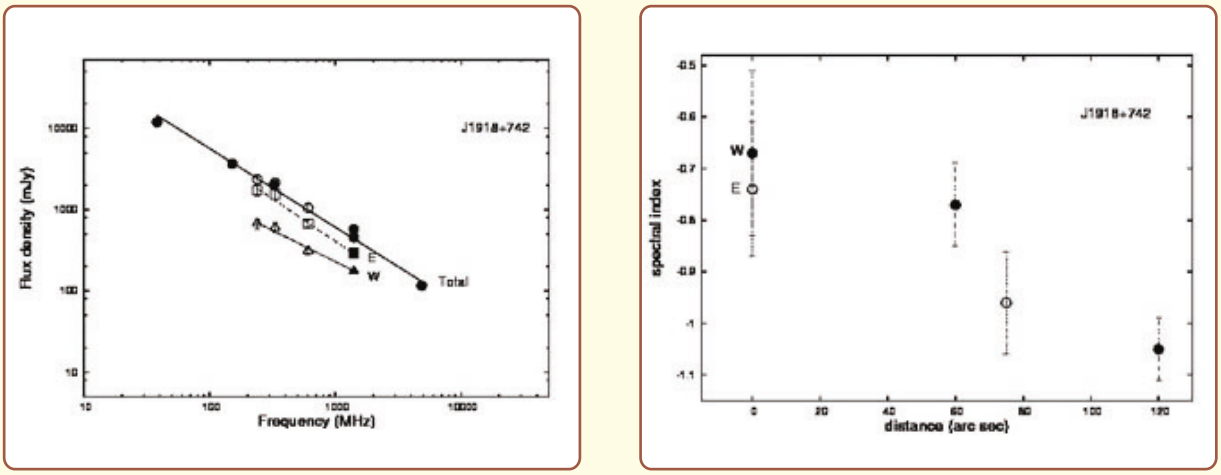
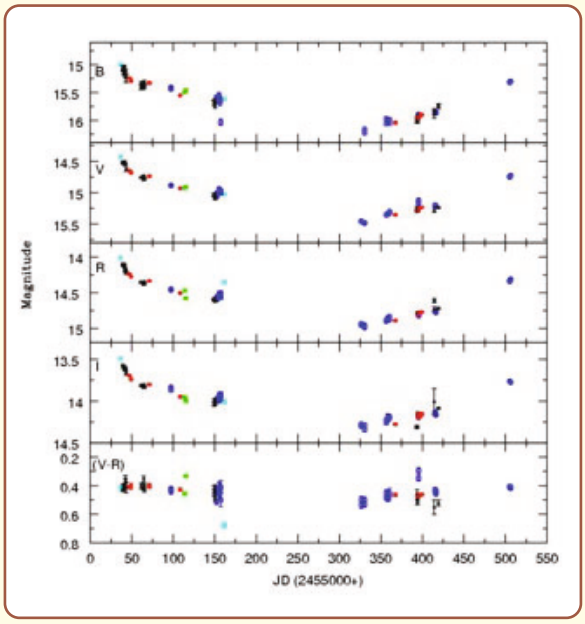


Figure 6. Spectra and spectral index profile for J1918+742.

c. Quasar and Blazars

Quasi-simultaneous two-band optical variability of the blazars 1ES 1959+650 and 1ES 2344+514:

We report the results of quasi-simultaneous two-filter optical monitoring of two high-energy peaked blazars, 1ES 1959+650 and 1ES 2344+514, to search for microvariability and short-term variability (STV). We carried out optical photometric monitoring of these sources in an alternating sequence of B and R passbands, and have 24 and 19 nights of new data for these two sources, respectively. No genuine microvariability (intranight variability) was detected in either of these sources. This non-detection of intranight variations is in agreement with the conclusions of previous studies that high-energy peaked BL Lacs are intrinsically less variable than low-energy peaked BL Lacs in the optical bands. We also report the results of STV studies for these two sources between 2009 July and 2010 August. Genuine STV is found for the source 1ES 1959+650 but not for 1ES 2344+514. We briefly discuss possible reasons for the difference between the intranight variability behaviour of high- and low-energy peaked blazars. [**Gaur, H.**, **Gupta, A. C.**, Strigachev, A., Bachev, R., Semkov, E., Wiita, P. J., Peneva, S., Boeva, S., Kacharov, N., Mihov, B. and Ovcharov, E.].



Short-term variability light curve of 1ES 1959+650. Starred, solid circle, open circle, triangle and square symbols represent data from the telescopes A, B, C, D and E, respectively.

Optical intra-day variability timescales and black hole mass of the blazars:

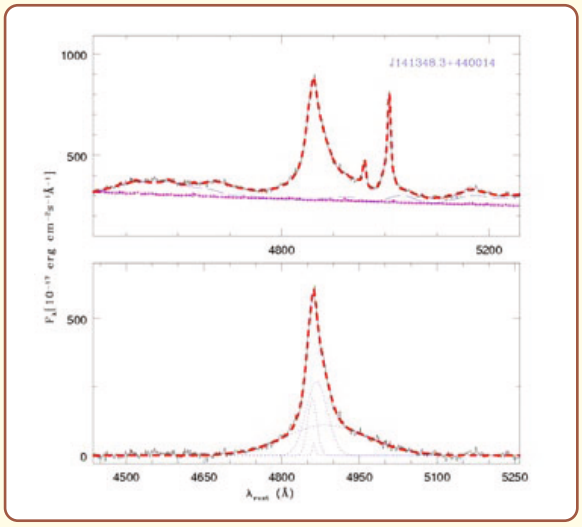
In this paper, we have used optical intra-day variability archive data to calculate the central black hole masses and Eddington luminosities for nine blazars: 3C 66A, AO 0235+164, S5 0716+714, PKS 0735+178, OJ 287, 1215+303, 1216-010, 1308+326, PKS 1510-089, Mrk 501 and BL Lac using intra-day variability timescales and periodicity (if present). The calculated central black hole mass of these nine blazars using intra-day variability timescales are found to be in the range of 1.22-25.30 × 10^7 M_{sun} and corresponding Eddington luminosity in the range of 1.58-32.88 × 10^{45} erg s^{-1} . The black hole mass and Eddington luminosity are in the range of 0.32-31.23 × 10^8 M_{sun} and 1.23-31.20 × 10^{46} erg s^{-1}, respectively when optical Doppler factor is taken into account. The comparison show, our estimated values of black hole mass are consistent with earlier reported values. Periodicity were present in two blazars OJ 287 and 1216-010 which give the central black hole mass of these blazars in the range of 1.32-14.6 × 10^7 M_{sun} and corresponding Eddington luminosity in the range of 1.60-19.0 × 10^{45} erg s^{-1}, respectively. [Gupta, S. P., Pandey, U. S., Singh, K., **Rani, B.,** Pan, J., Fan, J. H., and **Gupta, A. C.**].

Rapid Optical Variability of TeV Blazars:

To characterize the intranight optical variability (INOV) of TeV blazars, a well defined set of 22 TeV blazars were monitored on a total of 116 nights using the CCD camera attached on 1.04-m telescope at ARIES. We calculated the INOV duty cycle using a commonly employed C-test were calculated and found that the INOV duty cycles for two major sub-classes of TeV detected BL Lacs, namely LBLs and HBLs are -63 per cent and 38 per cent, respectively. An intriguing feature, clearly detected in the light curve of the HBL J1555+1111 where a 4 per cent ``dip'' on a 1 hour time-scale was found. This unique feature could have arisen from absorption in a dusty gas cloud, occulting a superluminally moving optical knot in the parsec scale jet. [Gopal-Krishna, **Goyal, A.**, **Joshi, S.**, **Karthick, Chrisphin, Sagar, R.**, Wiita, P. J., Anupama, G. C. and Sahu, D. K.].

Probing Spectral Properties of Radio-quiet Quasars Searched for Optical Microvariability –II:

In the context of AGN unification schemes rapid variability properties play an important role in understanding any intrinsic differences between sources in different classes. In this respect any clue based on spectral properties will be very useful toward understanding the mechanisms responsible for the origin of rapid small scale optical variations, or microvariability. Spectra of 46 radio-quiet quasars (RQQSOs) and Seyfert 1 galaxies to those of our previous sample of 37 such objects were added, all of which had been previously searched for microvariability. New optical spectra of 33 objects were taken and obtained 13 others from the literature. Their H-beta and Mg II emission lines were carefully fitted to determine line widths

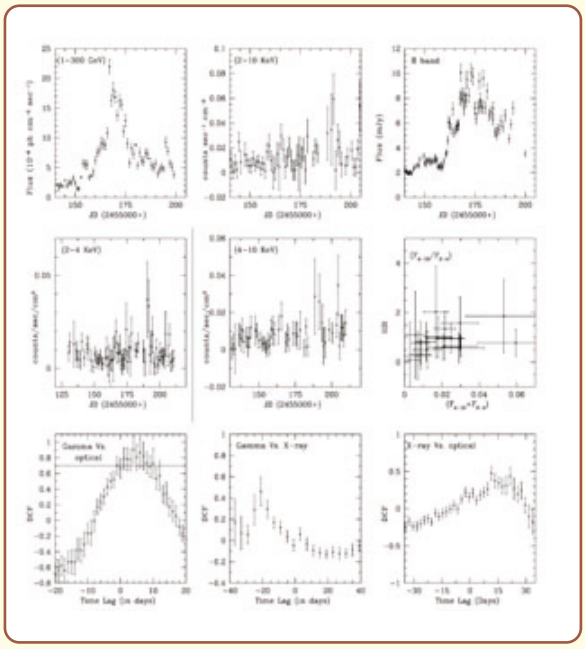


The best fit to the Hβ emission line of the IGO spectra of the QSO J141348.3+440014. Upper panel: complete spectrum fit (thick dashed/red) and components of the fit: power-law continuum (thin short-dashed/black line), broad Fe II (thin long-dashed/blue), narrow Fe II (dotted/magenta) lines. Lower panel: continuum, Fe II and metal-line subtracted spectrum (solid/black) with the best-fitting total Hβ profile (thick dashed/red) and Hβ components (dotted/blue) lines. Note that the entire fit is performed simultaneously (not first continuum subtraction then Hβ fit) but these aspects are shown separately for the sake of clarity.

(FWHM) as well as equivalent widths (EW) due to the broad emission line components. The line widths were used to estimate black hole masses and Eddington ratios. Both EW and FWHM are significantly anti-correlated with Eddington ratio; the former trend was strengthened by our new work and the latter was confirmed. However the tendency seen in the smaller sample for sources exhibiting microvariability to be of lower luminosity was not confirmed in our full sample of 83 AGN. Most importantly, this whole sample of EW distributions provides no evidence for the hypothesis that a weak jet component in radio quiet AGNs is responsible for their microvariability. [**Joshi, R.**, **Chand, H.**, Wiita, P. J., **Gupta, A. C.** and Srianand, R.].

Multiwavelength Variability of the Blazars Mrk 421 and 3C 454.3 in the High State:

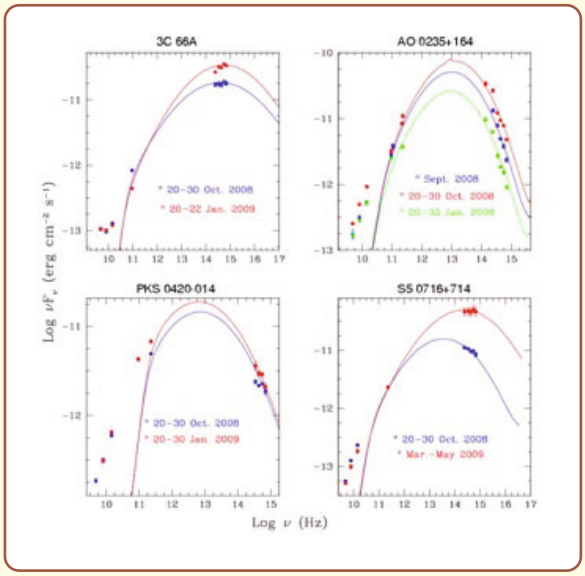
We report the results of photometric observations of the blazars Mrk 421 and 3C 454.3 designed to search for intraday variability (IDV) and short-term variability (STV). Optical photometric observations were spread over 18 nights for Mrk 421 and 7 nights for 3C 454.3 during our observing run in 2009-2010 at the 1.04 m telescope at Aryabhatta Research Institute of Observational Sciences, India. Genuine IDV is found for the source 3C 454.3 but not for Mrk 421. Genuine STV is found for both sources. Mrk 421 was revealed by the Monitor of All-sky X-ray Image (MAXI) X-ray detector on the International Space Station to be in an exceptionally high flux state in 2010 January-February. We performed a correlation between the X-ray and optical bands to search for time delays and found a weak correlation with higher frequencies leading the lower frequencies by about 10 days. The blazar 3C 454.3 was found to be in a high flux state in 2009 November-December. We performed correlations in optical observations made at three telescopes, along with X-ray data from the MAXI camera and public release γ-ray data from the Fermi space telescope. We found strong correlations between the γ-ray and optical bands at a time lag of about four days, but the X-ray flux is not correlated with either. We briefly discuss the possible reasons for the time delays between these bands within the framework of existing models for X-ray and γ-ray emission mechanisms. [**Gaur, H., Gupta, A. C.** and Wiita, P. J.].



Gamma, X-ray, and optical LCs of 3C 454.3 (upper panels); X-ray LCs for 3C 454.3 in 2–4 keV, 4–10 keV and hardness intensity plot (middle panels); DCF between gamma vs. optical (horizontal line indicates 99% significance level), γ -ray vs. X-ray, and X-ray vs. optical (in lower panels).

Spectral energy distribution variation in BL Lacs and flat spectrum radio quasars:

We present the results of our study of spectral energy distributions (SEDs) of a sample of 10 low- to intermediate-synchrotron-peaked blazars. We investigate some of the physical parameters most likely responsible for the observed short-term variations in blazars. To do so, we focus on the study of changes in the SEDs of blazars corresponding to changes in their respective optical fluxes. We model the observed spectra of blazars from radio to optical frequencies using a synchrotron model that entails a log-parabolic distribution of electron energies. A significant correlation among the two fitted spectral parameters (a, b) of log-parabolic curves and a negative trend among the peak frequency and spectral curvature parameter, b, emphasize that the SEDs of blazars are fitted well by log-parabolic curves. On considering each model parameter that could be responsible for



The modelled SED curves of the blazars 3C 66A, AO 0235+164, PKS 0420−014 and S5 0716+714. The points represent the observed data, while best-fitting models are shown by the curves. Since the low-frequency part ($\leqslant$ 1011 Hz) of blazars SEDs is governed by synchrotron-self-absorption mechanism, the modelled SED is steeper below a frequency of 1011 Hz (see text for details).

changes in the observed SEDs of these blazars, we find that changes in the jet Doppler factors are most important. [**Rani, B., Gupta, A. C.**, Bachev, R., Strigachev, A., Semkov, E., D'Ammando, F., Wiita, P. J., Gurwell, M. A., Ovcharov, E., Mihov, B., Boeva, S. and Peneva, S.].

Variability of Spectral Energy Distribution of Blazar S5 0716+714:

The emission from blazars is known to be variable at all wavelengths. The flux variability is often accompanied by spectral changes. Spectral energy distribution (SED) changes must be associated with changes in the spectra of emitting electrons and/or the physical parameters of the jet. Meaningful modeling of blazar broadband spectra is required to understand the extreme conditions within the emission region. Not only is the broadband SED crucial, but also information about its variability is needed to understand how the highest states of emission occur and how they differ from the low states. This may help in discriminating between models. Here we present the results of our SED modeling of the blazar S5 0716+714 during various phases of its activity. The SEDs are classified into different bins depending on the optical brightness state of the source. [**Rani, B., Gupta, A. C.** and Wiita, P. J.].

UV and X-ray Variability of Blazars:

It is well established that the blazars show flux variations in the complete electromagnetic (EM) spectrum on all possible time scales ranging from a few tens of minutes to several years. Here we report the review of various UV and X-ray flux variability properties of blazars. Our analysis show that UV variability amplitude is smaller than X-rays, mostly soft X-rays hardness ratio show correlations with blazar luminosity and different modes of variability might be operating for different time scales and epochs. Quasi periodic oscillations are seen on a few occasions in blazars, higher fraction of high energy peaked blazars show intra day and short term variabilities in X-rays but variability duty cycle is much less in optical bands on intra day time scale compared to low energy peaked blazars. But these results are yet to be established. [**Gupta, A. C.**].

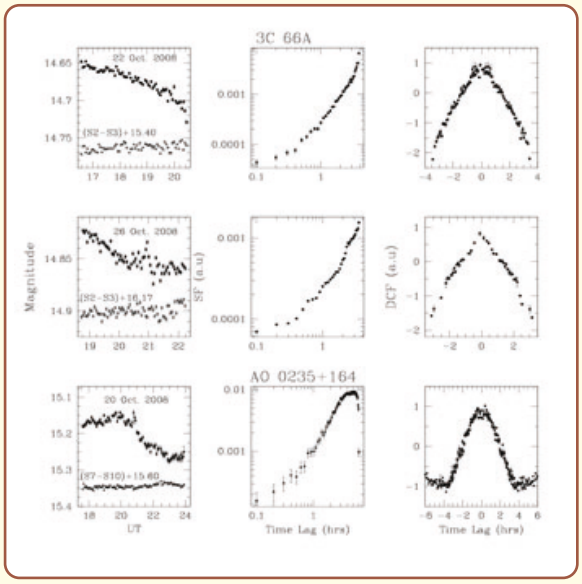
Re-Analysis of QPO in 3C 273 Light Curve:

We have developed analysis tools to search for quasi periodic oscillations in light curves from active galactic nuclei, using the following time series techniques: Wavelets,

periodogram, Lomb-Scargle periodogram, structure function and multi-harmonic analysis of variance. The analysis tools incorporate different noise models with significant levels for all the techniques that is an improvement over the previous work. By looking for consistently high significance, we make the detection of periodicities more robust. We apply this tool to a previously reported QPO (Espaillat et al. 2008) in the X-ray light curve of 3C 273 with a periodicity of ~3300 s and find that the significance is only 74% in the wavelet and fails to show up above 95% significance in the periodogram and multi-harmonic analysis of variance. [Mohan, P., Mangalam, A., **Chand, H.** and **Gupta, A. C.**].

Optical intraday variability studies of 10 low energy peaked blazars:

We have carried out optical (R band) intraday variability (IDV) monitoring of a sample of 10 bright low energy peaked blazars (LBLs). 40 photometric observations, of an average of ~4 h each, were made between 2008 September and 2009 June using two telescopes in India. Measurements with good signal-to-noise ratios were typically obtained within 1-3 min, allowing the detection of weak, fast variations using N-star differential photometry. We employed both structure function and discrete correlation function analysis methods to estimate any dominant time-scales of variability and found that in most of the cases any such time-scales were longer than the duration of the observation. The calculated duty cycle of IDV in LBLs during our observing run is ~52 per cent, which is low compared to many earlier studies; however, the relatively short periods for which each source was observed can probably explain this difference. We briefly discuss possible emission mechanisms for the observed variability. [**Rani, B., Gupta, A. C.,** Joshi, U. C., Ganesh, S. and Wiita, P. J.].



R-band optical IDV LCs of the blazars 3C 66A and AO 0235+164 and their respective SFs and DCFs.

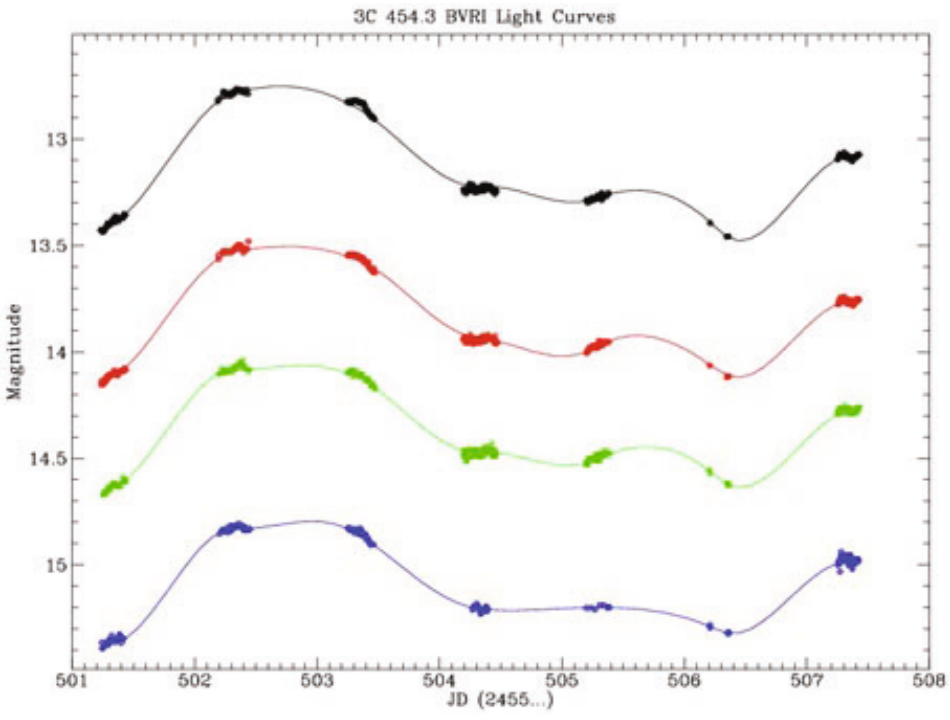
Optical microvariability properties of BALQSOs:

We present optical light curves of 19 radio-quiet (RQ) broad absorption line (BAL) quasi-stellar objects (QSOs) and study their rapid variability characteristics. Systematic CCD observations, aided by a careful data analysis procedure, have allowed us to clearly detect any such microvariability exceeding 0.01-0.02 mag. Our observations cover a total of 13 nights (~72 h) with each quasar monitored for about 4 h on a given night. Our sample size is a factor of 3 larger than the number of RQ BALQSOs previously searched for microvariability. We introduce a scaled F-test statistic for evaluating the presence of optical microvariability and demonstrate why it is generally preferable to the statistics usually employed for this purpose. Considering only unambiguous detections of microvariability we find that ~11 per cent of RQ BALQSOs (two out of 19

sources) show microvariability for an individual observation length of about 4 h. This new duty cycle of 11 per cent 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. [**Joshi, R., Chand, H., Gupta, A. C.** and Wiita, P. J.].

Intranight variability of 3C 454.3 during its 2010 November outburst:

3C 454.3 is a very active flat spectrum radio quasar (blazar) that has undergone a recent outburst in all observed bands, including the optical. In this work we explore the short-term optical variability of 3C 454.3 during its outburst by searching for time delays between different optical bands. Finding one would be important for understanding the evolution of the spectrum of the relativistic electrons, which generate the synchrotron jet emission. We performed photometric monitoring of the object by repeating exposures in different optical bands (BVRI). Occasionally, different telescopes were used to monitor the object in the same band to verify the reliability of the smallest variations we observed. Except on one occasion, where we found indications of a lag of the blue wavelengths behind the red ones, the results are inconclusive for most of the other cases. There were either no structures in the light curves to be able to search for patterns, or else different approaches led to different conclusions. [Bachev, R., Semkov, E., Strigachev, A., Mihov, B., **Gupta, A. C.,** Peneva, S., Ovcharov, E., Valcheva, A. and Lalova, A.].

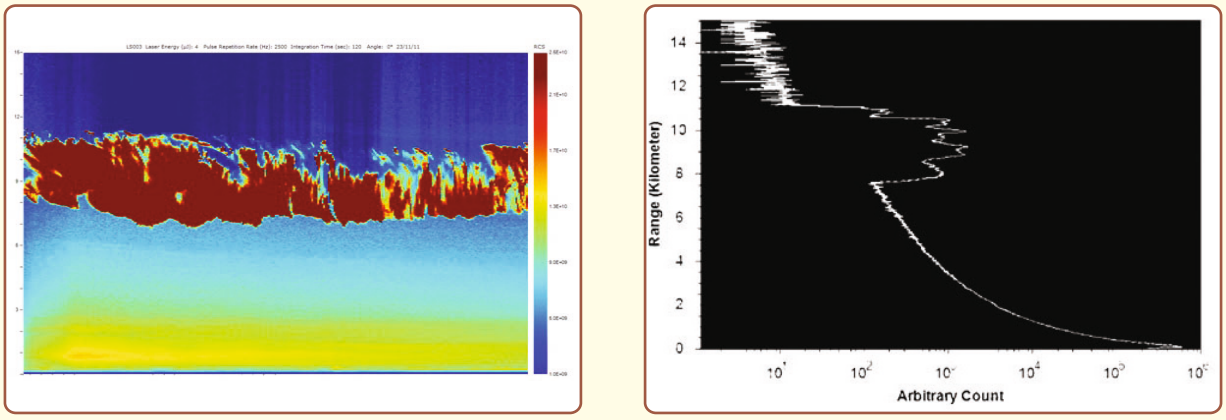


BVRI light curves (from bottom to top, in blue, green, red, and black, respectively) of 3C 454.3 during the most active monitoring period. Splines are added to guide the eye. Additional BVR data points for this observational period can be found from the Yale Fermi/SMARTS project (http://www.astro.yale.edu/smarts/glast/).

Vertical distribution of atmospheric aerosols over high altitude site Nainital:

The role of atmospheric aerosols (both from natural and anthropogenic sources) in modifying the radiation budget of the earth's atmosphere and hence affecting the climate system is being increasingly understood and recognized in recent years. However, lack of data base limits our understanding of variability in aerosol optical, physical and chemical properties through aerosol radiative forcing estimation on regional scale. Recent work has been devoted to reducing the uncertainties in aerosol radiative forcing by incorporating more observed data sets and using the global circulation models. With this background, an establishment of observational network observation such as ISRO-GBP Network, Aerosol Robotic Network (AERONET), European Aerosol Research Lidar Network (EARLINET), Micropulse Lidar Network (MPLNET), Regional East Atmospheric Lidar Mesonet (REALM) and Atmospheric Boundary Layer Network (ABLNC) dedicated to monitoring the aerosol properties and vertical distribution, as the knowledge of vertical profile of atmospheric aerosols is crucial.

In order to study the vertical profile of atmospheric aerosols a Micro Pulse Lidar system was installed at High altitude site at Nainital, located in the central Himalayas by the National Atmospheric Research Laboratory (NARL) under a joint scientific collaborative program between Aryabhatta Research Institute of Observational Sciences (ARIES) Nainital and NARL. The portable micro pulse Lidar system (popularly known as Lidar for Atmospheric Measurements and Probing [LAMP]) was developed by National Atmospheric Research Laboratory (NARL), to monitor the vertical profile of atmospheric aerosols in the lower troposphere has been installed at a temperature and humidity controlled room. The Lidar observation was carried out at ARIES, Nainital on regular basis to study the vertical distribution of aerosols and boundary layer structure etc. The LAMP system was operated at high altitude site ARIES (29.4° N, 79.5° E), Nainital (located at an altitude of ~2 km above the mean sea level in the foothills of central Himalayas) since October 2011. The backscattered return signal from atmospheric aerosols and high altitude



Contour plot of range corrected signal (top panel) and typical altitude profile of photon count (bottom panel) for 23 November 2011.

clouds such as cirrus were observed during the period under study. During the study period we found a 3 km thick layer of ice cirrus clouds on 23 November 2011 at altitude starting from 7 km to 10 km. A typical profile and the contour plot of range corrected signals is shown in Figure below. [**Dumka, U. C., Solanki, R., Pant, P.,** Kumar, Y. B., **Singh, N.** and Kumar, V.].

Black carbon aerosols over Manora Peak in the Indian Himalayan foothills: implications for climate forcing:

Collocated measurements of aerosol optical depth (AOD), black carbon (BC) aerosols and chemical composition of composite aerosols during July 2006 to May 2007 at Manora Peak are used to investigate the contribution of BC to the total AOD and subsequently to the direct radiative forcing (DRF) over Manora Peak in the central Himalayan foothills. The implication of evaluated DRF to the climate forcing has also been discussed. In this context concurrently measured BC mass concentrations were used in an aerosol optical model to deduce the radiatively important aerosol optical parameters for composite aerosols and solely for BC aerosols as well. Then the derived aerosol optical parameters were used independently in a radiative transfer model to estimate the DRF separately for composite and BC aerosols.

The average BC mass concentration was found to be 0.98 (±0.68) μg m^{-3} during the

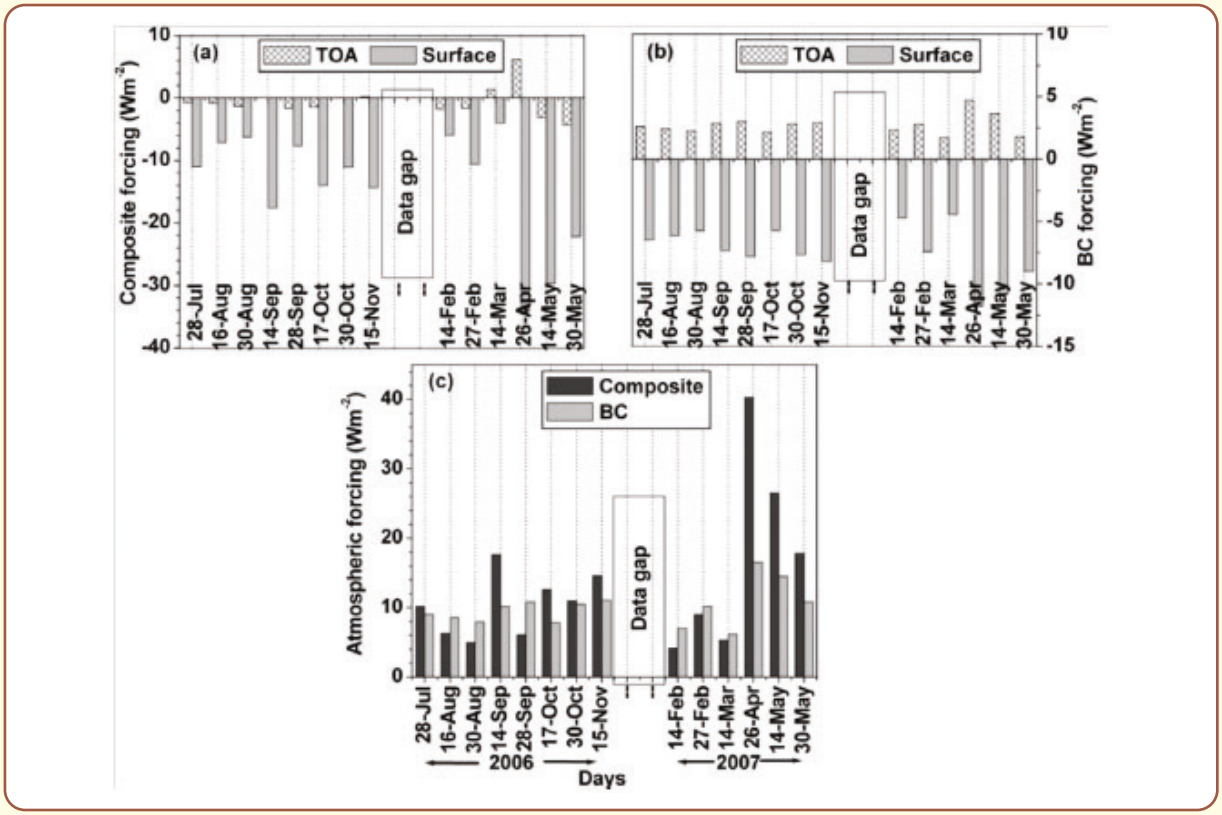
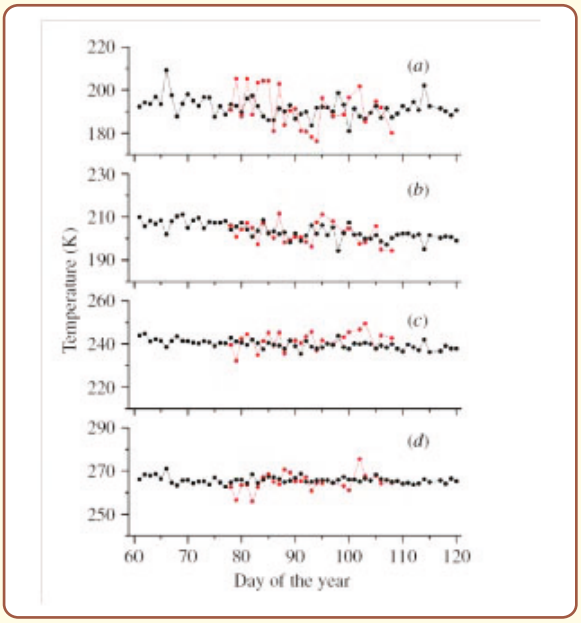


Figure 1. Daily TOA and surface forcing for (a) composite and (b) BC aerosols; (c) resultant atmospheric forcing for composite and BC aerosols.

entire observation period, which contributes <3% to the total aerosol mass and ~17% to the total AOD at Manora Peak. The mean surface forcing was found to be -14:0 (±9.7) and -7:4 (±2.1) W m^{-2} respectively for composite and BC aerosols whereas mean atmospheric forcing was about +14 (±10) and +10 (±3) W m^{-2} for these aerosols (Figure 1). These results suggest that BC aerosols exert relatively large surface heating (~45% higher) as compared to composite aerosols and contribute ~70% to the total atmospheric forcing at Manora Peak. Such a large warming effect of BC may affect the strength of Himalayan glaciers, monsoon circulation and precipitation over the Indian region. [**Srivastava, A. K.**, Ram, K., **Pant, P.**, Hegde, P. and **Joshi, H.**].

Observations of the ultra-fast Kelvin wave in the tropical mesosphere during equinox:

Regular and systematic measurements of mesospheric temperatures have been carried out during March and April 2007 to determine planetary-scale wave activities in the tropical region, utilizing ground-based Rayleigh Light Detection and Ranging (LiDAR) system and satellite-based Microwave Limb Sounder (MLS) data from Gadanki, India (13.5 °N, 79.2 °E) and MLS data over a site in North America (23.5 °N, 100 °W). A dominant component of 3–5 day period wave is revealed at four altitudes (80, 70, 60 and 50 km, figure 2) over these two observing stations. The estimated vertical wavelength (~ 40 km), zonal phase speed (~ 140 m s^{-1}), longitudinal and latitudinal extensions have suggested the wave to be an ultra-fast Kelvin (UFK) wave with zonal wave number 1. In addition to the UFK wave, a



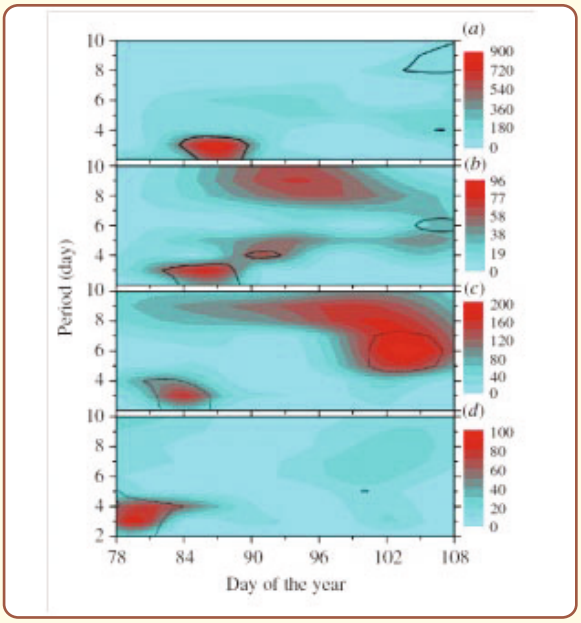
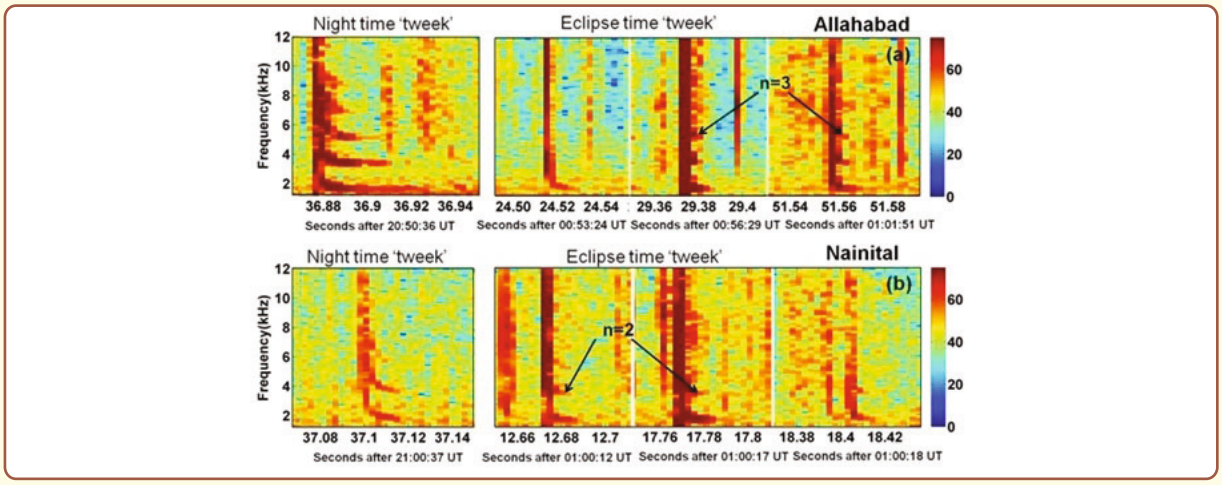


Figure 2. (a) Temperature variability plot of LiDAR (red) and MLS (black) during the March to April 2007 period for: (*a*) 80 km, (*b*) 70 km, (*c*) 60 km and (*d*) 50 km over Gadanki. (b) Wavelet power spectra of LiDAR temperature over Gadanki with respect to day of the year (DY) and period for: (*a*) 80 km, (*b*) 70 km, (*c*) 60 km and (*d*) 50 km. The solid lines represent the 90% significance level.

probable quasi 2 day Rossby gravity wave is also found to be present most of the time. Another 5–7 day wave component, observed at some altitudes with significant prominence, is surmised to be a manifestation of a 6.5 day wave. [Guharay, A., **Pant, P.,** Pande, B. and Pandey, K.]

D-region ionosphere response to the total solar eclipse of 22 July 2009 deduced from ELF-VLF tweek observations in the Indian sector:

The lightning discharge generated electromagnetic impulses travel thousands of kilometers in the earth-ionosphere waveguide (EIWG) with little attenuation. 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 tweeks. VLF receivers were set up at three sites (Geomagnetic Research Laboratory, Allahabad, ARIES, Nainital and BHU, Varanasi). in the year 2007 in collaboration with Indian Institute of Geomagnetism, Mumbai and Stanford University, USA under IHY-2007 campaign. During the total solar eclipse on



The tweek examples observed at (a) Allahabad and (b) Nainital stations on 22 July 2009 before, during and after the eclipse totality. The second and third harmonic tweeks are indicated as n = 2 and n = 3. On the left sides of Figures 2a and 2b, tweeks observed in the nighttime on 22 July 2009 are shown.

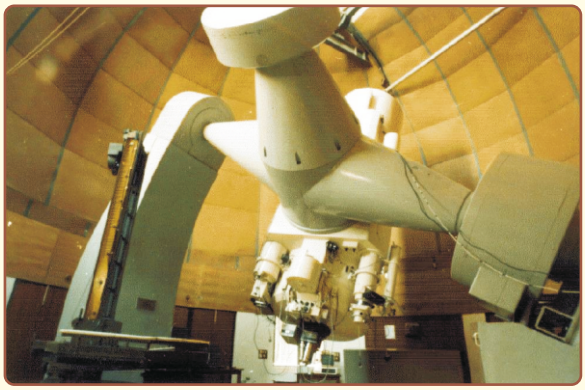
5. FACILITIES

1. Observing Facilities

1.1 Stellar Observing Facilities

The 104-cm Sampurnanand Telescope (ST) is still being utilized as a main observing facility in the optical domain by the students and scientists of ARIES, since 1972. The total research output of the ST reaches nearly 330 scientific publications in different refereed journals so far.

The major back-end instruments were Wright 2K CCD, Tek 1K CCD and ARIES Imaging Polarimeter (AIMPOL). Different major scientific programs such as; study of star-clusters, young star-forming regions, H_{II} regions, AGN and brown dwarfs, optical



The optical 104-cm Sampurnanand telescope at ARIES.

counterpart of Gamma-ray-bursts(GRBs), supernovae and X-ray sources, polarimetric studies of star-forming regions and late type stars were carried out with this telescope.

1.2 Aluminizing facility :

The 104-cm primary mirror (M1) of Sampurnanand Telescope, got new aluminum coating in July, 2011, after a long gap of six years. A new uploading jig got designed and fabricated by mechanical team, used later on in 1 m telescope house for installing new and additional hoist (one unit mainly for safety purpose) on the reverse roof of dome.

Cleaning the mirror before aluminization

Regular assistance continued to be provided to various projects, telescopes and labs, including the opto-mechanical 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 test mirrors passed the scotch tape test and visual tests at Optics laboratory. Routine jobs like evacuation of CCD dewars continued.

The mirror just after aluminization.

1.3. 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 H flare patrolling system, which takes fast sequence of images in the flare mode observations. 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.

15-cm Coude Solar tower telescope for solar observations.

1.4. Atmospheric science 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.

1.5. The 130-cm Telescope facility at Devasthal;

The telescope is equipped with 512 X 512 electronically coated CCD camera and standard astronomical filters. Routine observations with 130-cm telescope is successfully carried out by scientists according to their programme.

1.3-m Devasthal Optical Telescope.

2. Support Facilities

ARIES has a modern 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. Computer Centre

National knowledge Network Project:

Now ARIES is a part of prestigious NKN (National knowledge Network) project. The router provided by National Informatics Centre, New Delhi has been installed. The NKN(National knowledge Network) comprises of an ultra-high speed CORE 1 Gbps, complimented with a distribution layer at appropriate speeds. ARIES at the Edge will connect to the National Knowledge Network seamlessly at speeds of 1 Gbps or higher. The network is designed to support Overlay Networks, Dedicated Networks, and Virtual Networks.

Hindi Software SAARANSH has been procured for ARIES with unlimited licenses so that employees can do their work in Hindi also.

Annual Procurement and in-house training:
Two new workstations, one in mechanical section and the other EARTH are installed. 25 new desktops and 3 new laptops were procured to facilitate faculty members, students and other staff.

Training to Engineering and Diploma students on following topics-

- High Performance Cluster development using old computers
- Web Site Management
- Networking

Internet connectivity at Devasthal Guest House:
Using VDSL Technology Internet connectivity is provided in the Devasthal Guest House**.** VDSL technology extends LAN over Telephone Line.

2.2. 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 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 2011 – 2012, the following information resources were added:-

Books	:50
Subscription to Journals (Print + Online)	:100
ARIES Publications	:75
ARIES Theses	:8

The collection at the end of the period is Books	:Around 10,360
Bound volumes of Journals	:Over 11,100

Apart from books and journals, non-book materials such as slides, charts, maps, diskettes, CD-ROMs, etc. are also available in the KRC. During 2011 – 12, 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.

The ARIES KRC is a member of FORSA (Forum for Resource Sharing in Astronomy and Astrophysics), which was established by Indian Astronomy Librarians in 1979. The ARIES KRC is also a member of National Knowledge Resource Consortium. 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).

2.3. 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 2011 – 2012 are as follows: *At Manora Peak* Construction of 10 units of Lab (Residences) Blocks and ST Radar Building is in progress. *At Devasthal,* Guest House has 5 rooms with the necessary facilities. It has dining area with a sitting capacity of about 15 persons. Inauguration of the building was done by Prof. G. Srinivasan on 09 May, 2011.

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

2.4. 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, up-gradation 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.

2.5. Mechanical Section

Mechanical section provides mechanical engineering support to almost all sections 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 up-coming projects through out the year. The section is equipped with machine shop, welding shop and carpentry shop along with design section and stores. 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. The vendor for construction of 3.6-m DOT enclosure was identified. Tender documents for 3.6-m enclosure cranes and International Liquid Mirror Telescope (ILMT) enclosure design were also floated. ADFOSC preliminary design review was accomplished..

2.6. 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 support activities such as LIDAR project, B-N Schmidt telescope, 130-cm and upcoming 360-cm Devesthal optical telescopes.

The laboratory has acquired new vibration isolation tables, fiber optics, LASERS, wave-front 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 2922'26'' North; longitude 7940'57'' 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 3.6m 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 3.6m DOT project is monitored and advised periodically by a 9-member Project Management Board chaired by Professor P.C. Agrawal. The PMB met thrice during 2011-2012. 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 more than a dozen occasions to monitor the activities. Two progress review meetings took place at AMOS Belgium to discuss issues related to various interfaces of the telescope and the observatory. During April 2011 – March 2012, most of the scheduled project activities were carried out successfully.

3.1.2. Telescope Manufacturing: The telescope manufacturing is being done by AMOS Belgium. Two key milestones were completed – i.e. M1 delivery at AMOS and the test of active optics with active mirrors. The polishing of M1 mirror was completed by LZOS Russia in the second week of August 2011. The M1 mirror was successfully transferred to the AMOS workshop on 9th September 2011. Final measured value of the WFE RMS at 633 nm is less than 35 nm and the value of CIR at 500nm is greater than 0.99. The telescope was considered ready for integration of the optics in November 2011. Now, the telescope is fully integrated with the real optics and the sky tests are in progress at the workshop (**Figure 1**). Preliminary results from the sky tests done in March 2012 indicate that the telescope optics can deliver as good as 0.3 arcsec of resolution. The pre-shipment acceptance of the telescope is planned in May 2012. In order to ensure safe transportation of telescope components, a dry run to transport a largest size packing box was conducted by ARIES. The run was carried out from Kathgodam to Devasthal

starting on the night of 6th February 2012. The route via Gethiya-Bhowali was found suitable. The difficulties encountered at various places during the dry run were recorded and for safe transportation, ARIES has been following up for their timely solutions with various state departments.

Figure 1. Fully assembled telescope with real mirrors at AMOS workshop. The Dummy instrument with one axial port and two side ports are shown in yellow.

3.1.3. Telescope enclosure and auxiliary building : The design of the civil work up to plinth level of the telescope site was done by M/s PPS Limited, Pune. A contract for the civil work up to plinth level and site development was awarded to M/s Vidyawati construction company, Allahabad and the completion date was 13th December 2011. However, the contractor completed only about 33% value of work by the due time and hence as per suggestion of the 16th PMB meeting, the contract of M/s Vidyawati was not extended after 13th Dec 2011. For the completion of the remaining work, the contract is now awarded to M/s Ghar Construction, Moradabad. The civil work is progressing satisfactorily. For 'Manufacture, supply, erection and commissioning of telescope enclosure structure and equipments for the 3.6m Devasthal Optical Telescope', a contract agreement has been signed with the M/s Pedvak Hyderabad. The work is divided into three parts – extension of building structure, dome support structure and dome structure. The fabrication drawings have been finalized. Procurement of material and construction of structure is in progress at M/s Pedvak Hyderabad.

3.1.4. Observatory control and data archive system : An observatory control and data archive system for 3.6m DOT is being developed in-house at ARIES. The development of Dome control system is progressing satisfactorily. The algorithm to synchronize the motions of dome and the telescope has been developed. The study found that there would be two regions of avoidance (blind spot) near zenith, one for telescope and another for the dome. A detailed technical report has been prepared. A preliminary GUI for 3.6m DOT Dome control system as well as for the observatory control system has been tested. The design for hardware of the dome control system has been finalized.

3.1.5. ADFOSC instrument : ARIES-Devasthal faint object spectrograph and camera (ADFOSC) is the first generation instrument at the axial port of the 3.6m DOT and is being designed and developed in-

house. The instrument will cover the wavelength range of 350-1000 nm. The instrument will have two distinct observing modes - (i) direct broad- and narrow-band imaging capabilities with one-pixel resolution of less than 0.2 arcsec in the whole field of view (10 arcmin diameter) - (ii) low-to-medium resolution spectroscopy with spectral resolution (250-4000) covering the optical wavelength range of 350-1000 nm. The Critical Design Review of FOSC took place on 31st January 2012. The expert members of the CDR committee showed satisfaction on the presented optical and mechanical design of ADFOSC (**Figure 2**) and they recommended that the manufacturing process can be initiated. Consequently, a global tender for manufacturing the collimator and camera assembly of FOSC was floated and the Winlight system, France was selected for the supply of collimator and camera assembly and the contract was signed in March 2012.

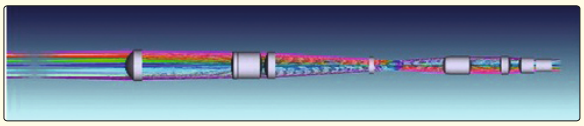


Figure 2 : The final optical design of ADFOSC instrument.

3.1.6. Optical Imager : In view of some anticipated delay in commissioning of the ADFOSC instrument, the development of a 4kx4k CCD camera with liquid Nitrogen Dewar has been recommended as a first light instrument in the 15th PMB meeting of 3.6m DOT. A detailed design report was prepared and it was decided that the CCD camera can be procurred while the mechanical and electrical interfaces can be developed in-house. The mecahnical interface design for the imager has been completed (**Figure 3**). A tender for procurement of the CCD camera was floated on 22nd November 2011, only two vendors responded and after evaluation of technical bid, the contract to build the CCD was signed with the Semiconductor Technology Associates (STA) in March 2012.

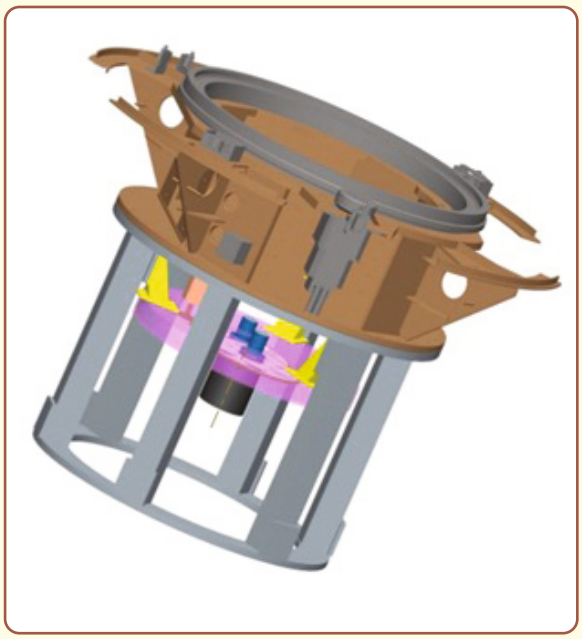


Figure 3. The mounting plan for the 4kx4k optical imager with the instrument interface of the 3.6m DOT.

3.1.7. High resolution optical spectrograph:

A preliminary ground work for development of a high-resolution optical spectrograph for 3.6m DOT has been completed. The chemical abundance and asteroseismological studies will be two key science goals and to achieve it, the instrument will have two resolution mode – 30k and 60k with a radial velocity resolution of 5m/s. A national committee has been constituted to monitor progress of the project. The work on opto-mechanical design of the instrument is in advanced stage. The manufacturing, assembly and testing are planned to be done in-house.

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. 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 is found to be almost opposite to that at Naintal.

3.2.2. 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.

3.2.3. 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.

6. Other Activities

1. Academic Committee

The Academic Committee (AC) of ARIES is pursuing the academic endeavours of the Institute. In the year 2011-12, ARIES has signed MoUs with Pandit Ravishankar Shukla Univeristy, Raipur and Gurukul Kangri, University Haridwar. In the previous years MoUs have also been signed with Deen Dayal Upadhyay University (DDUU), Gorakhpur and Pantnagar University, Pantnagar . The MoU with the Kumaun Univeristy, Nainital has been renewed. Apart from it, ARIES has been the participating institutes under JEST since last many years in conducting/selecting Ph. D. students for ARIES . Four research fellows were selected for pursuing their Ph. D. work during the period.

The summer project internship is one of the significant efforts of the academic committee which provides training to Bachelor/Master level students from various universities and provides glimpses in cutting-edge research and development activities of the Institute. In the summer of 2011-2012, twelve summer project students were selected for pursuing project at ARIES. At the end of the project each student submitted a project report and were asked to present their work as oral presentations.

Academic committee has made the detailed course work structure in Astronomy & Astrophysics, and Atmospheric Science for the students joining the ARIES. The course structure is well synchronized with the course works of various universities with whom we are having the MoUs. The courses contain the basic physical aspects, instrumental techniques, programming and numerical methods, and basic research methodology in the concerned topics. The course work is conducted in trimesters.

All the applications related to postdoctoral fellows are processed throughout the year by AC under the guidance of the Director. Two Post Doc Fellows were selected during the year.

2. Conferences/Workshops:

2.1. A Workshop on National technology day at ARIES, Nainital during 11-12 May-2011

On the occasion of National technology day workshop was organized during 11-12 May-2011, which was sponsored by Uttarakhand State Council for Science and Technology (**UCOST**), with the theme focused on "Astronomy: Pushing technology to its Edge".

In this two days workshop, first aim was to introduce astronomy to the school children, so that everyone should realize the impact of astronomy and other fundamental sciences on our daily lives, and understand how scientific knowledge can contribute to our understanding of the universe and as well towards a more equitable and peaceful society. In addition during the workshop there were (i) a live sky show to encourage the school children and teacher interest in this field (ii) poster exhibition about the various exciting astronomical phenomena (iii) Lecture demonstrating the path to

become a successful astronomer along with many lecture illustrating the link between astronomy and technology. Finally some books/literature on astronomy popularization were also distributed to the participants.

There were around 50 selected school students and about 10 school teachers as a participant of this workshop. The workshop was inaugurated by Dr. R. Dobhal, Director general UCOST. Prof. R. Sagar presented welcome address and talked about the ARIES effort to encourage science activity in school. Popular lectures were delivered by speakers from Vigyan Prasar, Planetarium and ARIES.

2.2. Workshop on Scientific exposure of Students on Astronomy (SESA) at ARIES in association with People's Association of Hill Area Launchers (PAHAL) during 28-30 May 2011

This workshop was held at ARIES, during 28-30 May 2011. The event was sponsored by Departments of Science & technology, Govt. of India and ARIES provided local hospitality along with organization of lectures by ARIES scientists. About 70 school students and about a dozen school teachers attended the workshop. The workshop was inaugurated by Prof. R. Sagar, Director, ARIES.

In this three days residential workshop of SESA-2011, aim was to introduce observational sciences to the school children, so that everyone should realize the impact of atmosphere & astronomy and other fundamental sciences on our daily lives, and understand how scientific knowledge can contribute to our understanding of the universe and as well towards a more equitable and peaceful society.

Students and Teachers viewing through telescope

2.3. Two day workshop on Introduction of Observational Sciences to the School children during 05-06 June, 2011

The two day workshop in association with NASI Allahabad, where 120 well selected students visited ARIES during 5-6 June 2011. The focus of this workshop was to introduce observational sciences to the school children (i) live sky show to encourage the school children and teachers interest in this field (ii) poster exhibition about the various exciting astronomical phenomena (iii) Lecture demonstrating the path to become a successful astronomer along with many lectures illustrating the link between astronomy and technology.

There were around 120 school students and about half dozen of school teachers as

Participants in this workshop selected from schools around the country.

2.4. A workshop on Astronomy and Planetary Science during 13-14 December, 2011

The two day workshop on the occasion of Geminids 'a meteor' which peak during 13-14 December-2011, in association with COSMOS-SAFARI, with the theme focused on "Astronomy and Planetary Science" was organized.

In this two days workshop , aim was (i) to introduce astronomy to the school children (ii) live sky watching of meteor shower (iii) Lectures demonstrating the path to become a successful astronomer along with many lectures illustrating the link between astronomy and technology.

3. Pedagogical Activities

3.1. Public Outreach

Public Outreach is an ongoing program at ARIES. Department of Science and Technology (DST) also supports these activities to increase general awareness about astronomy and basic sciences in common people. ARIES has made a science center comprising one lecture hall, equipped with projector and sitting arrangements of about 40 students and a exhibition hall to display the science model and posters. In addition a small 14 inch telescope has been installed to have direct display of live night sky on the lecture hall for general public. Visitors and group of students from different schools/colleges are entertained regularly during day and nights.

3.2. ARIES Training School on Radar Probing of the Atmosphere (07-11 November, 2011):

Aryabhatta Research Institute of Observational Sciences (ARIES) is going to establish and commission a Stratosphere-Troposphere Radar (ST-Radar) that will be a unique system of this kind, hence the ARIES decided to organize a DST sponsored school entitled: "Radar Probing of the Atmosphere" which was held during 08 – 22 November, 2011 at ARIES Campus. This school aimed to attract the young Ph.D./M. Sc. (Physics/Atmospheric/Environmental/Space Sciences/Geophysics) and B. Tech. (Environmental/Electronics Engineering) students to the upcoming ST-Radar facility of ARIES, Nainital. In total 115 applications were received from different Universities/Institutes out of these 30 candidates were shortlisted and invited to attend the school. Renowned experts from different Universities/Institutes were invited to deliver lectures and invited talks. In order to organize the school, DST kindly sanctioned the required budget. The local hospitality and travel support to all participants were borne by ARIES.

3.3. Five days training workshop for understanding the instruments and data analysis techniques under the Regional Aerosol Warming Experiment – (RAWEX) - Ganges Valley Aerosol Experiment (GVAX) at ARIES during 28th November – 02nd December 2011.

Five days training workshop for understanding the instruments and data analysis techniques under the Regional Aerosol Warming Experiment – (RAWEX) - Ganges Valley Aerosol Experiment (GVAX) was organized at Aryabhatta Research Institute of Observational Sciences (ARIES), Nainital during 28th November to 02nd December 2011. There were thirty participants from different institutes and universities/colleges.

Instrument at GVAX Site

Radiosonde Launch

Particpants attending the hands-onexperiences

ARIES Scientist with Dr. V. P. Ghate

3.4. ARIES training school in Observational Astronomy (ATSOA) -2012 (Feb 27-March 6, 2012)

The annual school ARIES training school in Observational Astronomy (ATSOA) was held between Feb 27-March 6 2012, The main motivation for this school was that our current understanding of the Universe depend not only on continuous growth of observation facilities, but also on the number of peoples utilizing them.

About 30 participants from various universities and institutes participated in the school. The focus was on hand on experience on observational Astronomy using 1m-ARIES telescope. There were about two dozen of lectures by ARIES faculty and small projects supervised by ARIES research scholars to give first hand experience dealing on real astronomical data. To give finishing touch on the projects, a small presentation was also given by participants on the project work carried out during the school.

7.PUBLICATIONS

REFEREED JOURNALS

A. Published

1. Study of atmospheric aerosols over the central Himalayan region using a newly developed Mie light detection and ranging system: Preliminary results, **T. Bangia, A. Omar, R. Sagar, A. Kumar, S. Bhattacharjee, A. Reddy**, P. K. Agarwal and **P. Kumar**, *Jr. Appli. Remo. Sens.* 2011, vol. 5, p. 053521-1.

2. Optical intraday variability studies of 10 low energy peaked blazars, **B. Rani, A. C. Gupta**, U. C. Joshi, S. Ganesh and P. J. Wiita, *Mon. Not. Roy. Astron. Soc.* 2011, vol. 413, p. 2157.

3. A second set of RATAN-600 observations of giant radio galaxies,M. L. Khabibullina, O. V. Verkhodanov, **M. Singh, A. Piya, S. Nandi** and N. V. Verkhodanova, *Astro. Rep.* 2011, vol. 55, p. 392.

4. A study of giant radio galaxies at RATAN-600, M. L. Khabibullina, O. V. Verkhodanov, **M. Singh, A. Priya, S. Nandi** and N. V. Verkhodanova, *Astrophy. Bull.* 2011, vol. 66, p.171.

5. SN 2008gz - most likely a normal type IIP event, **R. Roy** et al. (including **B. Kumar, Brajesh Kumar, S. B. Pandey** and **R. Sagar**), *Mon. Not. Roy. Astron. Soc.* 2011, vol. 414, p. 167.

6. Optical potometric study of the open clusters Koposov 12, Koposov 53 and Koposov 77, **R. K. S. Yadav**, E. V. Glushkhova, **D. P. Sariya**, A. V. Porokhova, **B. Kumar** and **R. Sagar**, *Mon. Not. Roy. Astron. Soc.* 2011, vol. 414, p. 652.

7. Crossing filaments, B. Filippov and **A. K. Srivastava**, *Sol. Phy.* 2011, vol. 270, p. 151.

8. Spectral and photometric monitoring of distant core-collapse supernovae in the SAO RAS, A. S. Moskvitin, T. A. Fatkhullin, V. V. Sokolov, V. N. Komarova, A. J. Drake, **R. Roy** and D. Yu. Tsvetkov, *Astrophy. Bull.* 2011, vol. 65, p. 230.

9. Discovery of the first giant double radio relic in a galaxy cluster found in the Planck Sunyaev-Zel'Dovich cluster survey: Plack G287.0+32.9, J. Bagchi et al. (including **S. Joshi**), *Ap. Jr. Lett.* 2011, vol. 736, L8.

10. The discovery and nature of the optical transient CSS100217:102913+404220, A. J. Drake et al. (including **R. Roy** and **B. Kumar**), *Astrophy. Jr.* 2011, vol. 735, p. 106.

11. Actors of the main activity in large complex centres during the 23 solar cycle maximum, B. Schmieder et al. (including **W. Uddin** and **P. Kumar**), *Adv. Space Res.* 2011, vol. 47, p. 2081.

12. Observations of the ultra-fast Kelvin wave in the tropical mesosphere during equinox, **A. Guharay, P. Pant**, B. Pande and K. Pandey, *Int. Jr. Rem. Sens.* 2011, vol. 32, p. 3043.

13. Stable carbon and nitrogen isotopic composition of bulk aerosols over India and northern Indian Ocean, R. Agnihotri, T. K. Mandal, S. G.

Karapurkar, **M. Naja**, R. Gadi, Y. N. Ahammmed, A. Kumar, T. Saud and M. Saxena, *Atmos. Envir.* 2011, vol. 45, p. 2828.

14. SN 2008in-bridging the gap between normal and faint supernovae of type IIP, **R. Roy, B. Kumar** et al. (including **Brajesh Kumar, S. B. Pandey** and **R. Sagar**), *Astrophy. Jr.* 2011, vol. 736, p. 76.

15. Light pollution: A menace to optical astronomy, **P. Pant**, *Geo Imaginations* 2011, vol. 1, p. 11.

16. Opto-mechanical design, analysis and economical manufacture of a large Lidar receiver telescope, **T. Bangia**, P. K. Agarwal, **A. Kumar, S. K. Singh** and **R. Sagar**, *Jr. Eng. Tech. Res.* 2011, vol. 3, p. 180.

17. Star formation in bright-rimmed clouds and clusters associated with the W5 E H II region, **N. Chauhan**, **A. K. Pandey**, K. Ogura, **J. Jose**, D. K. Ojha, **M. R. Samal** and H. Mito, *Mon. Not. Roy. Astron. Soc.* 2011, vol. 415, p. 1202.

18. Re-analysis of QPO in 3C 273 light curve, P. Mohan, A. Mangalam, **H. Chand** and **A. C. Gupta**, *Jr. Astrono. Astrophy.* 2011, vol.32, p. 117.

19. UV and X-ray variability of blazars, **A. C. Gupta**, *Jr. Astrono. Astrophy.* 2011, vol. 32, p. 155.

20. Variability of spectral energy distribution of Blazar S5 0716+714, **B. Rani, A. C. Gupta** and P. J. Wiita, *Jr. Astrono. Astrophy.* 2011, vol. 32, p. 217.

21. Observation of intensity oscillations above X-ray bright points from the Hinode/XRT: Signature of magnetohydrodynamic oscillations in the solar corona, M. Kumar, **A. K. Srivastava** and B. N. Dwivedi, *Mon. Not. Roy. Astron. Soc.* 2011, vol. 415, p. 1419.

22. Size distribution of atmospheric aerosols at Maitri, Antarctica, **V. Pant,** D. Singh and A. K. Kamra, *Atm. Env.* 2011, vol. 45, p. 5138.

23. Observations of X-ray flares and associated MHD oscillations in star ξ Boo, J. C. Pandey and **A. K. Srivastava,** *Adv. Geosci.* 2011, vol. 27, p. 181.

24. Evidence of the leakage of MHD oscillations above on-disk coronal hole, M. Kumar, B. N. Dwivedi and **A. K. Srivastava,** *Adv. Geosci.* 2011, vol. 27, p. 113.

25. Observation of kink instability as driver of recurrent flares in AR 10960, **A. K. Srivastava, P. Kumar,** T. V. Zaqarashvili, B. P. Filippov, M. L. Khodachenko and **W. Uddin,** *Adv. Geosci.* 2011, vol. 27, p. 141.

26. Search for P-mode pulsations in late-type CP stars, **S. Joshi** and N. K. Chakradhari, *Adv. Geosci.* 2011, vol. 27, p. 219.

27. On the source of the super-storm of solar-cycle # 23 associated with the so- lar flares on 18 November 2003, **P. Kumar,** P. K. Manoharan, **W. Uddin** and K. Mahalakshmi, *Adv. Geosci.* 2011, vol. 27, p. 129.

28. Quasi-spherical, time-dependent viscous accretion flow: One-dimensional results, S. Lee, D. Ryu and **I. Chattopadhyay,** *Astrophy. Jr.* 2011, vol. 728, p. 142.

29. Altitude variation of aerosol properties over the Himalayan range inferred from spatial measurements, **U. C. Dumka,** K. K. Moorthy, S. N. Tripathi, P. Hegde and **R. Sagar,** *Jr. Atmos. Sol. Terr. Phy.* 2011, vol. 73, p. 1747.

30. Rapid optical variability of TeV blazars, Gopal-Krishna, **A. Goyal, S. Joshi,** C. Karthick, **R. Sagar,** P. J. Wiita, G. C. Anupama and D. K. Sahu, *Mon. Not. Roy. Astron. Soc.* 2011, vol. 416, p. 101.

31. Star formation activity in the galactic H II complex S255-S257, D. K. Ojha, **M. R. Samal, A. K. Pandey,** B. C. Bhatt, S. K. Ghosh, **S. Sharma,** M. Tamura, V. Mohan and I. Zinchenko, *Astrophy. Jr.* 2011, vol. 738, p. 156.

32. Effects of the composition on transonic properties of accretion flows around balck holes, **I. Chattopadhyay** and S. K. Chakrabarti, *Ind. Jr. Mord. Phy-D* 2011, vol. 20, p. 1597.

33. A kinematic and photometric study of the galactic young star cluster NGC 7380, W. P. Chen, **A. K. Pandey, S. Sharma,** C. W. Chen, L. Chen, J. Sperauskas, K. Ogura, R. J. Chuang and R. P. Boyle, *Astrono. Jr.* 2011, vol. 142, p. 71.

34. The swift/Fermi GRB 080928 from 1 eV to 150 KeV, A. Rossi, et al. (including **S. B. Pandey**), *Astrono. Astrophy.* 2011, vol. 529, p. A142.

35. Multiwavelength study on solar and interplanetary origins of the strongest geomagnetic strom of soalr cycle 23, **P. Kumar,** P. K. Manoharan and **W. Uddin,** Sol. Phy. 2011, vol. 271, p. 149.

36. GRB 090618: detection of thermal x-ray emission from a bright gramma-ray burst, K. L. Page, et al. (including **S. B. Pandey**), *Mon. Not. Roy. Astron. Soc.* 2011, vol. 416, p. 2078.

37. A possibility of Magnus effect on disk galaxies, **A. Omar,** *Curr. Sci.* 2011, vol. 100, p. 1391.

38. Stars at the tip of peculiar elephant trunk-like clouds in IC 1848E: a possible third mechanism of triggered star formation, **N. Chauhan**, K. Ogura, **A. K. Pandey, M. R. Samal** and B. C. Bhatt, *Pub. Astrono. Soci. Japan* 2011, vol. 63, p. 795.

39. Observations of a pulse-driven cool polar jet by SDO/AIA, **A. K. Srivastava** and K. Murawski, *Astrono. Astrophy.* 2011, vol. 534, p. A62.

40. D-region ionosphere response to the total solar eclipse of 22 July 2009 deduced from ELF-VLF tweek observations in the Indian sector, R. Singh, et al. (including **P. Pant**), *Jr. Geophysical Res.* 2011, vol. 116, p. A10301.

41. Influences of the springtime northern Indian biomass burning over the central Himalayas, **R. Kumar, M. Naja,** S. K. Satheesh, **N. Ojha**, H. Joshi, T. Sarangi, **P. Pant, U. C.**

Dumka, P. Hegde and S. Venkataramani, *Jr. Geophysical Res.* 2011, vol. 116, p. D19302.

42. Multiwavelength observations of a failed flux rope in the eruption and associated M-Class flare from NOAA AR 11045,**P. Kumar, A. K. Srivastava**, B. Filippov, R. Erdelyi and **W. Uddin,** *Sol. Phy.* 2011, vol. 272, p. 301.

43. Spectral energy distribution variation in BL Lacs and flat spectrum radio quasars, **B. Rani**, et al. (including **A. C. Gupta**), *Mon. Not. Roy. Astron. Soc.* 2011, vol. 417, p. 1881.

44. Numerical simulations of solar macrospicules, K. Murawski, **A. K. Srivastava** and T. V. Zaqarashvili, *Astrono. Astrophy.* 2011, vol. 535, p. A58.

45. Photometric search for variable stars in the young open cluster Berkeley 59, **S. Lata, A. K. Pandey, G. Maheswar, S. Mondal** and **B. Kumar**, *Mon. Not. Roy. Astron. Soc.* 2011, vol. 418, p. 1346.

46. The new 130-cm optical telescope at Devasthal, Nainital, **R. Sagar, A. Omar, B. Kumar, M. Gopinathan, S. B. Pandey, T. Bangia, J. Pant, V. Shukla** and **S. Yadav,** Curr. Sci. 2011, vol. 101, p. 1020.

47. Distance to dense cores that contain very low luminosity objects, **G. Maheswar,** C. W. Lee and S. Dib, *Astrono. Astrophy.* 2011, vol. 536, p. A99.

48. Photometric study of the close eclipsing binary MM Dra, R. Bachev, et al. (including **A. C. Gupta**), *Bulg. Astrono. Jr.* 2011, vol. 15, p. 93.

49. A search for rapid optical variability in low-mass seyfert galaxies: NGC 4395, E. Semkov, et al. (including **A. C. Gupta**), *Bulg. Astrono. Jr.* 2011, vol. 17, p. 1.

50. Information seeking behavior of library users at aryabhatta research institute of Observational science (ARIES), India, **Prashant Kumar** and S. Kumar, *Inter. Jr. of Infor. Res.* 2011, vol. 1, p. 39.

51. A low-frequency study of two asymmetric large radio galaxies, **A. Pirya, S. Nandi**, D. J. Saikai and **M. Singh**, *Bull. Astron. Soc. India* 2011, vol. 39, p. 547.

52. A Multifrequency study off five large radio galaxies, **A. Pirya, S. Nandi**, D. J. Saikai, C. Konar and **M. Singh**, *Jr. Astrophy. Astron.* 2011, vol.32, p. 471.

53. Observation of X-ray flares in G-K dwarfs by XMM-Newton, **J. C. Pandy** and K. P. Singh, ASP Conf. Seri. 2011, vol. 448, p. 301.

54. Stellar contents and star formation in the young cluster stock 18, **H. Bhatt, R. Sagar** and **J. C. Pandy**, *New Astrono.* 2012, vol. 17, p. 160.

55. Influence of regional pollution and long range transport over western India: Analysis of ozonesonde data, S. Srivastava, S. Lal, **M. Naja**, S. Venkataramani and S. Gupta, *Atmos. Env.* 2012, vol. 47, p. 174.

56. A study of X-ray flares-II. RS CVn-type binaries, **J. C. Pandey** and K. P.

Singh, *Mon. Not. Roy. Astron. Soc.* 2012, vol. 419, p. 1219.

57. Observations of post-flare plasma dynamics during an M1.0 flare in AR11093 by the solar dynamics observatory/astmospheric imaging assembly, **A. K. Srivastava** and K. Murawski, *Astrophy. Jr.* 2012, vol. 744, p. 173.

58. Optical intra-day variability timescales and black hole mass of the blazars, S. P. Gupta, U. S. Pandey, K. Singh, **B. Rani**, J. Pan, J. H. Fan and **A. C. Gupta**, *New Astro.* 2012, vol. 17, p. 8.

59. Multiwavelength variability of the blazars Mrk 421 and 3C 454.3 in the high state, **H. Gaur, A. C. Gupta** and P. J. Wiita, *Astro. Jr.* 2012, vol. 143, p. 23.

60. Photometric study and detection of variable stars in the open clusters- I. NGC 6866, **Y. C. Joshi, S. Joshi, B. Kumar, S. Mondal** and L. A. Balona, *Mon. Not. Roy. Astron. Soc.* 2012, vol. 419, p. 2379.

61. Observational signatures of the coronal Kink instability with thermal conduction, G. J. J. Botha, T. D. Arber and **A. K. Srivastava**, *Astrophy. Jr.* 2012, vol. 745, p. 53.

62. Black carbon aerosols over Manora Peak in the Indian Himalayan foothills: Implications for climate forcing, **A. K. Srivastava**, K. Ram, **P. Pant**, P. Hegde and H. Joshi, *Enviro. Res. Lett.* 2012, vol. 7, p. 014002.

63. Faint high-energy gamma-ray photon emission of GRB 081006A from fermi observations, W. Zheng, C. W. Akerlof, **S. B. Pandey**, T. A. McKay, B. Zhang and B. Zhang, *Astrophy. Jr.* 2012, vol. 745, p. 72.

64. GRB 081029: A gamma-ray burst with a multi-component afterglow, S. T. Holland, et al. (including **S. B. Pandey**), *Astrophy. Jr.* 2012, vol. 745, p. 41.

65. Probing spectral properties of radio-quiet quasars searched for optical microvariability - II, **R. Joshi, H. Chand**, P. J. Wiita, **A. C. Gupta** and R. Srianand, *Mon. Not. Roy. Astron. Soc.* 2012, vol. 419, p. 3433.

66. Broad-band optical polarimetric studies towards the galactic young star cluster Berkeley 59, **C. Eswaraiah, A. K. Pandey, G. Maheswar**, W. P. Chen, D. K. Ojha and H. C. Chandola, *Mon. Not. Roy. Astron. Soc.* 2012, vol. 419, p. 2587.

67. Aerosol characterization over a high altitude location in central himalayas, **P. Pant**, *Jr. of Inst. Eng.* 2012, vol. 8, p. 87.

68. Black carbon aerosol characteristics and its radiative impact over nainital: a high-altitude station in the central himalayas, **A. K. Srivastava, P. Pant, U. C. Dumka** and P. Hegde, *Jr. of Inst. Eng.* 2012, vol. 8, p. 1.

69. Searching for soft relativistic jets in core-collapse supernovae with the IceCube optical follow-up program, R. Abbasi, et al. (including **S. B. Pandey**), *Astron. and Astrophy.* 2012, vol. 539, p. A60.

70. Quasi-simultaneous two-band optical variability of the blazars 1ES 1959+650 and 1ES 2344+514, **H. Gaur**, et al. (including **A. C. Gupta**), *Mon. Not. Roy. Astron. Soc.* 2012, vol. 420, p. 3147.

71. A multiwavelength study of an M-class flare and the origin of an associated eruption from NOAA AR 11045, B. N. Dwivedi, **A. K. Srivastava**, M. Kumar and P. Kumar, *New Astro.* 2012, vol. 17, p. 542.

72. FR Cns revisited: photometry, polarimetry and spectroscopy, A. Golovin, et al., (including **J. C. Pandey**), *Mon. Not. Roy. Astron. Soc.* 2012, vol. 421, p. 132.

73. The changes in near-surface ozone and precursors at two nearby tropical sites during annular solar eclipse of 15 January 2010, I. A. Girach, P. R. Nair, L. M. David, P. Hegde, M. K. Mishra, G. M. Kumar, **N. Ojha** and **M. Naja,** *Jr. Geophys. Res.* 2012, vol. 117, p. D01303.

74. VVV DR1: The first data release of the Milky Way bulge and southern plane from the near-infrared ESO public survey VISTA variables in the Vía Láctea, R. K. Saito, et.al (including **S. Sharma**), *Astron. Astrophy.* 2012, vol. 537, p. A107.

75. Simulations over South Asia using the weather research and forecasting model with chemistry (WRF-Chem): Set up and meteorological evalution, **R, Kumar, M. Naja,** G. G. Pfister, M. C. Barth and G. P. Brassur, *Geosci. Model Dev.* 2012, vol. 5, p.321.

B. Papers in Press

1. Observational evidence for black hole spin down in Swift/BAT data of long GRBs, **A. C. Gupta** and M. H. P. M. van Putten (*BASI*).

2. Photometric study and detection of variable stars in the open clusters - I. NGC 6866, **Y. C. Joshi, S. Joshi, B. Kumar, S. Mondal,** and L. A. Balona *(Mon. Not. Roy. Astron. Soc.)*.

3. Effect of equation of state and composition on relativistic flows, **I. Chattopadhyay**, S. Mandal, H. Ghosh, S. Garain, R. Kumar and D. Ryu *(Bull. Astron. Soc. India)*.

4. The globular cluster system of NGC 1316. II - The extraordinary object SH2, T. Richtler, **B. Kumar,** L. P. Bassino, B. Dirsch, A. J. Romanowsky (*Astron. and Astrop.*).

5. The globular cluster system of NGC1316. I. Wide-field photometry in the Washington system, T. Richtler, L. P. Bassino, B. Dirsch, **B. Kumar** *(Astron. and Astrop.)*.

6. The IMF of intermediate-mass stars in young star clusters, **R. Sagar** and **B. Kumar** *(ASI Conference Serices)*.

7. New optical telescopes at Devasthal Observatory : 1.3m installed and 3.6m upcoming, **R. Sagar, B. Kumar, A. Omar** and **Y. C. Joshi (***ASI Conference series)*.

8. Panchromatic observations of the textbook GRB 110205A: constraining physical mechanisms of prompt emission and afterglow, W. Zheng, et al. (including **S. B. Pandey**) *(Astrophy. Jr.)*.

9. A comprehensive multi-wavelength modeling of GRB 0505025A afterglow L. Resmi, et al. (including **S. B. Pandey**) *(Mon. Not. Roy. Astron. Soc.).*

10. Simulations over South Asia using the Weather Research and Forecasting model with Chemistry (WRF-Chem) : Set-up and meteorological evaluation, R. Kumar, **M. Naja**, G. Pfister, M. Barth and G. P. Brasseur *(Geoscientific Model Development).*

11. Observation of multiple surges associated with magnetic activities in AR10484 on 25 October 2003**, W. Uddin,** B. Schmieder, R. Chandra, **A. K. Srivastava,** P. Kumar and S. Bisht *(Astrophy. Jr.).*

12. Simulation of radiation driven wind from disc galaxies**, I. Chattopadhyay**, M. Sharma, B. B. Nath and D. Ray *(Mon. Not. Roy. Astron. Soc.).*

CIRCULARS/BULLETINS/CONFERENE PROCEEDINGS

1. Optical polarimetry and photometry of young sun-like star LO Peg, **J. C. Pandey, B. J. Medhi** and **R. Sagar,** IAU Symp. 273, 455, 2011.

2. Observations of radiatively and chemically active trace gases in the Central Himalaya and Indo-Gangetic plain region, **T. Sarangi, M. Naja**, K. P. Singh, Y. Kant, **N. Ojha, R. Kumar**, K. Pandey, S. Venkatramani, S. Lal and **R. Sagar**, *Climate Change in the Himalayas: Preserving the third pole for cooling the earth*, ed. by V. Singh, 61, 2011.

3. Impact of boundary layer dynamics on black carbon variation over the Central Himalaya and its foothills, **H. Joshi, P. Pant, M. Naja**, M. Choudhary and K. P. Singh, *Climate Change in the Himalayas: Preserving the third pole for cooling the earth*, ed. By V. Singh, 89, 2011.

4. Millimetre observations of gamma-ray bursts, A. J. Castro-Tirado, et al. (including **S. B. Pandey**), *AIP Conf. Proc.* 2011, vol. 1358, p. 109.

5. Transit include MHD oscillations: a tool to probe the solar active regions, **A. K. Srivastava**, V. M. Nakariakov, B. N. Dwivedi and P. Kumar, *ASI Conf. Series* 2011, vol. 2, p. 271.

6. On the triggering of M-class solar flare due to loop-loop interection in AR NOAA 10875, P. Kumar, **A. K. Srivastava**, B. V. Somov, P. K. Manoharan, R. Erdelyi and **W. Uddin**, *ASI Conf. Series* 2011, vol. 2, p. 315.

Ph.D. THESES

Awarded

1. Multiwavelength study of solar eruptive phenomena (space-weather events) and their interplanetary response, **P. Kumar,** (Supervisors: W. Uddin, P. K. Manoharan and Shuchi Bisht), *Kumaun University*, April, 2011.

2. Multi-wavelength studies of galactic HII regions, **M. R. Samal,** (Supervisors: A. K. Pandey, D. K. Ojha and B. Pande), *Kumaun University*, July, 2011.

3. Star formation in bright-rimmed clouds and small clusters associated with H_{II} regions, **Neelam,** (Supervisors: A. K. Pandey and P. S. Rawat), *Kumaun University,* July, 2011.

4. Multi-wavelength study of young open clusters, **H. Joshi,** (Supervisor: R. Sagar), *Kumaun University*, October, 2011.

5. Initial mass function and star formation in young star clusters, **J. Jose,** (Supervisors: A. K. Pandey and P. S. Rawat), *Kumaun University,* October, 2011.

6. Study of solar activity and solar terrestrial-links, **N. S. Bankoti,** (Supervisors: K. Pandey, W. Uddin and B. Pande), *Kumaun University,* December, 2011.

Submitted

1. Study of solar flares, prominences and CMEs, **N. C. Joshi**, (Supervisors: K. Pandey, W. Uddin & B. Pande), *Kumaun University,* July, 2011.

2. Search and study of pulsating variable stars, **Pandey, C. P.,** (Supervisors: S. Bisht and B. B. Sanwal), *Kumaun University,* October, 2011.


Gamma-Ray Bursts,
challenges and
excitements


संरक्षण समिति - सविद्या उप समिति
राष्ट्रीय विज्ञान दिवस पर आयोजित
कार्यशाला
रोल ऑफ केमिस्ट्री फॉर सस्टेनेबिल डेवेलपमेंट एण्ड
यूटीलाइजेशन ऑफ फॉरेस्ट इकोसिस्टम


Cosmos Saf
Welcomes
A group of Scientist








Panoramic View of Devasthal observing site of ARIES

SEPTEMBER, 2012

Consul, Nai