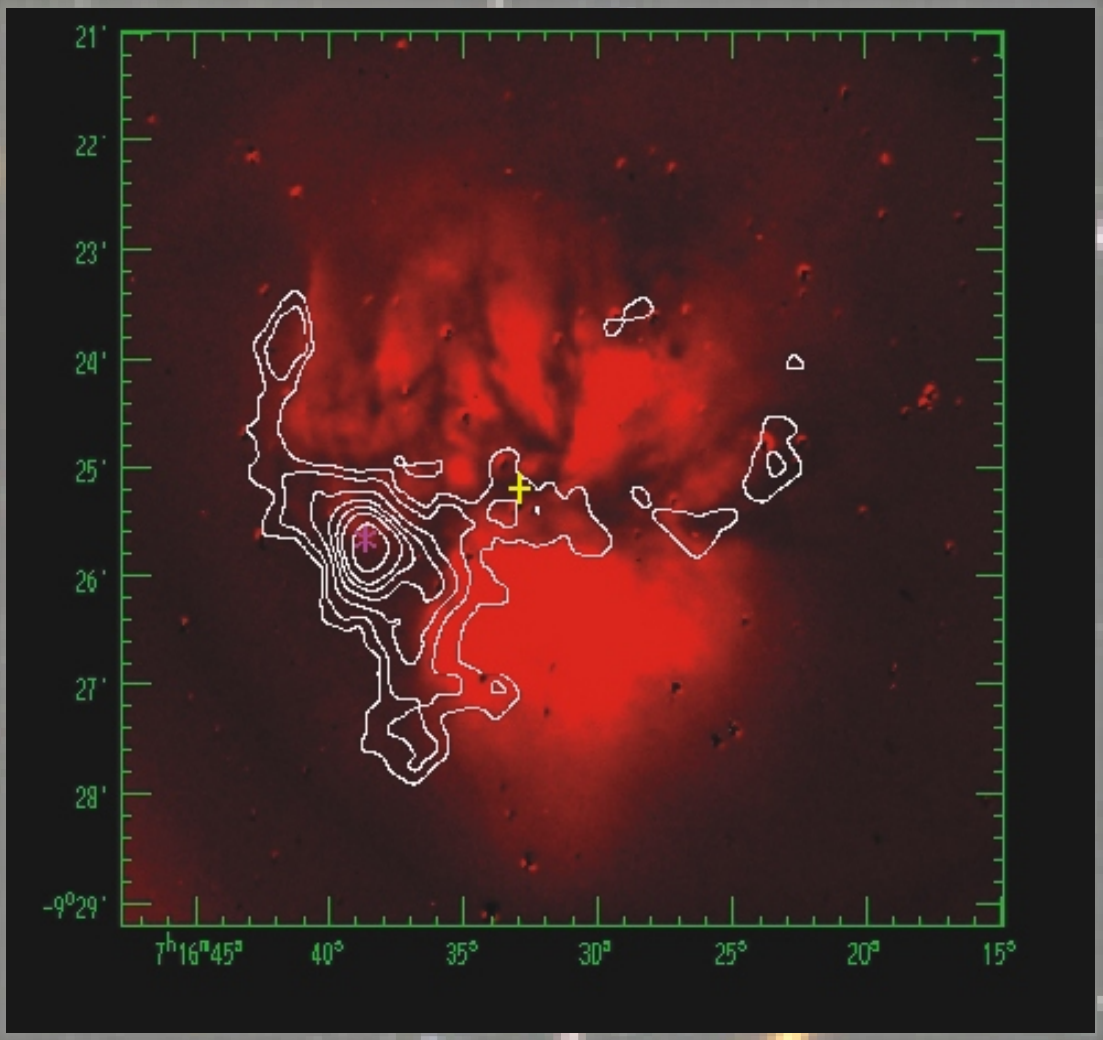
Aryabhatta Research Institute of Observational Sciences

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

Manora Peak, Nainital (India)



Academic Report
2007 – 2008

ARYABHATTA RESEARCH INSTITUTE OF OBSERVATIONAL SCIENCES

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

Manora Peak, Nainital - 263 129, India

ACADEMIC REPORT

2007 - 2008

(1st April, 2007 to 31st March, 2008)

ARIES, 2008, Academic Report: 2007 - 2008
No. 3, 48 pages

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Front cover :
MSX A-band intensity countours overlaid on an H line image of Sh 2-294 taken from 1.04-m Sampurnanand telescope at ARIES.

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August 2008

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ABBREVIATIONS

2MASS	Two Micron All Sky Survey
ADFOSC	ARIES Devasthal Faint Object Spectrograph and Camera
AGN	Active Galactic Nuclei
AMOS	Advanced Mechanical and Optical Systems
AOD	Aerosols Optical Depth
AWS	Automatic Weather Station
BNSTP	Baker Nunn Schmidt Telescope Project
CAWSES	Climate And Weather of the Sun-Earth System
CCD	Charged Coupled Device
CMD	Colour Magnitude Diagram
CME	Coronal Mass Ejection
CSD	Column Size Distribution
DFM	Dr. Frank Melsheimer
DOT	Devasthal Optical Telescope
ECIL	Electronics Corporation of India Limited
ENIGMA	European Network for the Investigation of Galactic nuclei through Multifrequency Analysis
ESO	European Southern Observatory
FORSA	Forum for Resource Sharing in Astronomy and Astrophysics
FWHM	Full Width at Half Maximum
GBP	Geosphere Biosphere Program
GRB	Gamma Ray Bursts
GRG	Giant Radio Galaxies
HETE	High Energy Transient Explorer
HIRES	High Resolution Image Restroration
IGY	International Geophysical Year
IHY	International Heliophysical Year
IMF	Initial Mass Function
IRAM	Institut de Radio Astronomie Millimetrique
IRAS	Infra Red Astronomical Satellite
ISM	Inter Stellar Matter
ISRO	Indian Space Research Organization
LCD	Liquid Crystal Display

LMC	Large Magellanic Cloud
LIDAR	Light Detection and Ranging
LISA	Library and Information Services in Astronomy
LZOS	Lytkarino Optical Glass Factory
MHD	Magnetohydrodynamic
MPG	Max Planck Gesellshaft
MSX	Midcourse Space Experiment
MWR	Multi Wavelength Radiometer
NARL	National Atmospheric Research Laboratory
NGC	New General Catalog
NIR	Near Infra Red
NLST	National Large Solar Telescope
NMHCs	Non Methane Hydrocarbons
NOAA	National Observatory of Astronomy and Astrophysics
OPAC	Online Public Access Catalogue
OPC	Optical Particle Counter
PMS	Pre Mail Sequence
PWG	Project Working Group
QPO	Quasi-Periodic Oscillation
RCC	Roller Compacted Concrete
SAG	Smart Auto Guider
SBIG	Santa Barbara Instrument Group
SDSS	Sloan Digital Sky Survey
SED	Spectral Energy Distribution
SPACE	Science Popularization Association of Communicators and Educators
ST Radar	Stratosphere Troposphere Radar
TAUVEX	Tel Aviv university Ultra Violet Explorer
TTS	T Tauri Star
UT	Universal Time
VLBA	Very Long Baseline Array
VLF	Very Low Frequency
VPD	Vector Point Diagram
WPC	Wireless Planning Commission
YSO	Young Stellar Object
ZAMS	Zero Age Main Sequence

EXECUTIVE SUMMARY

A brief account of the various activities carried out at the Institute during the period under review is presented in this Annual Report. The year 2007-08 will be remembered as a year where the good works of the previous one are being continued, with even greater zeal. ECIL, Hyderabad has been identified as a prime vender for a major project in the area of Atmospheric Physics, namely, the installation of ST Radar at ARIES.

The Institute continued to make important scientific contributions in different front-line problems of astrophysics and atmospheric sciences. Studies of fundamental nature were conducted in the areas of aerosols, solar activities, variable stars, star clusters, gamma-ray burst and supernova, extragalactic astronomy etc. The major activities carried out during the period under review are summarized below:

1. Major part of the scientific research of the Institute were published in scientific journals of International reputation. Thirty one papers were published/accepted in refereed journals, and another thirty three were published as circulars and conference proceedings. Three PhD theses have been awarded and another three PhD theses have been submitted. To facilitate academic and technical interactions between various institutions the Institute has signed MOU with Indian Institute of Geomagnetism, Mumbai, and G. B. Pant University of Agriculture and Technology, Pantnagar.

2. A flurry of activity has been started after ARIES signed a contract with Advanced Mechanical and Optical Systems (AMOS), Belgium for the design, manufacturing, integration, testing, supply and installation of the telescope at Devasthal. In order to manage and coordinate the Devasthal Optical Telescope (DOT) project, various working groups has been created (PWG). To monitor the timely completion of deadlines amongst these various PWGs a monitoring committee has been formed (Project Implementation team), which comprises the leaders of PWGs. The results are trickling in. The PWGs have done many exercises on dome design, infrastructural facilities are coming up, serious thoughts are being employed for back end instruments. Serious exercises are being conducted to iron out the challenges that might be posed by the hilly terrain, once the heavy components of the telescope are ready to be transported to the sight.

3. The construction of Telescope building for 1.3m telescope has progressed considerably. Related activities like electrification, computer networking of the building, development of the surrounding area is going on simultaneously.

4. Many important projects are being led by ARIES faculty members. Light Detection And Ranging or LIDAR project has been initiated to study aerosol characteristics and middle atmospheric dynamics. A PMB has been set up to monitor the progress of the project. Significant progress has been made in the first phase of the project where estimation of the Lidar parameters have been carried out. The construction of the Lidar building is on the verge of completion. Moreover, the fabrication of the Rayleigh telescope has been completed.

5. Department of Science and Technology has approved the setting up of a Stratosphere Troposphere (ST) Radar at ARIES, Nainital. Total cost of the project is around Rs 140

million. Initial steps for this projects have already been taken. This project will boost research work on Atmospheric Sciences in the Himalayan region.

6. The civil construction work relating to the Guest house, Hostel Building and Optical Workshop has made tremendous progress. The Guest house and the Optical workshop are on the verge of completion. The hostel buildings for the students have also progressed appreciably.

Major scientific results are:

(i) Comprehensive Multi-wavelength studies of young star cluster NGC 1893, Galactic H II region Sh 2-294 were carried out. The initial mass function of NGC 1893 was found out to be in agreement with the Salpeter value.

(ii) UBV Ic CCD photometry of the young open cluster Be 59 showed that there is evidence of second generation star formation outside the boundary of the cluster, which may be triggered by massive stars in the cluster.

(iii) For the first time, the QPO frequency evolution of an accreting X-ray pulsar 4U 1626-67, based on data for more than 20 years.

(iv) A signature of the transition of GRB 050319 after glow from stellar wind to ISM was observed.

(v) A likely explanation of the dark nature of GRB 051022 was provided.

(vi) A giant radio jet, largest so far, associated with elliptical galaxy CCCC 049-033 was detected.

(vii) Observations of tropospheric ozone have been made at Nainital, Devasthal and Pantnagar and have been used to study the processes responsible for ozone variations on local and regional scales.

7. A number of Scientists and Engineers of the Institute participated in national and international conferences/workshops/colloquia with invited and contributed presentations.

It is heartening to note that Prof. Ram Sagar has been elected as a Council Member of the National Academy of Sciences, India, Allahabad; Coordinator of the DST International Long Term Programme in the area of Physics and Astrophysics; Member of the Physical Sciences Research Committee of CSIR, New Delhi; Member of the TIFR Balloon facility Board; Member of the Governing Council of IITM, Pune; Member of the Indian Science delegation to Belgium and Russia led by DST, Secretary, Govt. of India; Member of the Editorial Board of Journal of Astrophysics and Astronomy and Bulletin of the Astronomical Society of India; and awarded Rajbhasha Gaurav Samman 2007 by Bhartiya Rajbhasha Prishad, New Delhi.

A number of young and meritorious researchers have joined ARIES. There is increased cooperation and interactions of ARIES faculty members with those of other Institutes in India and abroad. These encouraging developments indicate an even brighter future for the Institute.

Place : Nainital
Date : 10 August, 2008

RAM SAGAR
Director

Situated adjacent to the picturesque hill town of Nainital, ARIES an acronym of Aryabhatta Research Institute of observational sciencES, is one of the leading research Institutes which specializes in observational Astronomy & Astrophysics and Atmospheric Sciences. The Institute provides observing facilities in the optical wavelength, although multi-wavelength observations are also encouraged in the form of active collaborations with scientists and using facilities outside. The main research interests of Astronomy & Astrophysics division are in solar, planetary, stellar, galactic and extra-galactic astronomy including stellar variabilities, X-ray binaries, star clusters, nearby galaxies, quasars, and inherently transient events like supernovae and highly energetic gamma-ray bursts. The Atmospheric division investigates various phenomena like study of aerosols, trace gases etc. Moreover, to strengthen the scientific contribution the Institute has extended its horizon to theoretical and numerical studies in Relativistic Astrophysics. The unique position of ARIES (79° East), places it at almost in the middle of 180° wide longitude band, between Canary Island (20° West) and Eastern Australia (157° East), and therefore compliments observations which might not be possible from either of these two places. Thus ARIES makes unique contribution from time to time, to quote examples from the past, the first successful Indian optical observations of the afterglow of gamma-ray burst was carried out from ARIES on January 23, 1999, few micro-lensing events and quasar variability, new ring systems around Saturn, Uranus, and Neptune were discovered etc.

Facilities :

The Institute hosts three telescopes of apertures 15-cm, 56-cm and 104-cm. There are two 15-cm telescopes dedicated for solar observations. The 36 years old 104-cm telescope is used for most of the optical observations. It is equipped with 2k x 2k, and 1k x 1k liquid N_2 cooled CCD cameras, fast photometer, spectrophotometer, and standard astronomical filters. The telescope uses a SBIG ST-4 camera for auto-guiding through an auxiliary 20-cm telescope.

In order to carry out observations in the frontier areas of astronomy, the Institute is setting up 130-cm and 360-cm optical telescopes at a site called 'Devasthal' at a distance of ~ 60-Km from ARIES, which has the advantages of having dark skies and excellent observing conditions. The 130-cm telescope is expected to be operational by the end of 2008, and 360-cm telescope will be operational by 2012. The Scientists from the Solar group of ARIES are also participating in the national projects like space coronagraph and NLST. The Atmospheric division is setting up a 84-cm micro-pulse LIDAR system for high altitude studies of aerosols and a ST Radar (Stratosphere Troposphere Radar) to measure wind speeds up to an altitude of around 20Km.

Ph.D./PDF Programme:

Interested students participate in the Ph. D. program in the field of Astronomy & Astrophysics and Atmospheric Sciences, which is being offered by ARIES. The minimum qualification for a research scholar is a M. Sc. degree in Physics/Astronomy/Astrophysics. Research scholars are selected via an interview

of successful JEST/NET/GATE qualifiers. The students can register for the Ph. D. degree at a number of Indian universities have recognized ARIES as a research centre.

ARIES offers post-doctoral fellowships and visiting positions to work in selected branches of Astronomy & Astrophysics, Atmospheric Sciences, Engineering and Instrumentation and Software development.

Student Training and Short term Visit Programme:

A few bright students studying in different semesters of the M. Sc. courses can spend 2-3 months at ARIES to work with one of the scientists/engineers of the Institute 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 any time of the year.

Summer School:

ARIES organizes a 3-4 weeks summer school every year. The school is aimed at providing introduction to Astrophysics and Atmospheric physics to young graduate students in their M. Sc. programs. The school consists of lectures and a short-term project.

Evening Program:

As a part of science popularization program, ARIES is open to public in the evenings for night-sky viewing using one of the telescopes. Visitors can also attend the slide-shows and view the picture gallery describing celestial bodies. ARIES also participates in other science popularization program for students and common public.

Areas of Research:

Atmospheric Sciences: Aerosols characterization, radiation budget, lower thermosphere, coupling processes between different atmospheric regions.

Extragalactic Astronomy: Nearby galaxies, Wolf-Rayet galaxies, active galaxies, optical follow-up of gamma ray bursts (GRB) and supernova, quasar luminosity variability, and radio astronomy.

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

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

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

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

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

I. Galactic Astronomy

a. Star formation

Star formation in young star cluster NGC 1893

A comprehensive multiwavelength study of the star-forming region NGC 1893 to explore the effects of massive stars on low-mass star formation was carried out using near-infrared colours, slitless spectroscopy and narrow-band H photometry. The young stellar objects (YSOs) were identified in the cluster region. The YSOs are distributed in a pattern from the cluster to one of the nearby nebulae Sim129. The majority of these objects have ages between 1 and 5-Myr. The spread in the ages of the YSOs may indicate a non-coeval star formation in the cluster (Fig. 1). The slope of the K-band luminosity function for the cluster is estimated to be 0.34±0.07, which agrees well with the average value (~0.4) reported for young clusters. For the entire observed mass range $0.6 < M/M_{\odot}$ 17.7 the value of the slope of the initial mass function, , comes out to be -1.27 ± 0.08, which is in agreement with the Salpeter value of -1.35 in the solar neighbourhood.

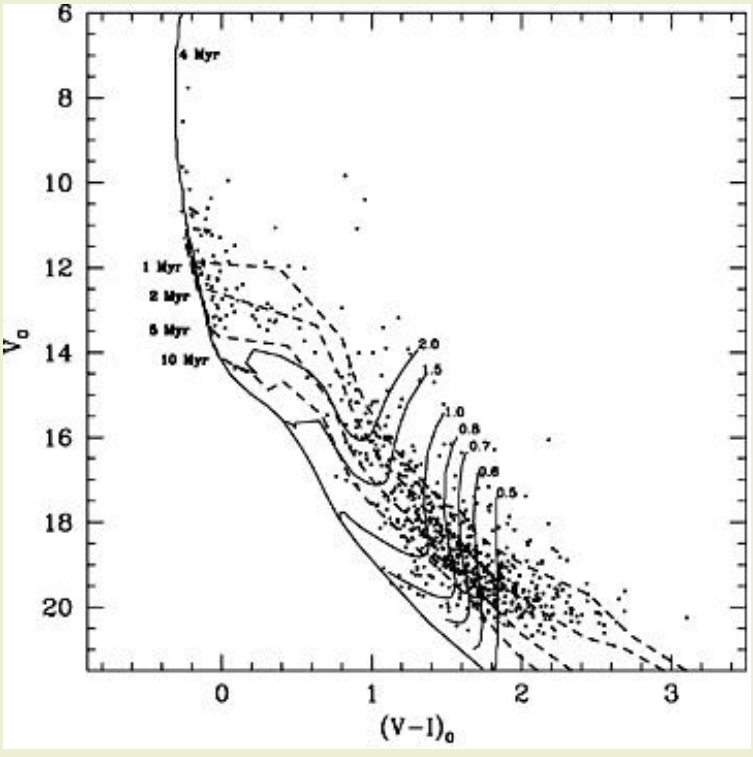

Figure 1. Statistically cleaned $V_0/(V\text{-}I)_0$ CMD for stars lying in the cluster NGC 1893 region. The isochrone for 4-Myr age by Bertelli et al. (1994) and PMS isochrones of 1, 2, 5, 10 Myr along with evolutionary tracks of different mass stars by Siess et al. (2000) are also shown. All the isochrones are corrected for a distance of 3.25 kpc.

However, the value of ` ' for pre-main-sequence phase stars (mass range 0.6 <M/$M_{\odot}$ 2.0) is found to be - 0.88 ± 0.09 which is shallower than the value (-1.71±0.20) obtained for main-sequence stars having mass range 2.5 <M/M 17.7, indicating a break in the slope of the mass function at ~2$M_{\odot}$. Estimated values indicate an effect of mass segregation for main-sequence stars, in the sense that massive stars are preferentially located towards the cluster centre. The estimated dynamical evolution time is found to be greater than the age of the cluster, therefore, the observed mass segregation in the cluster may be the imprint of the star formation process. There is evidence for triggered star formation in the region, which seems to govern initial morphology of the cluster. **[Sharma S., Pandey A. K.,** Ojha D. K., Chen W. P., Ghosh S. K., Bhatt B. C., **Maheswar G. and Sagar R.].**

A Multiwavelength Study of Galactic H II Region Sh 2-294

The star formation scenario in Galactic H II region Sh 2-294 (Fig. 2) has been studied using optical photometry, narrowband imaging, and radio continuum mapping at 1280 MHz, together with archival data from the 2MASS, MSX, and IRAS surveys. The ratio of the total to the selective extinction (Rv) is found to be 3.8±0.1, indicates an anomalous reddening law for the dust inside the cluster region.

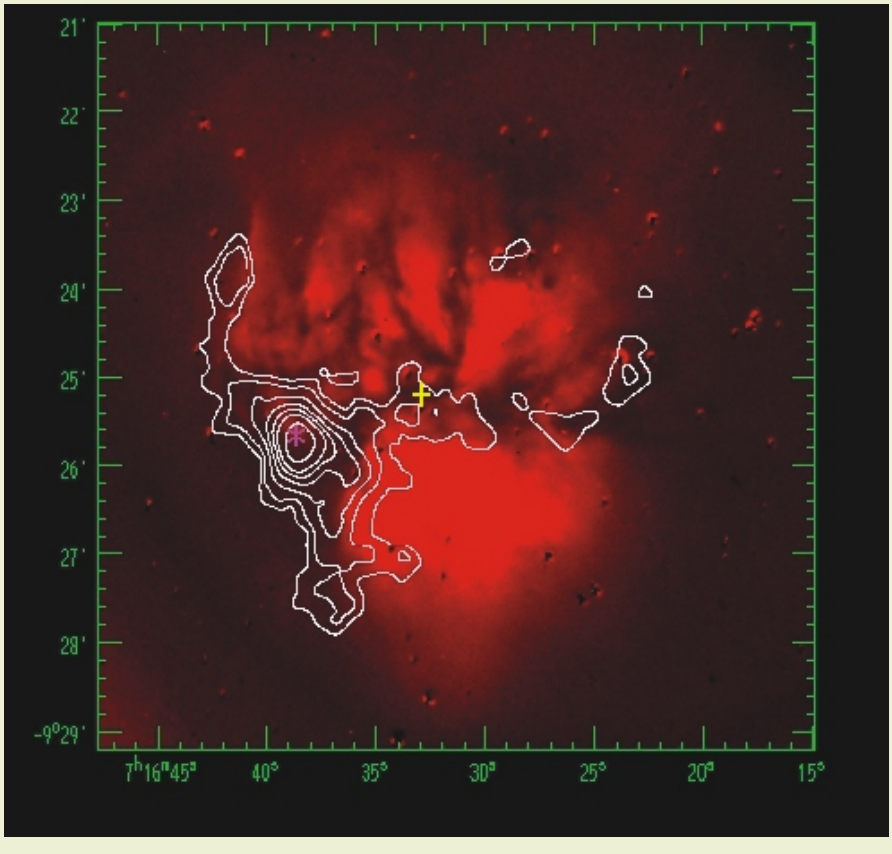

Figure 2. Contour diagram from the MSX A-band image , overlaid on an H line image of Sh 2-294 region. The plus sign represents the position of the central ionizing star that emits UV photons and the asterisk represents the position of massive embedded YSO at the border of H II region.

The ionizing source of the H II region is found to be a star of spectral type ~B0 V. The 2MASS JHK$_s$ images reveal a partially embedded cluster associated with the ionizing source along with a small cluster towards the eastern border of Sh 2-294. The radio continuum and H images show the ionization front along the direction of the small cluster. An arc-shaped diffuse molecular hydrogen emission and a half-ring of dust emission are also seen in the direction of the ionization front at 2.12 and 8 μm (MSX), respectively. Self-consistent radiative transfer model of mid- to far-infrared continuum emission detected near small cluster is in good agreement with the observed spectral energy distribution of a B1.5 ZAMS star. The morphological correlation between the ionized and molecular gas, along with probable timescale involved between the ionizing star, evolution of H II region, and small cluster, indicates that the star formation activity observed at the border is probably triggered by the expansion of H II region. **[Samal M. R., Pandey A. K.,** Ojha D. K., Ghosh S. K., Kulkarni V. K. and Bhatt B. C.].

Stellar contents and star formation in the young star cluster Be 59

UBVI$_c$ CCD photometry of the young open cluster Be 59 with the aim to study the star formation scenario in the cluster is carried out. The ratio of total-to-selective extinction in the cluster region is estimated as 3.7±0.3. The distance of the cluster is found to be 1.00 ± 0.05 kpc. Young stellar objects (YSOs) in the open cluster Be 59 region were identified using near-infrared (NIR) colours and slitless spectroscopy. The ages of these YSOs range between <1 and ~2 Myr, whereas the mean age of the massive stars in the cluster region is found to be ~2 Myr. There is evidence for second-generation star formation outside the boundary of the cluster, which may be triggered by massive stars in the cluster. The slope of the initial mass function, , in the mass range 2.5 < M/M$_\odot$ 28 is found to be -1.01±0.11 which is shallower than the Salpeter value (-1.35), whereas in the mass range 1.5 < M/M$_\odot$ 2.5 the slope is almost flat. The slope of the K-band luminosity function is estimated as 0.27 ± 0.02, which is smaller than the average value (~0.4) reported for young embedded clusters. Approximately 32 per cent of H emission stars of Be 59 exhibit NIR excess indicating that inner discs of the T Tauri star (TTS) population have not dissipated. The Midcourse Space Experiment (MSX) and IRAS-HIRES images around the cluster region are also used to study the emission from unidentified infrared bands and to estimate the spatial distribution of optical depth of warm and cold interstellar dust. **[Pandey A. K., Sharma S,** Ogura K., Ojha D. K., Chen W. P., Bhatt B. C. and Ghosh S. K.].

Stellar contents and star formation in the young open cluster Stock 8

UBVI$_c$ CCD photometry of the young open cluster Stock 8 has been carried out with the aim to study its basic properties such as the amount of interstellar extinction, distance, age, stellar contents and initial mass function (IMF) as well as star

formation scenario in this region. Using H slitless spectroscopy and Two Micron All Sky Survey (2MASS) near-infrared (NIR) data, H emission and NIR-excess young stellar objects (YSOs), respectively were identified. From their locations in the colour-magnitude diagrams, majority of them seem to have ages between 1 and 5 Myr. The spread in their ages indicates a possible non-coeval star formation in the cluster. Massive stars in the cluster region reveal an average age of 2 Myr. In the cluster region (r 6 arcmin) the slope of the mass function (MF), , in the mass range ~1.0 $M/M_{\odot} < 13.4$ can be represented by a power law having a slope of -1.38 ± 0.12, which agrees well with Salpeter value (-1.35). In the mass range 0.3 $M/M_{\odot} < 1.0$, the MF is also found to follow a power law with a shallower slope of = -0.58 ±0.23 indicating a break in the slope of the IMF at ~1 $M_{\odot}$ (Fig 3.). The slope of the K-band luminosity function for the cluster (r 6 arcmin) is found to be 0.31 ± 0.02, which is smaller than the average value (~0.4) obtained for embedded star clusters. A significant number of YSOs are distributed along a Nebulous Stream towards the east side of the cluster. A small cluster is embedded in the Nebulous Stream. The YSOs lying in the Nebulous Stream and in the embedded cluster are found to be younger than the stars in the cluster Stock 8. The radio continuum, MSX, IRAS mid- and far-infrared maps and the ratio of [SII]/H intensities indicate that the eastern

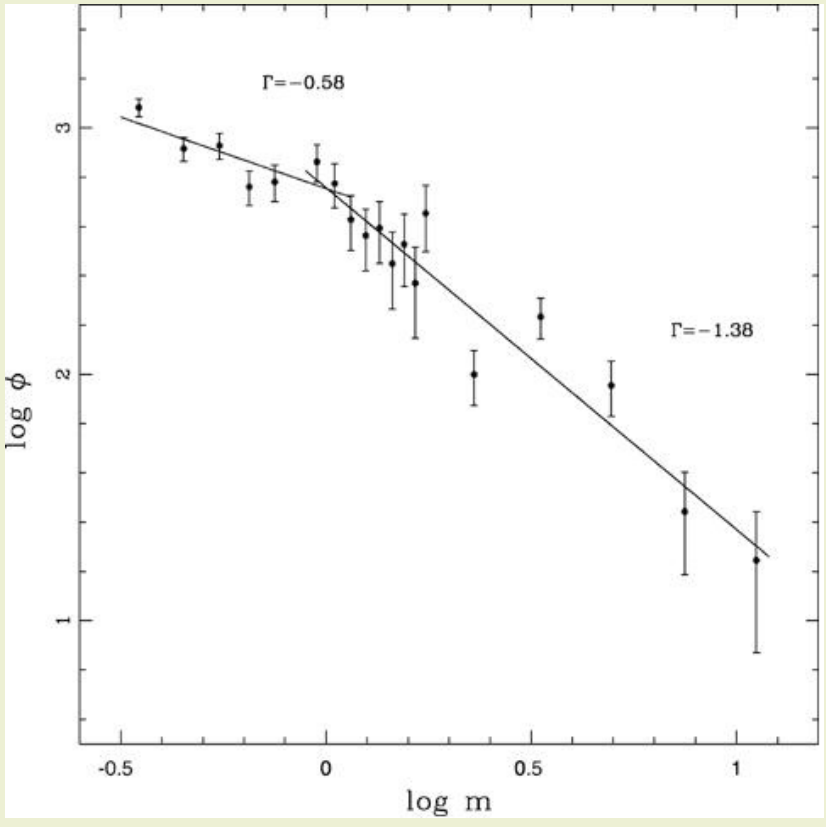

Figure 3. A plot of the MF for the Stock 8 region. The represents dN/dlog m. The error bars represent ± N errors. The continuous lines show least-squares fit to the mass ranges described in the text. The values of the slopes obtained are also mentioned in the figure.

region of Stock 8 is ionization bounded whereas the western region is density bounded. The morphology seems to indicate that the ionization/shock front caused by the ionizing sources located in the Stock 8 region and westwards of Stock 8 has not reached the Nebulous Stream. It appears that star formation activity in the Nebulous Stream and embedded cluster may be independent from that of Stock 8. **[Jose J., Pandey A. K.,** Ojha D. K., Ogura K., Chen W. P., Bhatt B. C., Ghosh S. K., Mito H., **Maheswar G. and Sharma S.].**

b. Star clusters

Stellar Contents of Two Intermediate Age Clusters: NGC 1912 and NGC 1907

CCD photometry in a wide field around two open clusters, NGC 1912 and NGC 1907 is carried out to study the morphology of the clusters. The clusters are situated at distances of 1400±100 pc (NGC 1912) and 1760±100 pc (NGC 1907), indicating that in spite of their close locations on the sky they may be formed in different parts of the Galaxy. Although the mass functions for the clusters are quite noisy, in the given mass range the slopes of the mass functions for clusters NGC 1912 and NGC 1907 turn out to be -1.12±0.30 and -1.23±0.21, respectively, which are in agreement with the Salpeter value. Because the ages of the clusters are much higher than the estimated relaxation time-scales, dynamical relaxation may be one of the reasons for the observed mass segregation in the clusters. A comparison of the observed CMDs of the clusters with the synthetic CMDs gives a photometric binary content as 30±10% (mass range 1.0 $M_{\odot}$ 3.1) and 20±10% (mass range 1.2 $M_{\odot}$ 3.2) in the case of NGC 1912 and NGC 1907, respectively. **[Pandey A. K., Sharma S.,** Upadhyay K., Ogura K., Sandhu T. S., Mito H. and **Sagar R.].**

Mass Functions and Photometric Binaries in Nine Open Clusters

Using homogeneous CCD photometric data from the 105-cm Kiso Schmidt telescope covering a 50' × 50' field, the mass functions (MFs) of nine open clusters were studied. The ages and Galactocentric distances of the target clusters vary from 16-2000 Myr and 9-10.8 kpc, respectively. The values of MF slopes vary from -1.1 to -2.1. The MFs in the outer regions of the clusters are found to be steeper than in the inner regions, indicating the presence of mass segregation in the clusters. The MF slopes (in the outer region as well as the whole cluster) undergo an exponential decay with the evolutionary parameter (=age/relaxation time). It seems that the evaporation of low-mass members from outer regions of the clusters is not significant at larger Galactocentric distances. It is concluded that IMF in the anti-center direction of the Galaxy might have been steeper than the IMF in the opposite direction. A comparison of the observed color-magnitude diagrams (CMDs) of the clusters with synthetic CMDs gives a photometric binary content of ~40%. **[Sharma S, Pandey A. K.,** Ogura K., Aoki T., Pandey K., Sandhu T. S. and **Sagar R.].**

Mass function study of nine young Large Magellanic Cloud star clusters

The distributions of stellar masses that forms in one star formation event in a given volume of space is called the initial Mass Function (MF). Some theoretical study predicts that the initial MF should vary with the temperature and pressure of star-forming clouds, while others reach exactly the opposite conclusion. The MF and star formation in nine young Large Magellanic Cloud clusters were studied using CCD BVRI data collected from 3.5m NTT/EFOSC2 in sub-arcsec conditions. Seven of the nine clusters are found to have ages between 16 and 25 Myr and the other two have ages less than 90 Myr. In the mass range of 2 - 12 $M_{\odot}$ the MF slopes for 8 out of nine clusters were found to be similar with the value of , N(M) M , ranging from 1.90±0.16 to 2.28±0.21. Mass segregation effects are observed for four clusters and its presence could be an imprint of star formation process as their ages are significantly smaller than their dynamical evolution time. Mean MF slope of = 2.22±0.16 derived for a sample of 25 young (<100 Myr) dynamically un-evolved LMC stellar systems provide support for the universality of initial MF in the intermediate mass range 2-12 $M_{\odot}$ (Fig. 4). **[Kumar B., Sagar R.** and Melnick J.].

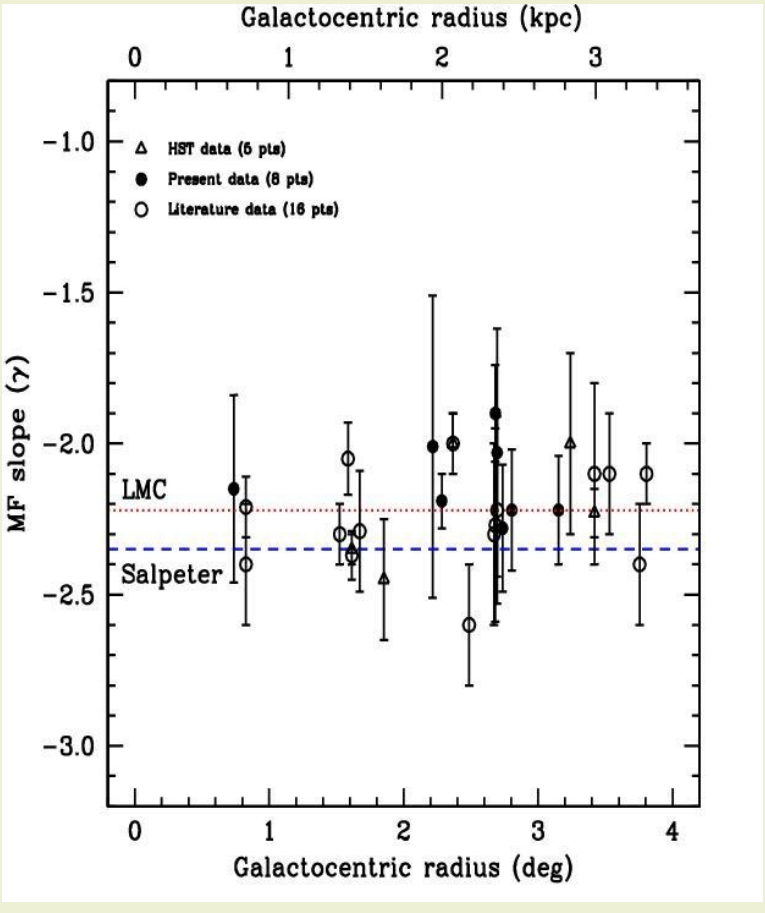

Figure 4. Mass function slopes for 25 young (< 100 Myr) LMC star clusters and associations as a function of a galactocentric radius in LMC. The horizontal dashed line represent Salpeter value of MF slope for the field stars in the solar neighbourhood, and the dotted line indicates the mean slope for LMC star clusters.

Ground-based CCD astrometry with wide-field imagers. A star catalog for M 67: WFI@2.2 m MPG/ESO astrometry, FLAMES@VLT radial velocities

In collaboration with Prof. Giampaolo Piotto, Padova Italy, a programme to determine proper motion and space velocity of open and globular clusters using wide field CCD photometric data has been developed. As a part of this programme the open cluster M67 was studied. The solar-age open cluster M67 is a touchstone in studies of the old Galactic disk. Despite its outstanding role, the census of cluster membership for M67 at fainter magnitudes and their properties are not well-established. Using the proprietary and archival ESO data, a catalogue of astrometric, photometric, and radial velocities of stars in a 34 x 33 arcmin^2 field centered on the old open cluster M67 has been prepared. The two-epoch archival observations separated by 4 years and acquired with the Wide Field Imager at the 2.2m MPG/ESO telescope have been reduced with the new astrometric techniques. Relative proper motions and membership probabilities for ~2,400 stars have been determined. The precision of proper motions for optimally exposed stars is 1.9 mas/yr, gradually degrading down to ~5 mas/yr at V=20 mag. Relatively precise proper motions at V>16 mag are obtained for the first time. Radial velocities are measured for 211 stars in the same field. It is demonstrated that the ground-based CCD mosaic observations just a few years apart are producing proper motions, allowing a reliable membership determination (Fig. 5). **[Yadav R. K. S.,** Bedin L. R., Piotto G., Anderson J., Cassisi S., Villanova, S., Platais I., Pasquini L., Momany Y. and **Sagar R.].**

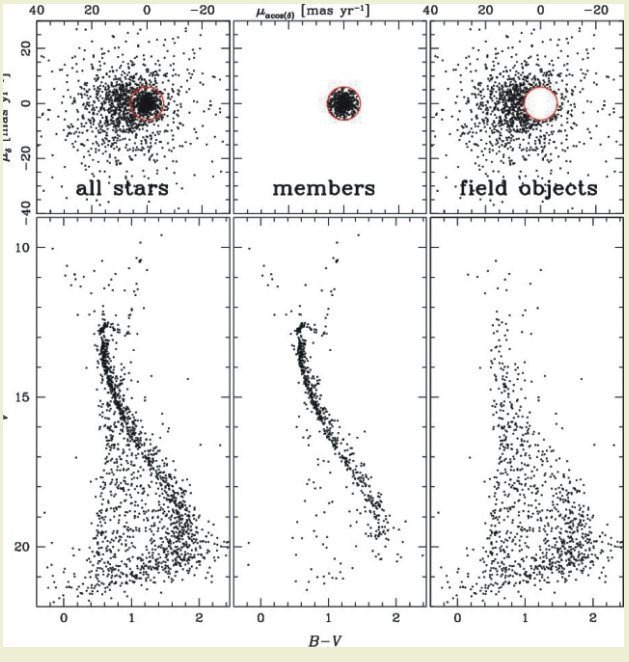

Figure 5. (Top panels) Proper motion vector-point diagram (VPD). Zero point in VPD is the mean motion of cluster stars. (Bottom panels) Calibrated (B-V), V color-magnitude diagram. (Left) the entire sample; (Center) stars in VPD with proper motions within 6 mas yr^{-1} around the cluster mean; (right) probable background/foreground field stars in the area of M 67 studied in this paper. All plots show only stars with proper motion less than ~20 mas yr^{-1} in each coordinate.

c. ISM

Interstellar dust studies with TAUVEX

Studies on the properties of interstellar dust using TAUVEX is proposed. Through the multi-band TAUVEX observations, particularly with the use of filters optimized for extinction observations of the 2175 Å feature, combined with optical observations and 2MASS archived data, the extinction curve from UV to near-IR for stars located in different regions and environments can be derived. The extinction curve is a sensitive indicator of the properties of the interstellar dust and, as such, will allow us to trace the properties and evolution of the interstellar dust as a function of environment. **[Maheswar G.,** Muthu C., Sujatha N. V., Pandey G., Bhatt H. C., Kameswara Rao, N. and Murthy J.].

d. X-ray Astronomy

Multiwavelength study of the transient X-ray binary IGR J01583+6713

Multiwavelength observations were carried out of a recently discovered X-ray binary pulsar IGR J01583+6713. Optical photometric observations were done using 1-m Sampurnanand Telescope during the outburst and later on spectroscopic observations from the 2-m Himalayan Chandran Telescope, Hanle during the quiescent state. The source did not show any variability in optical and an upper limit of 0.05 mag is set on photometric variations at the *V* band over a time scale of 3 months. The H line profile is of non-Gaussian shape and is found to be quite stable for a duration of 2 months. The spectral type of the companion star identified to be B2 IVe while distance to the source is estimated to be ~ 4.0 kpc. Using archival X-ray data, a variation is detected in the absorption column density, from a value of 22.0 $x10^{22}$ cm^{-2} immediately after the outburst down to 2.6 $x10^{22}$ cm^{-2} four months afterwards. In the quiescent state, the X-ray absorption is consistent with the optical reddening measurement of E(B-V) = 1.46 mag. A possible pulse detection with a period of 469.2 s indicates an orbital period in the range of 216 to 561 days for the Be-Xray binary system. **[Kaur R.,** Paul P., **Kumar B. and Sagar R.].**

Long-term evolution of Quasi-Periodic Oscillation (QPO) in the X-ray pulsar 4U 1626-67

In the Low Mass X-ray binary 4U 1626-67, the QPO evolution was analysed from 1984 to 2004 and it was found that the QPO frequency decreases with time since the pulsar has undergone torque reversal in 1991. Change in the QPO frequency is found to be only 4 %, however, it is expected to be more than 27% according to beat frequency model. Thus it may be possible that the observed X-ray flux change is not due to change in mass accretion rate by the same factor. It is for the first time that in an accreting X-ray pulsar the QPO frequency evolution is traced for more than 20 years. Fig. 6 shows the QPO frequency evolution of 4U 1626-67 from 1984 to 2004. **[Kaur R.,** Paul B., **Kumar B. and Sagar R.].**

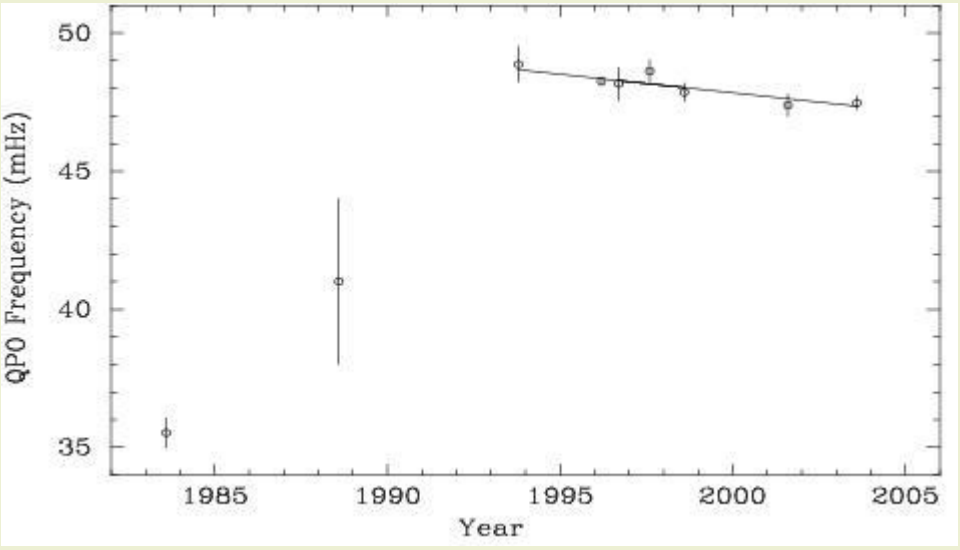

Figure 6. The QPO frequency evolution history of 4U 1626-67 from 1983 to 2004. The solid line is a linear fit to the data from 1993 to 2004. Error bars represent the 1-sigma confidence intervals.

e. Dwarf Stars and Exo-planets

To search and study the variability in atmosphere of brown dwarfs, a total of 5 brown dwarfs were observed. The high spectral-frequency variations are seen in some objects, but these detections are marginal and need to be confirmed. There is no evidence for large amplitude variations and upper limits of broad-band variability is of the order of 2 to 3%, depending on the targets and wavelengths, on the time scale of a few hours. The brown dwarf SDSS J1254-0122 shows numerous variable features, but a secure variability diagnosis would require further observations. It has been noticed that the typical physical scale of cloud cover disruption should be smaller than 5-8% of the disk area for four of our targets. The possible variations seen in SDSS J1254-0122 are not strong enough to allow us to confirm the cloud breaking hypothesis. [Goldman et al. including **Joshi S.** and **Sagar R.].**

II. Extra Galactic Astronomy

a. GRBs and Supernovae

Observations of the Optical Afterglow of GRB 050319: The Wind-to-ISM Transition in View

The collapse of a massive star is believed to be the most probable progenitor of a long gamma-ray burst (GRB). Such a star is expected to have its environment modified by the stellar wind. The effect of such a circumstellar wind medium is expected to be seen in the evolution of a GRB afterglow, but so far this has not been conclusively found. A signature of the transition from wind to constant density

medium of the circumburst medium is visible in the afterglow of GRB 050319. Along with the optical observations of the afterglow of GRB 050319, a model for the multiband afterglow of GRB 050319 is presented. The break seen in the optical light curve at ~0.02 days could be explained as being due to the transition from wind to constant density medium of the circumburst region, in which case, this could be the first ever detection of such a transition at any given frequency band. Detection of such a transition could also serve as confirmation of the massive star collapse scenario for GRB progenitors, independent of supernova signatures. [Kamble A., Resmi L. and **Misra K.].**

The dark nature of GRB 051022 and its host galaxy

Multiwavelength (X-ray/optical/near-infrared/millimetre) observations of GRB 051022 between 2.5 h and 1.15 yr after the event is presented. It is the most intense gamma-ray burst (10^{-4} erg cm^{-2}) detected by HETE-2, with the exception of the nearby GRB 030329. Optical and near infrared observations did not detect the afterglow despite a strong afterglow at X-ray wavelengths. Millimetre observations at Plateau de Bure (PdB) detected a source and a flare, confirming the association of this event with a moderately bright (R = 21.5) galaxy. Spectroscopic observations of this galaxy show strong [O II], H and [O III] emission lines at a redshift of 0.809. The spectral energy distribution (SED) of the galaxy implies A_V (rest frame) = 1.0 and a starburst occuring 25 Myr ago, during which the star-forming-rate reached 50 $M_\odot$/yr. In conjunction with the spatial extent (1'') it suggests a very luminous (M_V = -21.8) blue compact galaxy, for which it was also found that Z~$Z_\odot$. The X-ray spectrum shows evidence of considerable absorption by neutral gas with $N_{H,\ X\text{-}ray}$ = $3.47^{+0.48}_{-0.47} \times 10^{22}$ cm^{-2} (rest frame). Absorption by dust in the host galaxy at z = 0.809 certainly cannot account for the non-detection of the optical afterglow, unless the dust-to-gas ratio is quite different than that seen in our Galaxy (i.e. large dust grains). It is likely that the afterglow of the dark GRB 051022 was extinguished along the line of sight by an obscured, dense star forming region in a molecular cloud within the parent host galaxy. This galaxy is different from most GRB hosts being brighter than L by a factor of 3. A SFR ~ 50 $M_\odot$/yr has also been derived and it has been predicted that this host galaxy will be detected at sub-mm wavelengths. [Castro-Tirado A. J. et al. including **Pandey, S. B.].**

b. Quasars

A Giant Radio Jet Ejected by an Ultramassive Black Hole in a Single-lobed Radio Galaxy

During a search for radio emission from rich clusters, it was found that a radio galaxy is associated with an elliptical galaxy CGCG 049 -033. The detail study of this radio galaxy revealed that the largest yet detected jet emanates from the center of the galaxy, is highly asymmetric, emits strongly polarized synchrotron radiation

and can be traced all the way from the galactic nucleus to the hot spot located ~ 440 kpc away. With this discovery, one can understand how a black hole ejects the jets and how the matter within the jets binds themselves together to millions of light years. This is an exceptionally useful laboratory for testing the role of magnetic field in jet stabilization and radio lobe formation. [Bagchi J., Gopal K., Krause M. and **Joshi S.].**

Prominent activity of the blazar OJ 287 in 2005. XMM-Newton and multiwavelength observations

Two guest-observer XMM-Newton pointings of the blazar OJ 287 in 2005 are introduced, along with part of the radio, mm, near-IR, and optical data obtained during a coordinated and intensive WEBT campaign, during longer-term monitoring observations performed by teams of the ENIGMA network, and during other independent observing programs (like VLBA observations). In that year OJ 287 showed an interesting variable behavior in the optical band. An optical outburst, well matched by WEBT observations, is claimed in the period Oct.-Nov. 2005, and the XMM-Newton X-ray observations are performed in correspondence with two active optical states (an intermediate flare and such outburst). X-ray data indicates different flux levels, spectral slopes, and emission components, and VLBA radio maps are consistent with a jet precession model. This appreciable observing effort is still ongoing (a further XMM-Newton pointing is planned in 2008), joined with further parallel/multi-monitoring observing programmes devoted to this interesting object. [Ciprini et al. including **Goel A.** and **Sagar R.].**

The nature of the intranight variability of radio-quiet quasars

A sample of 10 radio-quiet quasars with confirmed intranight optical variability and with available X-ray data is selected. The variability properties and the broad-band spectral constraints to the predictions of intranight variability are compared by three models: (i) irradiation of an accretion disc by a variable X-ray flux, (ii) an accretion disc instability, (iii) the presence of a weak blazar component. It is concluded that the third model, e.g. the blazar component model, is the most promising if the cannonball model for the jet variable emission is adapted. In this case, the probability of detecting the intranight variability is within 20-80 per cent, depending on the ratio of the disc to the jet optical luminosity. Variable X-ray irradiation mechanism is also possible but only under additional requirement: either the source should have a very narrow Hβ line or occasional extremely strong flares should appear at very large disc radii. [Czerny B., Siemiginowska A., Janiuk A. and **Gupta A. C.].**

Helical Eruptive Prominence Associated with a Pair of Overlapping CMEs on 21 April 2001

The eruption of limb prominence on 21 April 2001 associated with two coronal mass ejections (CMEs) is investigated. H images reveal two large-scale eruptions (a prominence body and a southern foot-point arch), both showing helical internal structure. These two eruptions are found to be spatially and temporally associated with the corresponding CMEs. The kinematics and the study of geometrical parameters of the prominence show that the eruption was quite impulsive (with peak acceleration 470 m s^{-2}) and has taken place for relatively low pitch angle of helical threads, not exceeding tan 1.2. The stability criteria of the prominence are revisited in the light of the model of Vršnak (1990) and the analysis shows that the eruption violates the instability criteria of that model. Finally, the energy stored in the prominence circuit and the energies (kinetic, potential, and magnetic) of the associated CMEs are estimated and it is found that there was enough energy stored in the prominence to drive the two CMEs. [Ali S. S., **Uddin W.,** Chandra R., Mary D. L. and Vršnak B.].

Total Solar Eclipse Observations on 29th March 2006

A 12.5 cm f/5 refractor equipped with red coronal line 6374/ 2 Å filter at the Manavgat, Turkey (N 36^0 49', E 31^0 18') was installed for fast imaging of the solar corona. The detector was a 12 bit, 512 x 512 pixel, 15 micron square PXL Photometrics CCD camera at a plate scale of 4.95 arc sec/pixel. The CCD has a field of view of 2.8 $R_\odot$ X 2.8 $R_\odot$ which covers inner corona. During the totality period of 3 minutes and 45 seconds we obtained a total of 250 images with a temporal resolution of 0.9 seconds. A mini weather station was installed at the observing site manufactured by Weather Technologies (India) Private Limited, Pune. There were four sensors mounted on the weather station to measure solar radiation, ambient atmospheric air temperature, relative humidity, wind speed and its direction. The silicon pyranometer has sensitivity in the range of 400 to 1000 nano meters. The sensing device for temperature sensor is standard platinum RTD element while the humidity sensor uses a solid-state capacitor. The temporal resolution for each sensor was 5 seconds.

Fast imaging in FeX (6374 Å) coronal line has been carried out, and meteorological data obtained during 29 March 2006 total solar eclipse from Manavgat, Turkey. The power spectrum analysis shows a power peak at 88 second. Detection of such periodic variations may be associated with the oscillations of magnetohydrodynamic (MHD) waves that are likely to be responsible for the coronal heating, and wind acceleration. From the meteorological data, the decrease

in temperature by ~2.5^{0}C was observed. The time lag between the temperature minimum and the time of totality may be interpreted in terms of the thermal inertia of air and ground. **[Uddin W, Joshi B., Kumar T. S., Sharma S. and Sagar R.].**

Co-spatial Evolution of Photospheric Doppler Enhancements and H-alpha Flare Ribbons Observed during the Solar Flare of 2003 October 28

The first detection of an interesting solar photospheric phenomenon, viz. "Doppler ribbons" or localized velocity enhancements has been reported (Fig. 7). These ribbons were seen to accompany the solar chromospheric H-alpha ribbons during the 4B/X17.2 flare of 28 October 2003. These velocity enhancements match exactly the H-alpha brightness enhancements in space, and are delayed by approximately 1 minute in time. These Doppler enhancements may be due to plasma shock being launched at the site of explosive chromospheric evaporation, which reaches the photosphere after approximately 1 minute. The excitation of 3 minute oscillations in the photosphere after the flare is a clear signature of the response of the solar atmosphere to a pressure pulse in the form of a "wake".

Precise timing information on the commencement of H-alpha brightening and start of the photospheric Doppler enhancement can also be used to measure the speed of the downward propagating shock wave. Assuming that the shock travels with the speed of sound (~ 7 km/s), the observed lag of ~ 60 s implies a height of ~ 400 km of the evaporation site above the photosphere, which coincides with the base of the chromosphere. The combination of all the evidence is therefore in favour of the Doppler ribbon being a manifestation of a pressure impulse striking the photosphere, following explosive evaporation in the chromosphere. The fact that these Doppler ribbons are not observed commonly also indicates that the electron flux from the flare must be extraordinarily large to be able to produce a discernible effect in the photospheric Doppler signal. [Venkatakrishnan P., Kumar B., and **Uddin W.]**.

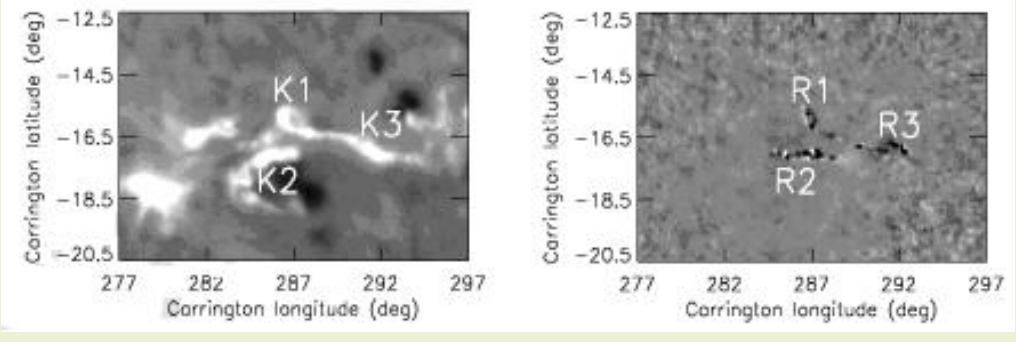

Figure 7. H filtergram obtained at ARIES at 11:01 UT on 28 October 2003 showing the locations of the flare kernels (K1, K2 and K3) in the active region NOAA AR 10486 at the start of the flare (left panel). Co-spatial photospheric velocity enhancements above this background during the flare appear in the form of Doppler ribbons analogous to the H flare ribbons as seen in the patchy region. The locations of the cluster of Doppler sources R1, R2 and R3 at 11:03 UT are also shown in the image (right panel).

Long Period Slow Longitudinal MHD Waves in Solar Wind Source Region

Considering compressive viscosity and thermal conductivity, the propagation and dissipation of long period slow longitudinal MHD waves in polar coronal holes are described. The energy flux density of 60 s wave is of the order of $\sim 10^4$ ergs cm^{-2} s^{-1} in coronal hole and solar wind, however, it is of the order of $\sim 10^3$ ergs cm^{-2} s^{-1} for the slow longitudinal MHD waves with periods 180 s and 300s (Fig. 8). Energy flux densities of these waves in the solar wind source region are too low. Hence, one can only account the major role of high frequency Alfvén waves in the solar wind source region (1.0058 R_O - 1.03 R_O). However, the energy flux of the long period slow longitudinal MHD waves is of the order of ~ 10^4 ergs cm^{-2} s^{-1} in upper part of this region (1.03 R_O - 1.35 R_O). Hence, they may be one of the possible energy sources in this part, and may contribute a fraction of energy required for coronal hole and solar wind. Estimated Mg 609.78 Å theoretical line widths for Alfvén and slow longitudinal MHD waves in polar coronal holes show decreasing or flat arms beyond ~ 1.21 R_O, which can be inferred as the reduction in the non-thermal component of the line width due to the MHD wave dissipation. [Dwivedi B. N. and **Srivastava A. K.].**

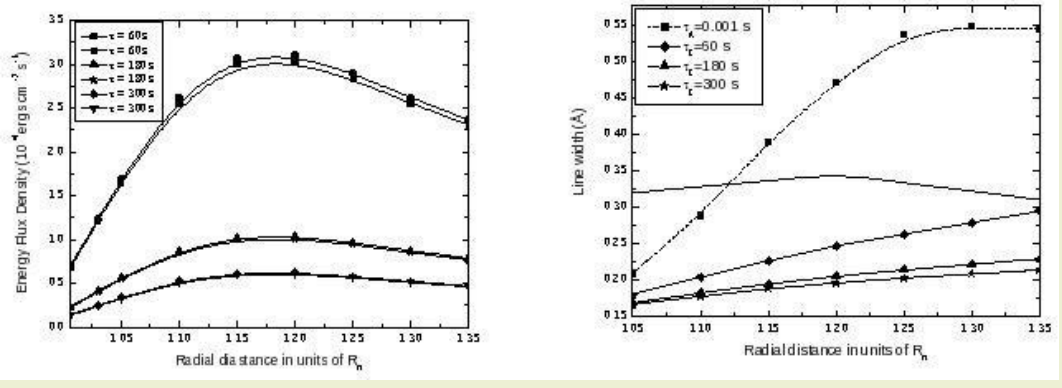

Figure 8. Spatial variation of energy flux density of slow longitudinal MHD waves with the periods 60s, 180s, and 300s (left panel). Spatial variation of theoretical and observational Mg X 609 Å line widths. The solid curve shows the observed line width, while the lines with symbols show theoretical line widths (right panel).

Studies on trace gases and aerosols

Observations of tropospheric ozone have been made at Nainital, Devasthal and Pantnagar and are used for studying the processes responsible for ozone variations on local and regional scales. These observations are being carried out using UV based ozone analyzers with a time resolution of 15 minutes. Observations of other trace gases (CH_4, CO and NMHCs) and greenhouse gases (CO_2, N_2O and SF_6) are made by collecting the air samples and analyzing them in collaboration with NIES, Tsukuba Japan and PRL, Ahmedabad. Surface ozone is being observed continuously since September 2006 at Nainital, while these observations were available during May 2007 and June-October 2007 at Devasthal and Pantnagar respectively.

Ozone shows spring maximum, which is found to be largely due to regional photochemical production, forest fires and long range transport from northern Africa and southern Europe. Regionally polluted ozone is estimated using back trajectory approach and found to be highest (~ 68 ppbv) in May. Interestingly, ozone variations do not exhibit daytime insitu photochemical production at Nainital and Devasthal while daytime insitu photochemical production is discernible at Pantnagar (Fig. 9). Moreover, noon time (1200-1700 hours) ozone levels at Pantnagar are found to be nearly similar to the average ozone levels at Nainital, which supports the suggested influences of regional pollution at Nainital. **[Naja M, Kumar R.,** Lal S., Singh K. P., Mukai H., Machida T., **Dumka U. C, Hegde P., Pant P. and Sagar R.]**.

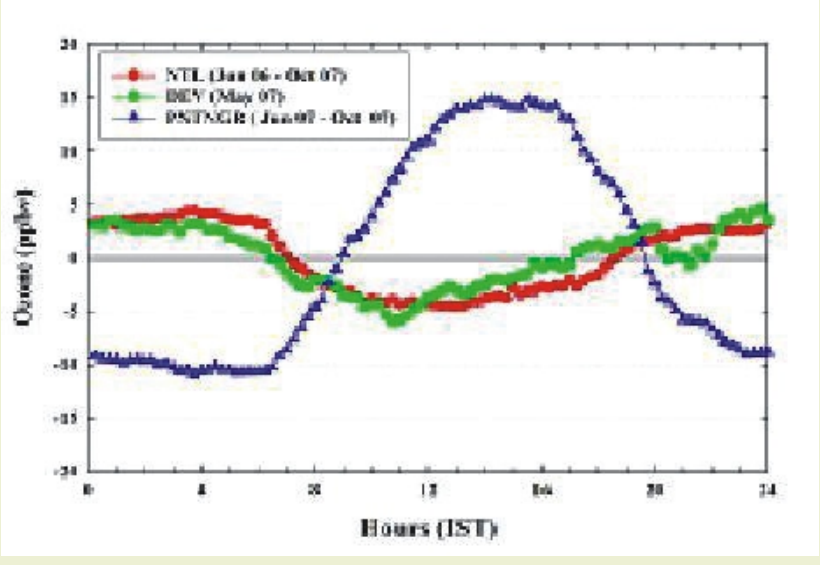

Figure 9. Normalized diurnal variations in ozone mixing ratios at Nainital (NTL), Devasthal (DEV) and Pantnagar (PNTNGR). Daytime photochemical build up is seen at Pantnagar while lower ozone values are discerned at Nainital and Devasthal in daytime.

Observation of Quasi Terdiurnal Tide in Mesospheric Airglow Emissions in a Low Latitude Station

Airglow measurements in a low latitude site reveals the presence of terdiurnal tide in day to day nocturnal temperature pattern of O_2 and OH airglow emissions in the mesospheric region during late winter time. The data were further analyzed by applying a band pass digital filter centered at 8 hour and FWHM ~ 2 hour. Monthly mean temperature profile shows ~ 1 hour phase difference among OH and O_2 layer. Wavelet analysis on the filtered data shows quasi 8 hour wave dominance in both the layer. Cross wavelet analysis shows a strong ~ 7 hour wave (Quasi terdiurnal tide), which is coexisting in two altitudes (at 87 Km & at 94 Km). **[Guharay A. and Taori A.].**

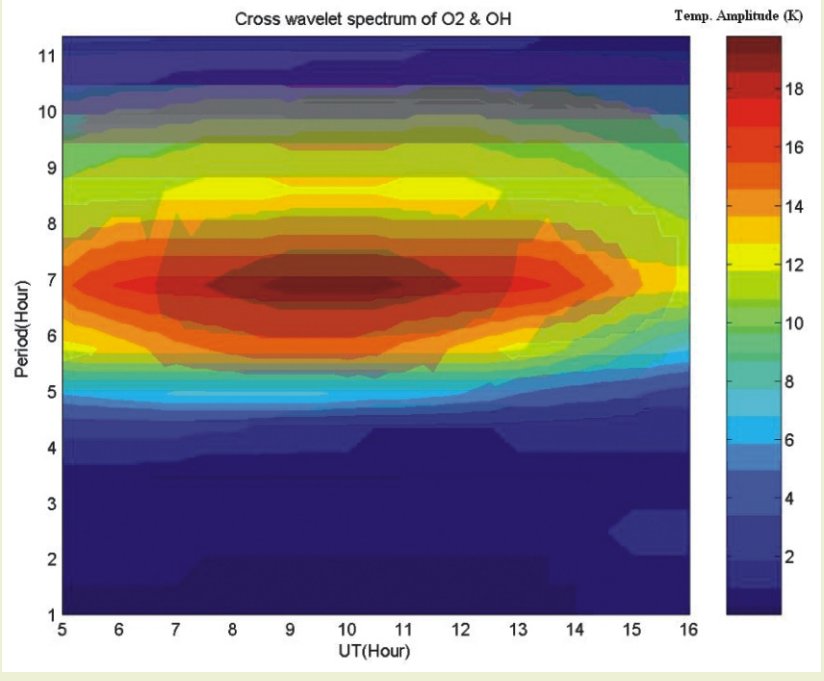

Figure 10. Cross wavelet spectrum of O_2 and OH temperature of February 2003.

Characteristics of Aerosol Spectral Optical Depths over Nainital - A High - Altitude Station in the Central Himalayas

In order to evolve a comprehensive characteristics of aerosols over a high altitude site in Central Himalayas, the temporal and spectral variabilities have been investigated using the collocated and long-term, extensive measurements of the columnar spectral AODs, number concentration including size distributions of composite aerosols and mass concentration of black carbon aerosols near the surface. The observational data on spectral aerosol optical depth spanning over a period of more than six years, starting from January 2002 have been used to study the aerosol mapping over the study region. The major findings are as follows:

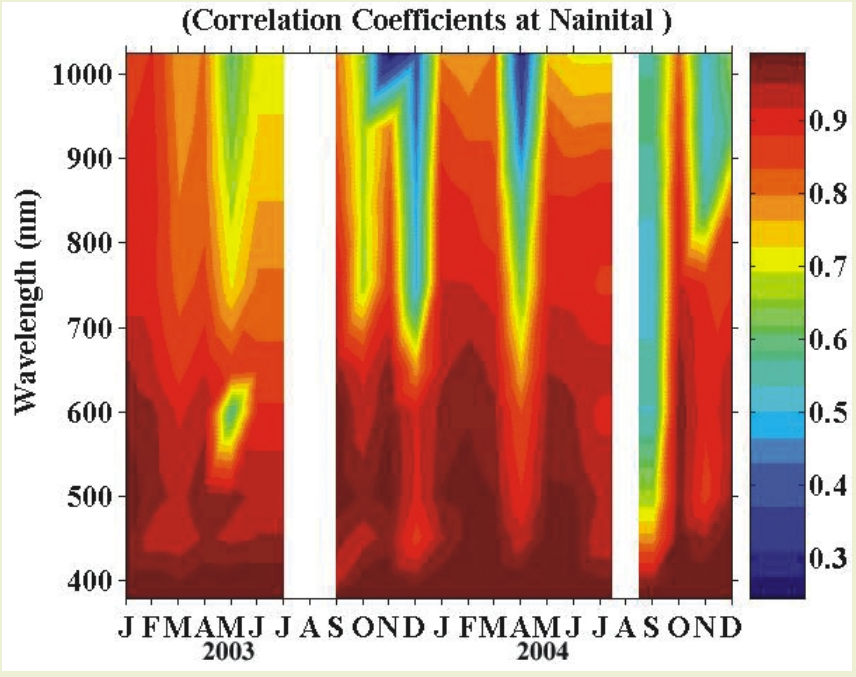

Figure 11. The monthly mean correlation coefficients of AODs at 0.38 μm with other wavelengths during January 2003 to December 2004.

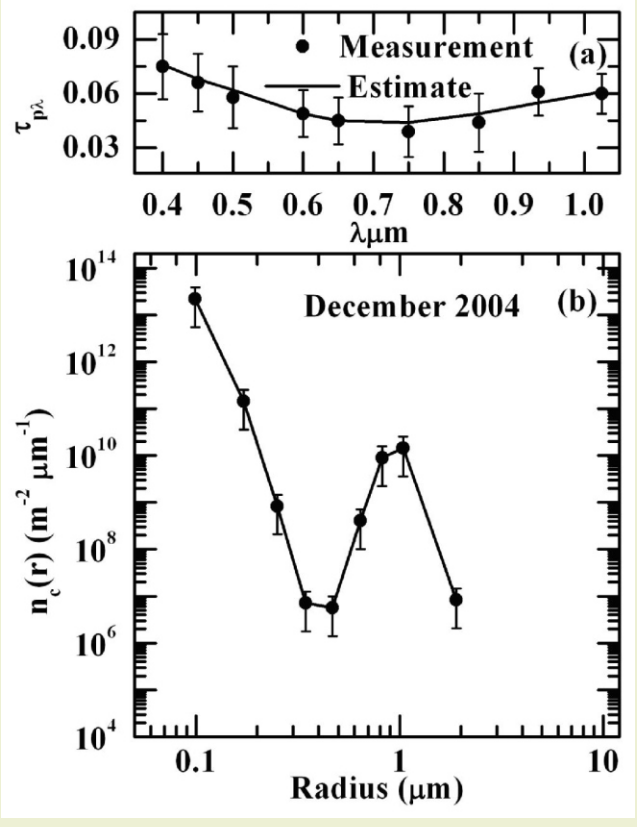

Figure 12. Top panel (a) shows the $_p$ values estimated from the MWR measurements with error bars (filled circle) whereas the continuous line represents $_p$ values re-estimated from the retrieved CSDs. Bottom panel (b) shows the typical example of the CSD retrieved from monthly mean spectral AOD for the month of December 2004.

1. Figure 11 shows the monthly mean contour plot of the correlation coefficients of AOD at 0.38 μm with other wavelengths indicating that the spectral optical depths are well correlated during the winter season, whereas during the summer season there is a sharp decrease in the correlation coefficients at higher (>0.60 μm) wavelengths, implying the presence of multiple sources of aerosols during summer season.

2. Figure 12, represents the columnar number size distribution, deduced by using inversion of spectral aerosol optical depths. The size distributions show bimodal (combination of power law and uni-modal log normal) distributions, with a prominent secondary mode (coarse mode) occurring at r >0.5 μm, while the primary peak (of fine mode aerosols) does not appear explicitly. The basic shape of the columnar size distribution does not change significantly with the seasons.

South Asian dust episode in June 2006: Aerosol observations in the central Himalayas

A dust storm blew through the Thar Desert on 12 June 2006, which has significantly influenced aerosol physical and optical properties over the central Himalayas on 13

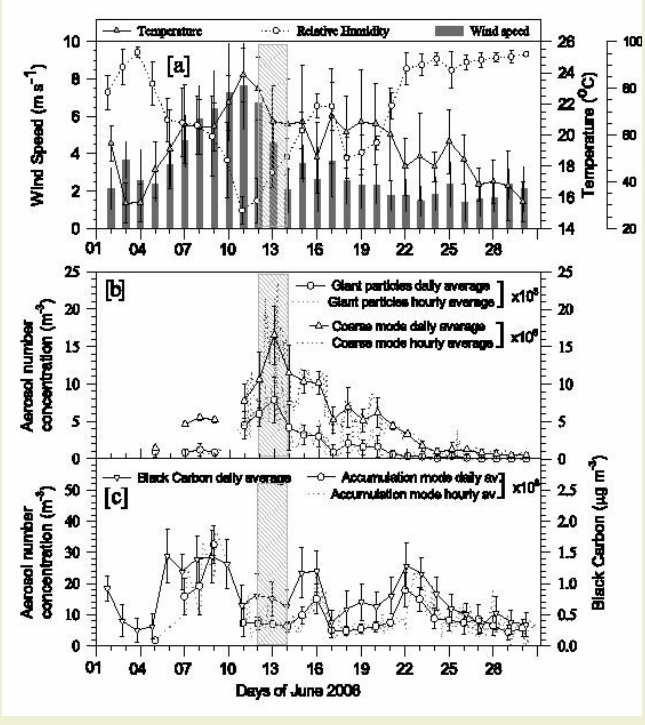

Figure 13. Daily average variations in (a) wind speed, temperature, and relative humidity, (b) aerosol number concentrations for OPC data in coarse and giant mode, and (c) accumulation mode particles and mass concentration for Aethalometer in June 2006. One hourly average data of aerosols number concentrations are also shown for three sizes. Scales of aerosol number concentrations are different in Figures 14b and 14c. Vertical bars are one standard deviation. Observations from OPC were not available on 6 and 10 June 2006. Shaded area shows the period of dust storm.

June 2006. Dust particles greatly influenced the aerosol number concentrations in the coarse and giant modes on 13 June 2006 found to be five (26×10^6 m^{-3}) and ten (17.2×10^3 m^{-3}) times higher as compared to their respective monthly mean values. Aerosol optical depth values also showed two to four times increase, particularly at longer wavelengths suggesting increase in the concentrations of coarse and giant particles. This is supported by three to five times increase in Ångström turbidity coefficient ( ) and significant reduction in Ångström wavelength exponent ( ). Absence of enhancements in black carbon and accumulation mode particles suggests negligible changes in the influences of anthropogenic activities at the site during the study period. **[Hegde P., Pant P., Naja M., Dumka U. C. and Sagar R.].**

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

Keeping in mind the importance of low mass stars in the coronal regions of clusters, wide field photometry is being pursued around open clusters using the 1.05-m Kiso Schmidt and 1.04-m ARIES telescope in collaboration with Prof. K. Ogura, Tokyo, Japan under Indo-Japan cooperative science program (DST, India and JSPS, Japan).

Multi-wavelength studies of a few star forming regions to study the global view of star formation in these regions, in collaboration with Prof. K. Ogura (Japan), Prof. W. P. Chen (Taiwan), Prof. S. K. Ghosh, Dr. D. K. Ojha (TIFR, Mumbai) are being carried out. Deep photometry of small clusters in HII regions with special focus on bright-rimmed clouds in order to examine "small-scale sequential star formation hypothesis" is also being carried out.

Collaborative studies with Prof. K. P. Singh (Tata Institute of Fundamental Research, Mumbai) are being carried out to study the coronal evolution of cool stars. In the first phase of this work, a sample of six G-K dwarf stars observed from XMM-Newton has been studied. In another collaboration with Prof. K. P. Singh and Dr. S. A. Drake (USRA/GSFC, NASA, USA), search for new chromosphericaly active stars on the basis of their high X-ray to bolometric luminosity is being carried out.

To study of molecular gas in early-type galaxies, the observations of a few S0 galaxies in collaboration with F. Combes (LERMA, Paris) are scheduled with the 30-m IRAM mm-wave telescope. The aim is to quantify molecular gas content in S0 galaxies. To study of steep spectrum diffuse radio sources an observing program using the GMRT and VLT, in collaboration with R. V. Weeren, H. J. A. Rottgering, M. Pandey (Leiden Observatory, Leiden), A. Cohen (NRL, Washington DC), M. Bruggen (Germany) is being carried out to study a complete sample of steep spectrum radio sources detected by VLA 74 MHz survey.

Follow-up observations of GRBs and SNe, in collaboration with IAA-Granada, Spain; MSSL-UCL, U.K; IUCAA, Pune and IAA, Bangalore are being carried out to understand their inter-corelation.

To search and study the photometric variability in chemically peculiar stars a program in collaboration with D. L. Mary of Labratoire Universitaire d' Astrophysique de Nice, France; Prof. D. W. Kurtz of Centre for Astrophysics, University of Central Lancashire, Preston, UK; Dr. Peter Martinez of South African Astronomical Observatory (SAAO) , South Africa; Dr. S. Seetha, V. Girish and B. N. Ashoka of ISRO Satellite Center, Bangalore, is being carried out. To study the

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

A collaborative project entitled " Photometric and Spectroscopic study of Chromospherically Active Stars" is going on in collaboration with Dr. Padmakar Singh Parihar, Indian Institute of Astrophysics, Bangalore, India and Dr. Sergio Messina, Catania Astrophysical Observatory, Italy. The aim of this project is to study the cause of chromospheric activity and to determine how the chromospheric activity varies during a star's life in different groups of chromospherically active stars e.g.; TTauri, RSCVn, BYDra, Algol, WUma and FKcom.

Solar Physics group of ARIES is a part of the INDO-FRENCH Project on "Transient Phenomena in the Sun-Earth System" (Prof. P. Venkatkrishnan, USO, Udaipur is PI from India, and Prof. G. Molodij, Observatory de Paris, Meudon is a PI from French side). Under this project, active collaboration is being pursued with Dr. Nandita Srivastava, Dr. Ashok Ambastha, Dr. S.K. Mathew, Dr. Sanjay Gosain (USO, Udaipur), Prof. P.K. Manoharan (RAC, Ooty). Collaborative project with Prof. Debi Prasad Choudhary, California State University, Northridge, USA on some major solar flares observed at ARIES in October-November 2003 to study energy build-up and energy release mechanisms is being carried out. ARIES is also a part of the (a) CAWSES India Project on " Space Weather aspects of Active Region Vector Magnetic Fields", (b) X-ray Spectrometer (SOXS) project with Prof. Rajmal Jain (PRL, Ahmedabad) and Prof. A.R. Rao (TIFR, Mumbai), (c) "Indian Space Coronagraph Project", (d) "National Large Solar Telescope (NLST)" project of 2 meter class. The solar-physics group of ARIES also collaborates with Dr. Syed Salman Ali, Aligarh Muslim University (AMU), Prof. Abdul Qaiyum (AMU), and Prof. B.N. Dwivedi, (I.T. BHU). The solar physics group is also active in data analysis of SOHO, Hinode, STEREO data and in theoretical modeling.

Analytical investigations of jet formation from accretion discs around compact object has been investigated in great details, in the recent past. Presently, jet formation in presence of various dissipative processes such as viscosity and cooling mechanism is being numerically investigated, in close collaboration with Prof. Diego Molteni of University of Palermo, Italy.

Relativistic astrophysics with correct thermodynamics and fluid composition is being applied to accretion onto compact objects, GRBs, astrophysical jets. The investigation is being undertaken both in the theoretical as well as numerical domain, and is being done in close collaboration with Prof. Dongsu Ryu, of Chungnam University, South Korea.

To study the physical, chemical and optical characterizes of aerosol and trace gase over Nainital, three projects (i) Aerosol Radiative Forcing over India

(ARFI) (ii) Atmospheric Boundary Layer Network and Characterization (ABLN&C) and (iii) Environmental Observatory are being carried out under Indian Space Research Organization - Geosphere Biosphere Programme (ISRO-GBP) in collaboration with SPL, Thiruvananthapuram and PRL, Ahmedabad. Another project for low latitude VLF whistler studies is going on in collaboration with Indian Institute of Geomagnetism (IIG), Mumbai.

Observations of greenhouse gas are being carried out in collaboration with National Institute for Environmental Studies, Tsukuba, Japan. Additional, continuous observation of surface ozone is being carried out at Pantnagar in collaboration with G. B. Pant University of Agriculture and Technology, Pantnagar.

1. OBSERVING FACILITIES

1.1. Stellar Observing Facilities

The 104-cm Sampurnanand reflecting telescope, located at ARIES, is the main observing facility for Ph.D. students and faculty members of ARIES. The telescope of 104-cm primary mirror size has a focal ratio of f/13 and mounted on the two-pier equatorial English system. Currently used the major back-end instruments for observations are 2K X 2K Wright CCD, ARIES imaging polarimeter (AIMPOL) and 3-channel fast photometer. Puntino Sack-Hartman sensor is used for guiding the telescope during the deep imaging observations program.

Broadly the scientific programs studying with this observing facility include study of star-clusters, young star-forming and HII regions; optical variability in roAp stars, AGN and brown dwarfs; optical counterpart of Gamma-ray-brusts (GRB), supernovae and X-ray sources; Wolf-Rayet Galaxies and Giant Radio Galaxies. Details of some of the studies could be found elsewhere in this report.

Figure 14. The new 512 X 512 frame transfer CCD recently installed for characterization at the back-end of the 104-cm Sampurnanand telescope of ARIES. This instrument will be one of the back-end instruments for the new upcoming 1.3-m telescope at Devasthal.

1.2. Solar Observing Facilities

The main solar observing facility is 15-cm Coudé Solar Tower Telescope equipped with Bernhard Halle H filter, and fast imaging CCD camera. The main aim is to observe the solar eruptive events (e.g., solar flares, filaments and prominences, surges etc.) in the chromosphere of the Sun. We have CaII K 3933 Å , G-band 4305 Å

filters to observe the dynamics of lower solar atmosphere. We also have FeX 6374 Å, FeXIV 5303 Å, FeXI 7892 Å filters etc. to observe the corona during total solar eclipse.

Figure 15. 15-cm Coude Solar Tower Telescope for solar activity observations.

1.3. Atmospheric Observing Facilities

The atmospheric research at ARIES was initiated during January 2002 when a Multi-Wavelength solar Radiometer (MWR) was installed under Indian Space Research Organization - Geosphere Biosphere Program (ISRO-GBP).

The measurements are comprised of aerosol spectral optical depths (MWR and Microtops II, Sunphotometer), mass and number size distributions (GRIMM, optical particle counter), BC concentration (Aethalometer), size distribution of sub- and super- micron aerosols using GRIMM and spectral AOD data, total columnar ozone, water vapour content (MWR and Microtops II Ozonometer), Total Suspended Particulate matter (High Volume air Sampler), and meteorological parameters (Automatic weather station, AWS). Besides these instruments a Micro pulse lidar system in collaboration with NARL, Gadanki is available to study the vertical extent of aerosol and clouds in the troposphere. The schematics of instruments have been shown in Figure 16. Recently ARIES has acquired an ozone

analyzer to study of tropospheric ozone. Further air samples are also being collected at ARIES to analyse other trace gases (e.g. CO, CH_4, SF_6, N_2O, NMHCs).

Figure 16. Existing facilities related to aerosol characterization at ARIES.

2. Support Facilities

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

2.1. Aluminizing Unit

Since mirrors used in the telescope lose their reflectivity due to weathering etc., their realuminization is a must. To do this, ARIES has an aluminizing plant with 124-cm diameter coating unit. This unit is used to realuminize the primary mirror of the 104-cm telescope. Another small 30-cm diameter unit has also been used at the institute for small jobs less than 30-cm. Both units are regularly used for aluminizing mirrors under a vacuum of 4×10^{-6} torr. The smaller unit is also used for evacuating the Dewars of CCD systems and IR photometer. Few mirrors were aluminized for LIDAR during the year, some more mirrors were received from amateur astronomers for recoating. The 5-Tonne mechanical hoist and accessories were loaned few times for emergencies inside and outside ARIES and Devasthal.

2.2. Computer Centre

With the ever increasing need for better communication with the outside world, be it for collaborations or for other scientific purposes, ARIES requires a modern computational facility.

The Institute is keen to make its computer centre, the very best. It has a user base of about 100. The Centre has more than 100 Linux and window XP PCs, and work-stations to cater to the computational needs of the researchers. All the computers in the ARIES are connected through a 10/100/1000 Mbps network. The data archival capacity in the institute has increased by several folds. Portable external USB Hard disk, DAT, DVD and CD storage devices are used for backup. The latest Color LaserJet printer with duplex facility is available for all end users.

The Institute is striving to increase its bandwidth capacity, to meet the ever increasing demand of the users. To that end, the Institute has procured a dedicated 1Mbps link, which has made the connectivity much better than the previous years, although it is falling short of the actual requirement. The Institute has also experimented by procuring a broadband connection to increase its bandwidth capacity.

With the advent of new researchers who are experts in modeling and simulations, the Institute is increasing its computational facilities, by procuring a high end workstation (16GB RAM, quad core 3 Ghz clock speed), which also serves as the IDL server.

Apart from the PCs, laptops, workstations provided to the researchers, the Computer Centre also has Multi-functional devices (scan, photocopy, print). In order to present the latest information, the Computer Centre has developed a new website. An Archive for the 1.3m and 3.6 m DOT project has also been created, and it can be accessed through the ARIES website, albeit password protected. It carries the information of the latest stage of development of these projects.

2.3. Library

Ever since the inception of the Observatory in 1954, its library has been steadily building up through the years. The library 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 library acquires books and journals mainly related to Astronomy & Astrophysics and Atmospheric Sciences. The library also acquires reference books from time to time.

Library Resource Development

During the period 2007 - 08, the following information resources were added:-

Books	:	153
Bound Volumes of Journals	:	150
Subscription to Journals (Print + Online)	:	96
ARIES Publications	:	33
ARIES Theses	:	4

The collection at the end of the period is

Books	:	Around 9810
Bound volumes of Journals	:	Over 10,000

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

Modernization

During 2007-08, the LIBSYS software of the library was upgraded. Added with new features, it is being used for multiple users. The new features of Online Catalogue is available at Web-OPAC on ARIES home page as well as ARIES Intranet. The subscribed E-journals are also available at ARIES Library home page. ARIES Academic Reports and List of Publications are available at ARIES Library home page. The stack of Periodicals, etc. are re-arranged in the ARIES Library. For up gradation of existing facilities two Toshiba digital photocopiers including one colour with networking facilities and two Sanyo LCD Projectors have been acquired.

Consortia

The ARIES library is a member of FORSA (Forum for Resource Sharing in Astronomy and Astrophysics), which has been established by Indian Astronomy Librarians in 1979. At present 12 members are of FORSA. Online subscription of Springer Journals and Nature are continued under FORSA Consortium. UCP Journals (Print + Online) are subscribed under FORSA Consortium. A meeting of the FORSA Members was organized at Raman Research Institute, Bangalore on January 23, 2008 and it was decided that a meeting of LISA - VI (Library and Information Services in Astronomy) will be held at India in 2010. In the meeting it was also decided that LISA - VI will be held at IUCAA, Pune in February 2010.

2.4. Civil Works Section

The civil work section looks after the routine maintenance, and modifications/renovation of the ARIES office and residence buildings and roads.

During 2007 - 08, some of the works done by the section at Manora Peak and Devasthal are :

At Manora Peak

(i) Guest House :

- Suites : Most of the work has been completed, except the fixing of roof sheets and insulation work.
- Single Rooms : Remaining works of stone work, electrical, painting, Sanitary fixture, wood work, are in progress except the fixing of Roof sheeting and insulation work.
- Kitchen/Dining Block: Remaining work of stone work, electrical, painting, Sanitary fixture, wood work, are in progress except the fixing of Roof sheeting and insulation work.

(ii) Hostel building :

- PDF Block : First floor roof casting work is in progress. Ground floor plastering and flooring work has been completed.
- Research Fellow Block : Ground floor slab has been casted and brick work is in progress. First floor roof casting work is in progress.
- Kitchen/Dining Block: Plinth beam has been casted and columns have been casted upto lintel level.

(iii) Visitor Centre : All columns have been casted upto lintel level and back side RCC Retaining wall work is in progress.

(iv) Optics Lab : Brick work in ground and first floor is almost completed and flooring work has also been completed. Plastering and stone work are in progress.

(v) Computer/Lecture Theatre : All columns have been casted upto lintel level along with RCC Chajja. Brick work is in progress.

(vi) Workshop Building : Layout of Site has been carried out and all working drawings have been handed over to the Contractor.

(vii) Other Works :

- LIDAR House : The work has been completed.
- SCHMIDT Telescope Building - All working drawings have been given to the contractor and foundation work is in progress.
- Annual Maintenance work : Contract has been finalized and work is in progress.
- Electric Cable laying work in Manora Peak : Work mostly complete.
- Barbed fencing work : Work has been mostly completed.

- Repair and maintenance work in 40" telescope building. : Brick work and RCC work have been completed and plastering is in progress.
- Miscellaneous repairing works in the Office and Campus are being carried out.

At Devasthal

Laying of inter and top coat of approach road from P.W.D. road to 130-cm. Telescope site has been completed. Construction of Pre Fab Building is almost completed.

WORKS IN PROGRESS

- 130 Cm. Telescope building : Work is completed up to door bend level.
- Scientist Guest Rooms : Layout has been given to the contractor.
- Generator Hall-2 : the work is almost complete.
- Laying of Electrical Cable : Work is almost complete.

2.5. Electronics Workshop

Electronics section caters to the overall electronics and electrical aspects related to instrumentation and infrastructure. In this section a group of engineers and engineering assistants is involved in design, development, upgradation and maintenance activities. This section comprises of different labs and related facilities to aid to the above activities. Since electronics has become a vital part in advanced instruments and telescopes this section plays an important role in all the new projects and installation of new instruments. This section works in coherence with other engineering sections in the field of opto-electronics systems, electro-mechanical systems and hardware interfacing and also with all the scientific groups for customizing their instruments. During the year 2007-08 engineers from this section were actively involved in all the ongoing projects.

This section is also involved in infrastructure development and maintenance activities. The electronic section is responsible for installation and maintenance of facilities vital for effective functioning of the organization like strong telecommunication setup, electric substation, centralized UPS and other useful appliances. Cables with enhanced loading capacities have been installed in ARIES, Manora Peak Campus. Installation of electrical substation, essential cabling and networking activities for ARIES, Devasthal site has been initiated.

2.6. Mechanical Workshop

The manufacturing, fabrication, maintenance and modifications in various equipments, telescopes and their accessories along with other miscellaneous jobs were carried out by the mechanical workshop. Mechanical maintenance of the stellar and solar telescopes was done on a regular basis. Servicing and maintenance of the institute vehicles and generators was also carried out.

During the year 2007-08, three students from other educational institutions pursuing mechanical engineering completed their 45 days vocational training by taking up projects related to mechanical design & developments in the mechanical section.

Summary of the major developmental works carried out by mechanical workshop:

- Design, fabrication and installation of Roll-off roof for LIDAR building.
- Design and development of housing for detection optics and electronics for Rayleigh Telescope of LIDAR project.
- In-house design and fabrication of 512 CCD Mounting with four filter option in single assembly along with mountings for Camera cooler and controller base.
- In-house complete design, manufacturing and assembly of compact filter box housing with removable filter disk option.
- Repair & maintenance works have been carried out in 40" Dome.
- Development of 1k CCD Filter Housing & Lens Advancing System for Solar Telescope.
- Development of housing for a subsystem of Ozone Analyzer.
- Design & machining of tools and Radius turning attachment for Optics Section
- Base Plate Machining for Turbo Pump connection at Aluminizing Section.
- VLF Amplifier housing fabrication for Weather Station.
- Fabrication of Junction Boxes for Devasthal site.
- Rollers with bearings were manufactured for smooth operation of 40" Dome shutter.
- Modifications in the sliding disc of Secondary Mirror of BLL LIDAR
- Disc manufacturing for Stepper Motor of Electrical Lab.

2.7. Optics Workshop

The optics workshop has an automatic grinding and polishing machine capable of taking the jobs up to 75-cm diameter, two rotating spindles for manual work on jobs up to 25-cm diameter, a drilling assembly for scooping holes, a glass slitting machine and a grinding machine capable of taking jobs up to 20-cm. The optics workshop looks after the routine maintenance, optical design, testing and modifications of the optical equipments of the institute.

A preliminary optical design of ADFOSC, the initially proposed focal plane instrument for 3.6-m DOT, has been simulated with ZEMAX-EE. Various physical "re-arrangements" got effected within optics stores and workshop to accommodate execution of current maintenance jobs. Mitutoyo digital vernier calliper is received for measuring distances up to 1.5-m. Similar digital vernier with 1-m range was used to verify dimensions of Schmidt parts with representatives of M/S Avasarala in connection with Schmidt Telescope Project developments. LIDAR Project got

regularly assisted with alignment and design inputs. New filter disc was provided with square 76-mm UBVRI filters after several modifications, for 104-cm telescope observing. Milky Way Voyage expedition was assisted by storing many telescopes with mountings. A 134-mm Newtonian telescope from Tata Energy Institute, Mukteshwar was repaired. Planning is in process for creating standard polishing, smoothing & grinding shops, stores, clean-room and test-labs in new optics building.

3. Upcoming Facilities

ARIES has 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 and upcoming projects.

3.1. Devasthal Site

Devasthal (latitude 29°:22':26'' North, longitude 79°:40':57'' East, Alt: 2500 meter above msl) is being developed as an astronomical site. Two optical telescopes with size 1.3-meter and 3.6-meter are being set up for observations of celestial sources at optical and near infrared bands. The site is far from any urban development and is most suitable for astronomical observations.

Construction of 3.5 km long metalled road connecting the state highway, from Jarapani junction to Devasthal site, is in progress. Top coat consolidation on the road has been completed in January 2008. Hydroelectric 150 kW Power Transmission line has been laid down by Uttarakhand power corporation and it will be energized soon. The power requirement has been met successfully by installing a bore well and locating a water table (30-feet wide) about 110 feet below the ground surface. The bore well is located at the base of Devasthal site. Further, there is a plan to recharge the water level around the bore-well by land-water harvesting. A plan for tapping roof water is also under progress. In order to enable the transfer of electronic data at Devasthal site, the optical fiber cables have been installed from the base camp to the proposed telescope site.

3.1.1. 3.6-m Devasthal Optical Telescope

Contract for the Design, Manufacture, Integration, Testing, Supply and Installation was awarded to Advanced Mechanical and Optical Systems (AMOS), Belgium on 29 March 2007. AMOS submitted the preliminary optical design description and mechanical description of the telescope. These designs were reviewed by the review groups and discussed in the Project Management Board meetings. Primary and Secondary mirror designs were finalised and the contract for the production of these mirrors were awarded by AMOS to LZOS Russia. The mirror blanks for these mirrors were tested by AMOS and found that the M2 mirror blank is as per

specification however, M1 mirror blank did not meet the specifications. Therefore an alternative mirror blank from SCHOTT Germany is being acquired.

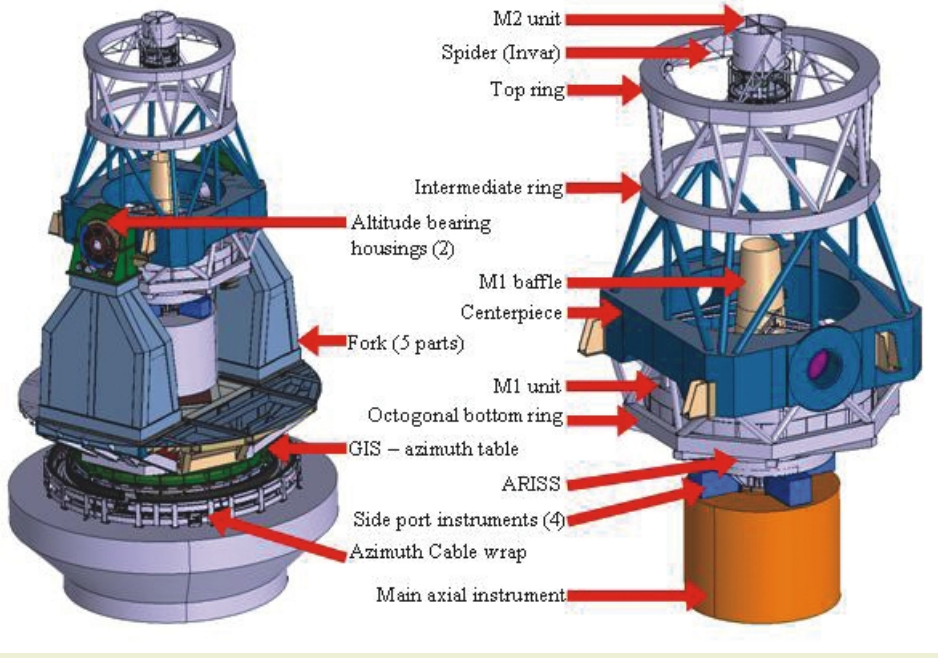

Figure 17. A mechanical design of the 3.6-meter Devasthal Optical Telescope.

Mechanical components designed by AMOS were examined from the transport point of view. It was found that some of the designed components like Ground Interface Structure, Fork base, Bearing housing, Centerpiece were too heavy and large for the transportation and installation at the Devasthal site. Therefore AMOS conducted a road survey. Preliminary Design of telescope has been completed and it has been reviewed by a Design review committee. The milestone payment due at this stage has been made.

The design review committee suggested modification in the volume of the Cassegrain instrument and position of the focus for the side port instruments. This has a positive impact on the size and total weight of the telescope. To solve the transport and installation issue AMOS now designs the telescope pieces to a limit of 20 tons.

Inter and top consolidation on the access road to Devasthal site has been completed. Two electric substations have been constructed. HT line installation and LT cable and Optical Fiber Cable laying is in the final stage.

3.1.2. 1.3-m Optical Telescope

The construction of the 130-cm Telescope building at Devasthal has been progressed considerably and the plan is to complete it by early September 2008. Other related activities like electrification of the building, computer networking and development of the surrounding area is going on simultaneously. The link road

at Devasthal will also be ready by November 2008. The roll-off-roof construction of the telescope building will start soon after completion of the civil work.

Figure 18. Proposed 1.3-meter telescope at Devasthal.

The design and material procurement for the roll-off-roof construction has already been completed. The overall plan is to complete the building for the telescope installation by November 2008.

At DFM Engg. U.S.A., the mechanical parts of the Telescope are almost ready and the polishing of the mirrors have been started from January 2008. The results of the mirror polishing stages are satisfactory. Hopefully the polishing of the mirrors and SAG design will be completed by October 2008. The Telescope will be transported for the installation, soon after its completion. The payment to DFM is going on as per schedule. The first light from the Telescope is being expected by January 2009.

3.2. Projects at Manora Peak

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

3.2.1. High Energy Pulse LIDAR System

A lidar project was started to fabricate and to assemble a powerful Rayleigh and Mie LIDAR (light detection and ranging) to study aerosol characteristics and middle atmospheric dynamics during the year 2005. This has been taken up as in house technology development project with estimated budget of about Rs. 2 crore. For monitoring the project, a PMB was formulated by the governing council of ARIES. There have been three reviews by the PMB so far. First phase of the project was to build the mechanical assembly of telescopes (84-cm for Rayleigh and 38-cm for Mie) before going for the next phase (procurement of laser source, electronics and other optical components).

Following progress has been made in connection to the setting up of a pulsed Lidar system:

- One set of electronics components such as Multi Channel Scalar card (MCS-card + software) Phillips 6908 / ORTEC 9327 amplifier/discriminator, PMT - 9863/350B has been acquired and lab tested for signal detection.
- Integrating the above components in the electronics lab, the detection electronics has been tested. Front-end optical components (such as: beam splitters, collimating lenses, laser mirror and beam expander x10) have also been procured.
- Preliminary estimations of Lidar parameters, such as FOV, and atmospheric parameters (molecular density profiles and molecular backscattering coefficients) were carried out.
- The construction of the Lidar building was started in April 2007 and the building is on the verge of being completed.
- The fabrication of the Rayleigh telescope (84-cm telescope) has been completed. The designing of optical bench for Mie telescope for lidar use has also been completed.
- The front end optical components housing is under testing phase. The optical testing of the optical beam through the optical assembly is being under test.

3.2.2. Stratosphere Troposphere Radar

Department of Science and Technology has approved the setting up of a Stratosphere Troposphere (ST) Radar at ARIES, Nainital. Total cost to setup the ST-Radar and its running cost for the period of three years is about Rs. 14 crores. This decision has provided a significant boost for research work in atmospheric sciences in the Himalayan region of India. The proposed ST Radar could provide continuous (both time and height) observational data of winds. The measurements from ST Radar can be made in all weather conditions. Finally, ST Radar offers an unique opportunity to study not only gross features of the total wind field, but also small-scale, time-varying structures such as the gravity waves and exchange process

between stratosphere and troposphere. This Radar facility is expected to be operational in the year 2010.

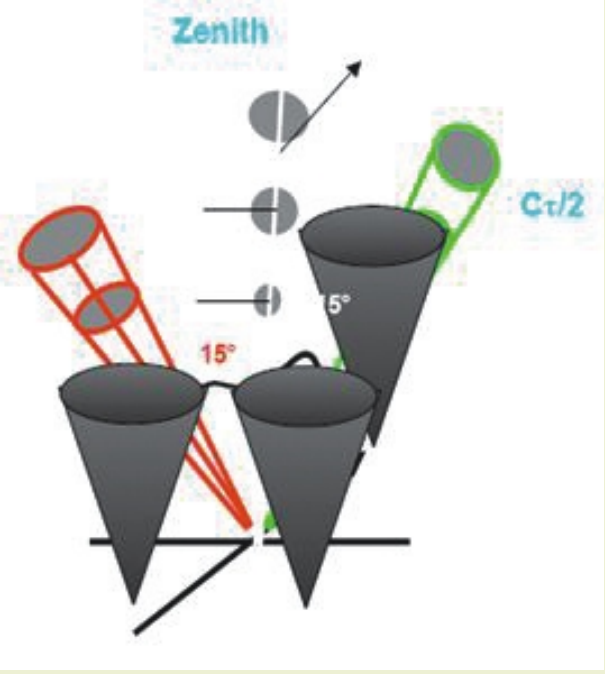

Figure 19. DBS/SAD multi mode clear air profiler.

Present status of the proposed ST Radar at ARIES, Nainital is given below:

- Wireless Planning Commission (WPC) has given clearance for round the clock operation of ST Radar at 206.5 MHz.
- In a 2nd meeting of PMB, release of funds and placements of order to ECIL was recommended. A meeting between ARIES and ECIL was held on 7th and 8th March 2008 and the contract document was signed on 17th March 2008 and subsequently a purchase order was released in favor of ECIL, Hyderabad.
- ECIL has replaced the amplifier BLF 248 by BLF 369 in TR module. TR module and its housing is being designed considering the natural cooling.
- Architectural design of ST Radar building is in the preparatory stage. It is planned that the radar will be put on the rooftop and TR modules will be underneath.
- Radiosondes are planned to be launch in June in collaboration with PRL.

3.2.3. Environmental Observatory under ISRO-GBP

Under the aegis of ISRO-GBP it is planned to set up an environmental observatory at ARIES, Nainital, to study the chemical composition of surface air. *Insitu* simultaneous measurements of ozone, CO, NO-NO_y and SO_2 will be carried out, which will provide the regional representation of these parameters over the region including air quality. The observations will also be helpful to understand the impact of long range transport.

3.2.4. 50/80 Baker - Nunn Schmidt Telescope Project (B N S T P)

The project moved forward into actual (mechanical in particular) fabrication with steady parallel progress in other aspects. The old site got fully cleared, now shifted to a better choice of Optics - front. Field Flattener & Meniscus lenses have been reordered now to two firms / Indian agents. On repeated requests by the expanded PWG and Mr. K. G. Gupta is corresponding with FLI for tackling intricacies in FF mounting near CCD chip. Electronics & control system design and development is

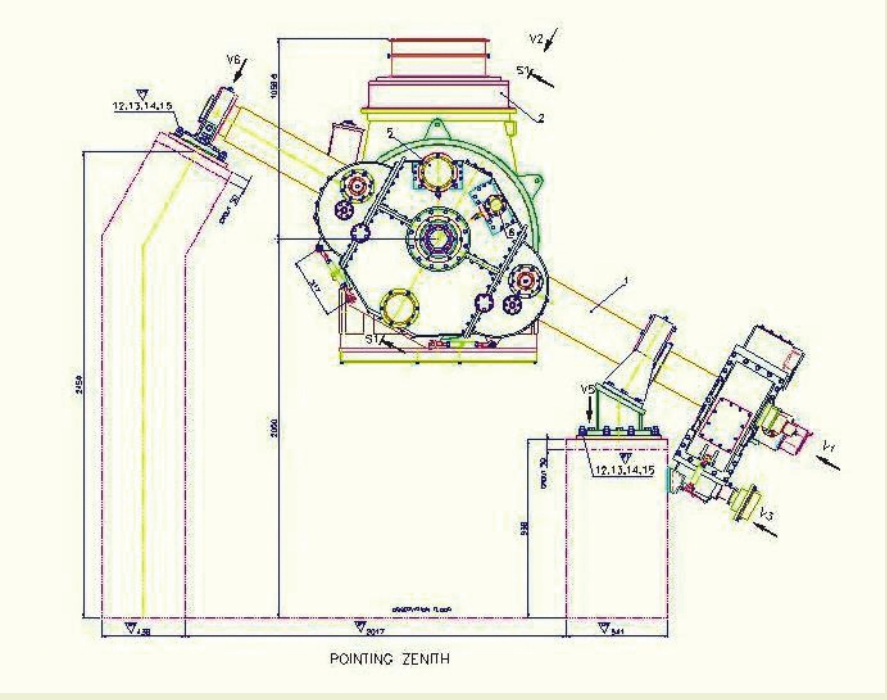

Figure 20. A mechanical assembly drawing of SCHMIDT Telescope.

well on schedule, building and dome have been designed, to be constructed / fabricated / installed by the selected firms. Useful correspondence took place with Dr. O. Fors and others involved in Baker-Nunn Projects elsewhere. A PMB meeting was held on 11.08.2007, attended by the Chairman, Prof. D. Bhattacharya and Prof. A. K. Pati. First draft of the DPR-II on projected scheme for the first-time opto-mechanical assembly, OTA-alignment and squaring-on of the modified Baker-Nunn Schmidt optical system has been compiled. PWG members are striving together to achieve first light at the telescope focus during December 2008 to March 2009, for which the new Project Manager, Mr. T. Bangia is coordinating various activities. KGG and others visited M/S Avasarala for contract-signing for mechanical fabrication of telescope, M/S High Precision Instruments for procurement of precise and digital optical spherometer, IIA-Bangalore for discussion, Mr Sampson showed him a 4-m dia steel dome in construction at their machine shop for an outreach telescope , IDDC in IIT Delhi in connection with optical fabrication and technical meetings during Sep. 17 to 22, 2007.

1. Conferences/Workshops

IHY Workshop on "Super Active Region of Solar Cycle 23 and their Geo-space Impact" organized at ARIES during May 07-10, 2007

India has actively participated in IGY programs and in the continued growth of space science since 1957. During IGY optical tracking of artificial satellites has been carried out with Baker-Nunn camera successfully at ARIES in collaborations with the Smithsonian Astrophysical Observatory (SAO), USA. On the 50th anniversary of IGY, IHY Workshop on "Super Active Region of Solar Cycle 23 and their Geo-space Impact" has been organized at ARIES during 7-10 May 2007. IHY is a Golden Jubilee celebration of International Geo-physical Year (IGY). There was 16 members in the SOC under the Co-chairmanship of Dr. Wahab Uddin, ARIES, and Prof. P.K. Manoharan, RAC, Ooty (IHY India coordinator). There were 16 members in the LOC under the chairmanship of Prof. Ram Sagar, Director, ARIES. Prof. N. Gopalswami, GSFC, NASA, has participated in this Workshop who is international IHY coordinator.

Figure 21. Inaugural ceremony of IHY Workshop on "Super Active Region of Solar Cycle 23 and their Geo-space Impact" at ARIES during 07-10 May 2007

Dr. M.C. Pande's book on Solar Physics has been released by the chief guest, Prof. A.P. Mitra. A ceremony was organized to felicitate IGY Scientists for their significant contribution during IGY (1957-58). More than forty oral and about fifteen poster presentations have been made during the Workshop. The proceedings of the above IHY Workshop will be published in Indian Journal of Radio and Space Physics (IJRSP). The following topics have been covered in the workshop :

1. Properties of Super Active Regions
2. CMEs, Flares and Shocks from Super Active Regions
3. Geo-effectiveness of Solar Phenomena & the Changing Sun
4. Solar Wind
5. Solar Wind-Magnetosphere-Ionosphere Interactions
6. Ground and Space Based Instruments
7. IHY Public Outreach

(a) (b)

Figure 22. (a) Book release of Dr. M. C. Pande by the chief guest on Solar Physics during inaugural ceremony of the IHY Workshop at ARIES during 07-10 May 2007.
(b) IGY scientist's felicitation ceremony on the IHY Workshop at ARIES during 07-10 May 2007.

About 65 participants from different Institutes/Universities/Colleges from India and abroad and about 40 participants from ARIES attended the IHY Workshop. This Workshop was co-sponsored by CAWSES-ISRO, India program and NCRA-TIFR.

Figure 23. Participants of IHY Workshop at ARIES during 07-10 May 2007.

2. Pedagogical Activities

Weekly Seminars

The seminars by Institute's students, scientists and engineers were organized regularly every week. Weekly seminars increase the academic interactions amongst the scientists and researchers during and after the presentations. About 45 lectures were delivered during the period 2007 - 2008.

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. Nainital and nearby places are full of school and colleges and is a major center for primary education in this part of the country.

Here at ARIES, people are visiting on regular basis as well as on the occasions of popular astronomical events like eclipses and other planetary occultations. On occasions of major astronomical events special arrangements are made to provide related information to the visitors and the sky-watching programs using the telescopes. Apart from this we also make use of print and electronic media to communicate information related to astronomical events as and when required as a part of the activities. Popular talks in the nearby schools and collages are also arranged as a part of the programs.

On 28 February 2008 (National Science day), ARIES organized a special program for school students. The students visited the ARIES Telescopes, attended talks on fundamental astronomy and participated in a quiz program and a prize distribution ceremony.

During March 07-09, 2008, a program called "Milky Way Voyage", the first largest star party of amateur astronomers in India, was hosted by ARIES. It was organized by a group of amateur astronomers and their team under the umbrella of an organization called SPACE (Science Popularization Association of Communicators and Educators). In this program about 150 amateur astronomers were participated from all over India at ARIES Nainital. In the inaugural ceremony largest telescopes made by Indian amateur astronomers namely 20 inch, 16 inch and 10 inch were unveiled in first light ceremony. During the above program more than 50 telescopes were used to observe the different astronomical objects and a basic astrophotography demonstration, participants presentation, judgment the astrophotography contest, etc. were successfully organized.

(a)

(b)

Figure 24. (a) Inaugural ceremony of Milky Way Voyage Programme and first light of telescopes made by Indian amateur astronomers at ARIES during March 07-09, 2008.

(b) Under the guidance of ARIES staff, the largest 20 inch amateur telescope made by Indian amateur astronomers ready to observe during Milky Way Voyage Programme.

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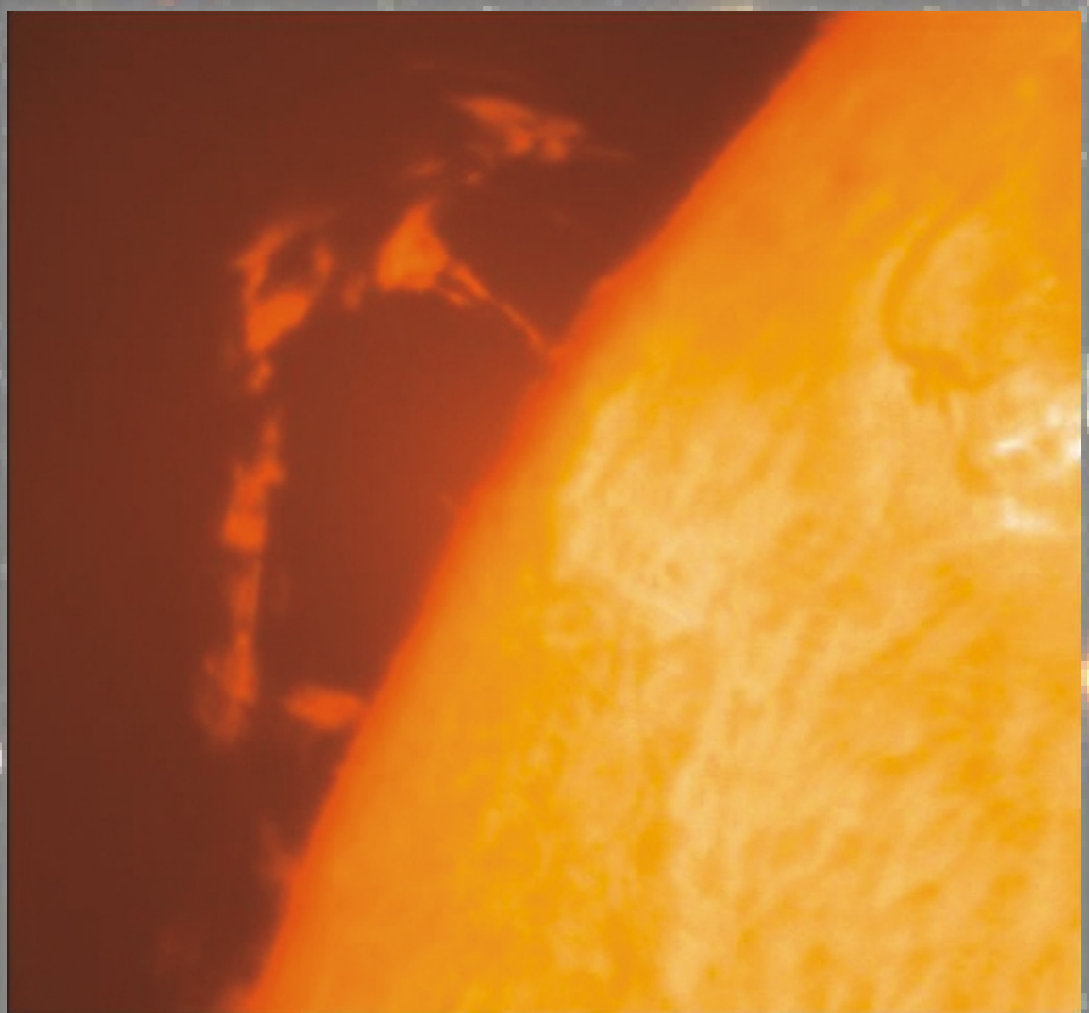

August 2008

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