Aryabhatta Research Institute of Observational Sciences

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

Manora Peak, Nainital (India)

Academic Report
2005 – 2006

ARYABHATTA RESEARCH INSTITUTE OF OBSERVATIONAL SCIENCES

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

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104-cm Sampurnanand Optical Telescope at Manora Peak, Nainital

August 2006

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EXECUTIVE SUMMARY

After transfer from the Uttaranchal State Government to the Government of India last year, the Institute stabilized during the year under review. A number of activities ranging from infrastructure development to frontline research out put were successfully completed during this period. For example, order for the procurement of 130-cm. Telescope has been given to DFM Engineering, USA; First meeting of the Scientific Advisory committee was held and all the formalities regarding construction work at ARIES were completed. All these will contribute significantly to the grow of the institution.

During the year long, Golden Jubilee celebration of the Institute from May 2004 to April 2005, ARIES hosted a number of academic activities. Of them, the last one was International Solar Workshop on Transient Phenomena on the Sun and Interplanetary Medium during April 5-7, 2005. The proceedings of the workshop is being published as a special volume in Journal of Astrophysics and Astronomy. Prof. R. C. Pant, Vice-chancellor, Kumaun University, Nainital inaugurated the workshop. The highlight of inaugural function was the release of a book entitled "Fundamentals of Solar Astronomy" authored by Prof. Arvind Bhatnagar and Prof. William Livingston. Prof. Ram Sagar, in the evening lecture, highlighted the research activities of the institution over the last five decades.

The Devasthal Project site located about 50 km from Nainital at an altitude of about 2420 meter is being developed for the installation of proposed 1.3 meter and 3.5 meter class optical telescopes. The work on the approach road from Jarapani to Devasthal is in progress. The earth cutting work has been completed. Foundation stone of this Jarapani-Devasthal road was laid by Padmashree Dr. Sambhu Dayal Sinvhal, member of Governing Council of ARIES on 27 October 2005. To provide electricity at the site, work on the high tension line is in progress. Location for the installation of transformer, 1.3 meter optical telescope and the guest house has been finalized. A high speed 2.4 GHz microwave link has been installed to transfer digital data between Devasthal and Manora Peak. The total usable bandwidth is 14 Mbps. This link has enabled the transfer of computer data, INTERNET data, and telephone voice data for communication between the two places.

Thirty six papers were published /accepted for publication in standard refereed journals and another thirty eight were presented in the scientific meetings/workshops etc. Thus the publications grew during the year by more than 50 percent. Number of National and International collaborations also increased. Valuable scientific results were obtained in the area of Solar Physics, Atmospheric Physics and extra-galactic Astronomy during the year. Some of them are listed below:

1) A new evolved RS Cvn binary, HD81032 has been identified and chromospheric activities have been clearly noticed in RF Canceri, HD 95559 and LO Pegasi based on their X-ray, optical and IR multiband study.

2) Formation of low-mass stars precedes the formation of most massive stars in young star cluster NGC 663 while that did not cease after the formation of most massive star in another young star cluster NGC 654.

3) Optical, millimeter and radio observations of the afterglow of GRB 030329 indicate the simultaneous presence of two jets and its association with Supernova SN2003dh.

4) A new Herbig Be star and several intermediate mass pre-main sequence stars have been identified in a young open star cluster NGC 146.

Our institute in collaboration with Indian Institute of Astrophysics, Bangalore carried out successfully a number of valuable observations of Total Solar Eclipse event on 29 March, 2006 at Manavgat, Turkey. Such observations have been recorded for the first time in the history of the Institute. A 12.5 cm f/5 refractor equipped with red coronal filter and CCD camera was used for fast imaging. During totality, about 250 CCD filtergrams were obtained. These observations are being used to probe the solar corona at a temperature of about million degree Kelvin. We have also carried out the measurements of solar radiation, air temperature and relative humidity along with those of wind speed and direction during the total solar eclipse to study the response of Earth's atmosphere to the eclipse. It is observed that the temperature minimum occurred about 8 minutes after the totality which is attributed to the thermal inertia of the atmosphere.

It is heartening to note that in 2005, Dr. A. K. Pandey, Scientist 'D' of ARIES has been elected as Fellow of National Academy of Sciences, India while Prof. Ram Sagar has been elected as a Council member of the National Academy of Sciences, India with effect from January, 2006.

Significant progress has been made on the Schmidt-telescope, LIDAR and Air-glow photometer projects. For academic/technical interactions, MOU has been finalized with IIT, Kanpur and the University of Western Ontario, Canada. It is expected that such interaction will go a long way in strengthening the academic activities at ARIES.

Representing the true national character of the Institute, a number of young and motivated staff members mainly in the category of Engineers, Scientists and Ph.D. students representing different regions of the country joined the Institute. This indicates that the young generation of the country is now willing to contribute to the growth of the Institute. The number of visitors to ARIES and also interaction of ARIES staff with the other national and international academic institutions have increased significantly. I, therefore, see a bright future for the ARIES.

Place: Nainital
Date: 02 August, 2006

RAM SAGAR
Director

THE INSTITUTE

The primary objective of ARIES is to provide national optical observing facilities to carry out research in the front-line areas of Astronomy & Astrophysics and Atmospheric Sciences. The main research interests are in solar, planetary, stellar and galactic astronomy including stellar variability and pulsation, star clusters, photometric studies of nearby galaxies, quasars, and transient events like supernovae and highly energetic gamma-ray bursts, study of aerosols, airglow emission, mesosphere - lower thermospheric regions, and various coupling processes between different atmospheric regions of the Earth. The observations carried out at ARIES are well recognized internationally. The longitude of ARIES (79° East) locates it almost in the middle of about an 180-degree wide longitude band having modern astronomical facilities between Canary Islands (20° West) and Eastern Australia (157° East). The observations which are not possible from Canary Islands or Australia due to day light can be obtained at ARIES. Because of its geographical location and existence of good astronomical site, ARIES has made unique contributions to many areas of astronomical research, particularly those involving time critical phenomena. For example, the first successful attempt in the country to observe optical afterglow of Gamma-Ray Bursts was carried out from ARIES. Recently, a few cases of micro-lensing events and Quasar variability have been confirmed from the Observatory. In the past, new ring systems around Saturn, Uranus, and Neptune were discovered from the Observatory. In coming years, the Institute plans to setup extended new observational facilities in the Himalayan region.

Facilities: ARIES presently hosts six optical telescopes of sizes 15-cm, 25-cm, 38-cm, 52-cm, 56-cm, and 104-cm. The 33 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 N2 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. The Institute has a 15-cm Coude telescope for solar observations. The oldest telescope namely the 25-cm Cooke refractor is used for science popularization programs.

Considering the aspirations of the Institute, it is planned to maintain and upgrade its existing facilities, and design and fabricate new equipments to carry out observations in the frontier areas of astronomy. For this purpose, the Institute plans to set up a 1-meter class and a 3.5-meter class optical telescope. ARIES plans to develop optical observing facilities at a site called 'Devasthal', which has the advantages of having dark skies and excellent observing conditions. It is also planned to set up a 1-meter class micro-pulse LIDAR system to carry out research on the atmosphere of the Earth. ARIES also participates in science popularization programs for students and the common public.

Ph.D./PDF Programme: ARIES offers fellowships to pursue Ph.D. in Astronomy & Astrophysics and Atmospheric Sciences for which the select students as research scholars via the JEST exam. and also via the NET and GATE exams. The minimum qualification is an M.Sc. degree in Physics/Astronomy/Astrophysics or a B.E./B.Tech.

degree. ARIES is recognised as a research centre by many Indian universities, where students can register for the Ph.D. degree.

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 B.E./B.Tech./M.Sc. courses can spend 2-3 months at ARIES to work with one of the scientists 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 4-6 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./B.Tech. programs. The school consists of lectures and a short-term project.

Evening Programs: The observatory is open to public in the evenings for night-sky viewing using one of the telescopes at the Institute. Visitors can also attend the slide-shows and view the picture gallery describing celestial bodies.

Areas of Research:

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

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

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

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

Extragalactic Astronomy: Nearby galaxies, Optical follow-up of Gamma Ray Bursts (GRB) and Supernova, Active galaxies, Quasar luminosity variability and Radio Astronomy, the last one being a colloborative progamme with other observatories.

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

STARS AND STELLAR SYSTEMS STUDIES

1. STAR CLUSTERS

NGC 146: A young open cluster with a Herbig Be star and intermediate mass pre-main sequence stars :

Low resolution spectroscopic and deep UBV CCD photometric observations of stars in the field of the young open cluster NGC 146 yield a reddening value of E (B-V)=0.55 ± 0.04 mag and a distance modulus of (m-M) 0 =12.7 ± 0.2 mag corresponding to a distance of 3470 ($+^{335}_{-305}$)pc. An age of 10-16 Myr has been estimated for the cluster by fitting the isochrones and synthetic colour magnitude diagrams to the observed ones. Two main sequence B type stars with emission have been identified for the first time. One of them has been classified as a new Herbig Ae/Be star. Present study also indicates that NGC 146 is a young cluster with a large number of intermediate mass pre-main sequence stars. [A. Subramaniam (IIA, Banglore), D. K. Sahu (IIA, Banglore), **R. Sagar** and P. Vijitha (MTU, Kodaikanal]

VRI CCD Photometry of NGC 663 and NGC 654 :

VRI CCD photometry in a wide field around two young open clusters, NGC 663 and 654, were carried out. Hα and polarimetric observations for the cluster NGC 654 were also obtained. The observed photometric data were used to construct colour-colour and colour-magnitude diagrams to investigate the reddening, age, mass and evolutionary states of the stellar contents of the these clusters. The reddening across the cluster regions is found to be variable. There is evidence for anomalous reddening law in both the clusters; however, more infrared and polarimetric data are needed to conclude about the reddening law. Both clusters are situated at about a distance of 2.4 kpc. Star formation in both clusters is found to be a continuous process. In the case of NGC 663, star formation seems to have taken place sequentially, in the sense that formation of low-mass stars precedes the formation of more massive stars. In the case of NGC 654, formation of low-mass stars did not cease after the formation of the more massive stars in the cluster. [**A. K. Pandey** et al. (8 investigators from 4 institutions including **R. Sagar**)]

VLT-UVES analysis of two giants in the globular clusters HP-1 :

The high resolution spectra of two giant stars of the bulge globular cluster HP-1, obtained at the 8-m VLTUT2-Kueyen telescope with the UVES spectrograph, were studied. This is the second metal-poor globular cluster in the bulge for which a detailed abundance analysis was done. Multiband V,I,J,H,Ks photometry was used to derive effective temperatures. The present analysis provides a metallicity [Fe/H] = -1.00±0.2. The a-elements oxygen and silicon show [a/Fe] ~+0.3, whereas magnesium, calcium and titanium show solar ratios. A proper motion analysis indicates that both the stars are cluster members. It is concluded that the metallicity is unexpected for a Blue Horizontal Branch (BHB) cluster. HP-1 is the first known cluster with such a high

metallicity combined with a BHB and a steep Red Giant Branch (RGB). Together with NGC 6388 and NGC 6441 with [Fe/H] ~ -0.6 it would be third with such characteristics, but it differs from them, since these two other clusters also have a populous Red HB, and a normal slope of the RGB for their metallicity, which is not the case with HP-1. [B. Barbuy et al. (11 investigators from 8 institutions including **R. K. S. Yadav**)]

High-precision CCD Astrometry of Star clusters :

A new software to do astrometry (and photometry) on wide-field CCD images has been developed. Using this software the study of the proper motion of open and globular clusters can be done. This new technique has been applied for the proper motion measurements on two-epoch archive data of the two closest Galactic globular clusters: NGC 6397 and NGC 6121. Vector point diagrams of displacements of stars in NGC 6397 are shown in Figure 1. It is found that a precision of ~ 7 milliarcsec (in each coordinate) in a single exposure for a well-exposed star can be achieved, which allows a very good cluster-field separation in both NGC 6397 and NGC 6121, with a temporal baseline of only 3.1, and 2.8 years, respectively. [J. Anderson et al. (6 investigators from 3 institutions including **R. K. S. Yadav**)]

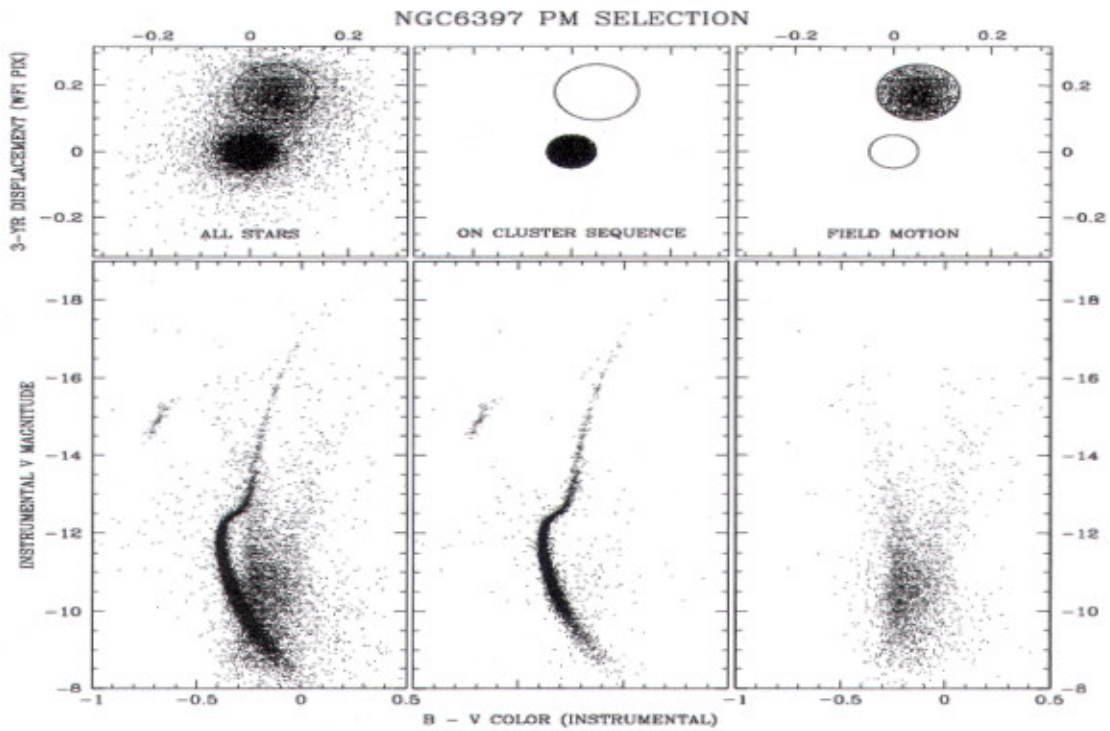

Figure 1. (Top panels) Vector point diagrams of displacements of stars in units of WFI@2.2m pixels (238 mas/pixel) after 3.1 years. Since all the reference stars were cluster members, the zero point of the motion is the mean motion of the cluster stars. (Bottom panels) Instrumental colour magnitude diagrams. The magnitude is calculated as -2.5logDN, where DN is the total digital count above the local sky for the considered stars.(Left) The entire sample; (Center) stars with the same proper motion (within 0.05 pixels) as the MS stars, i.e. with proper motion smaller than 3.8mas/yr. (Right) The stars that fell in the bulk of the field distribution.

Mass Function study of six Open Clusters :

CCD photometric data have been used to determine the luminosities and mass functions of six open clusters. Members of clusters have been identified using photometric and statistical criteria. The mass function slopes for clusters Be 10, Be 67, To 5, Be 15, Be 71 and King 1 are 1.39(±)0.73, 3.41(±)0.98, 1.32(±)0.47, 1.35(±)0.46, 3.02(±)0.81 and 1.46(±) 0.71 respectively. These slopes agree with the Salpeter value (x=1.35) within errors except for clusters Be 67 and Be 71 which have steeper slopes. The clusters Be 10, Be 67, To 5 and Be 15 show mass segregation while King 1 gives weak evidence of mass segregation while Be 71 does not show the effects of mass segregation. All the clusters under study are dynamically relaxed. **[S. Lata]**

2. GAMA RAY BURST AND SUPERNOVA OBSERVATIONS

The optical monitoring of Gama Ray Burst (GRB) afterglows and Supernova were continued using the 104-cm telescope. As a part of this programme, during April 2005 to March 2006 seven GRBs namely GRB050401, GRB050408, GRB050525, GRB051109A, GRB060124, GRB060210 and GRB060218/SN2006aj were observed. The successful afterglow detection includes the earliest ground based observations of the afterglow observations of GRB060124 in R band. GRB060218/SN2006aj was a strange event at a low red shift which showed prominent supernova association three days after the burst. It was followed for 40 days after the GRB trigger. Analysis of these events is in progress. **[K. Misra]**

Radio, millimeter and optical monitoring of GRB030229 afterglow :

The radio, millimeter and optical observations of the afterglow of GRB 030329 were studied. UBVRcIc photometry was presented for a period of 3 h to 34 days after the burst. Radio monitoring at 1280 MHz had been carried out using the GMRT for more than a year. Simultaneous millimeter observations at 90 GHz and 230 GHz had been obtained from the Swedish-ESO Submillimeter Telescope (SEST) and the IRAM-PdB interferometer over more than a month following the burst. These data were used to examine the double jet model proposed by Berger et al. (2003) for this afterglow. It is also examined whether instead of the two jets being simultaneously present, the wider jet could result from the initially narrow jet, due to a fresh supply of energy from the central engine after the "jet break". [L. Resmi et al. (18 investigators from 12 institutions including **S. B. Pandey** and **R. Sagar**)]

3. EXTRA-GALACTIC ASTRONOMY

Multiband optical monitoring of the blazers S5 0716+714 and BL Lacertae :

Multiband optical photometric monitoring of two well-known blazars, S5 0716+714 and BL Lacertae, carried out during 1996 and 2000-01, were examined in order to study the optical variations on time-scales ranging from minutes to hours, and longer. The light curves were derived relative to comparison stars present on the CCD frames. Night-to-night intensity variations of ~ 0.1 mag were observed in S5 0716+714 during

a campaign of about 2 weeks in 1996. A good correlation between the light curves in different optical bands was found for both inter-night and intra-night observations. In all, two prominent events of intra-night optical variability were detected in S5 0716+714. Each of these rapidly varying segments of the light curves can be well fitted with an exponential intensity profile whose rate of variation is essentially the same in both the cases. Our long-term monitoring data of S5 0716+714 showed a distinct flare around JD 2451875, which can be identified in the BVRI bands. This flare coincides with the brightest phase recorded during 1994-2001 in the long-term light curves reported by Raiteri et al. No evidence for the object to become bluer when brighter was noted on either inter-night or intra-night time-scales. On the other hand, our essentially simultaneous multiband optical observations of BL Lacertae in 2001 October showed flux variations that were not achromatic. This blazar was definitely found to become bluer when brighter on intra-night time-scales, and there is a less significant trend of the same type on inter-night time-scales. Based on five nights of observations during a week, BL Lacertae showed a peak night-to-night variability of ~0.6 B mag. Thus, we found that the present optical observations of the two prominent blazars, made with similarly high sensitivity, reveal a contrasting behaviour in terms of the dependence of spectral hardening with increasing brightness, at least on intra-night, and possibly also on inter-night, time-scales. [C. S. Stalin et al. (6 investigators from 5 institutions including **R. Sagar** and **A. K. Pandey)**]

Photometric studies of the quasar SDSSJ153259.96-003944.1 :

The optical Cousins R- and I-band monitoring observations of the high redshift (z= 4.67) quasi-stellar object (QSO) SDSS J153259.96-003944.1 which does not show detectable emission lines in its optical spectrum was reported. It is found that this object varies with a maximum amplitude of ~0.4mag over 1yr and 3months of monitoring. Combined with two other epochs of photometric data available in the literature, it is shown that the object has gradually faded by ~0.9mag during the period 1998 June-2001 April. A linear least-squares fit to all available observations gives a slope of ~0.35mag yr-1 which translates to ~1.9mag yr-1 in the rest frame of the quasar. Such a variability is higher than that typically seen in QSOs but consistent with that of BL Lacs, suggesting that the optical continuum is Doppler boosted. Alternatively, within photometric errors, the observed light curve is also consistent with the object going through a microlensing event. Photoionization model calculations show the mass of the broad line region to be a few tens of Msolar similar to that of low-luminosity Seyfert galaxies, but ~2 orders of magnitude less than that of luminous quasars. Further frequent photometric/spectroscopic monitoring is needed to support or refute the different alternatives discussed here about the nature of SDSS J153259.96-003944.1. **[C. S. Stalin** and R. Srianand]

Wolf-Rayet Galaxies :

CCD photometry of Wolf-Rayet galaxies and clusters of galaxies is being done. Their multicolour CCD observations (in the BVRI and Ha) were taken with 104-cm telescope of ARIES equipped with 2k X 2k pixel CCD camera. Image processing of these observations is being done with DAOPHOT, IRAF and STSDAS softwares. Spectroscopic observations of few galaxies have also been taken with HCT of IIA, Bangalore. [**M. Singh** and **B. B. Sanwal**]

Galaxies at Radio Wavelength :

HI 21cm-line observations of four early type disk galaxies (S0/a) were carried out from GMRT. These galaxies belong to the Eridanus group of galaxies. Previously, GMRT observations revealed significant HI deficiency in the late type disk galaxies of this group. The present observations resulted into non-detections down to HI mass limit of 2x107 solar-mass. It indicates that early type disk galaxies are also extremely HI deficient in this group. [**A. Omar** and K. S. Dwarakanath (RRI, Bangalore)]

The galaxies in the Eridanus group were studied for their morphological and kinematical lopsidedness. The HI images previously obtained from GMRT were used to estimate degree of lopsidedness using the Fourier decomposition of total HI and velocity field images of 18 galaxies. The preliminary results indicate that galaxies in this group are perturbed and show significant lopsided features with averaged mean lopsidedness $<A1> > 0.2$. This value of A1 is twice the average values seen in the field galaxies. Further, a larger fraction (30%) of the Eridanus galaxies shows $A1 > 0.3$. The present work has extended the radial range to twice the distance over which the lopsidedness has been usually measured using optical and IR photometry. It is predicted that if the origin of lopsidedness is due to the disc response to the halo asymmetry, then the dark matter halo potential can be shown to have a strong lopsidedness of nearly 10%. [**A. Omar**, R. A. Angiras (RRI, Bangalore), C. J. Jog (IISc., Bangalore) and K. S. Dwarakanath (RRI, Bangalore)]

The GMRT observations were carried out on 4 face-on galaxies. These observations are aimed at studying z-motion and velocity dispersion of HI gas in galaxies. Face-on galaxies provide data which is un-corrupted by systemic large scale in-plane galactic rotation thereby making such studies easier. The preliminary data analysis indicates that the velocity dispersion of gas decreases systematically in the outer regions. The presence of streaming motions near the spiral arms of one of the galaxies is also noticed. [**A. Omar**]

4. VARIABLE STARS

Nainital Cape survey for roAp stars :

The observations were continued from Nainital for the Nainital-Cape roAp Star Survey. During 2005 - 2006 several chemically peculiar stars of spectral types A-F were observed

using 104 -cm telescope to search for pulsations present in them.The detection limits imposed by the observing conditions at Manora Peak and Devasthal sites for the Nainital Cape survey programme are estimated and described. The scintillation noise on the best photometric nights is about 0.1 to 0.2 millimagnitude for both sites. Consequently they are well-suited for carrying out the proposed survey work as one can detect a few mmag variation in bright stars (B = 12 mag). The main characteristics of the three channel ARIES photometer are presented. Important discovery made by this instrument in the area of this programme have been highlighted. **[R. Sagar, D. L. Mary** and **S. Joshi]**

SS 433: Results of a recent multiwavelength campaign :

A multiwavelength observational campaign of SS 433, an enigmatic compact star, ranging from radio to X-rays was carried out during September 25 to October 6, 2002 with an aim to detect the nature of the short time-scale variabilities and to obtain a broad-band spectrum. Sharp intensity variations on time scales of a few minutes in the X-ray, IR and radio wavelengths have been observed. Short time-scale variations may indicate disc instabilities causing ejection of bullet like entities, which could be formed due to shock oscillation in the adjective flows at the jet base. A signature of delay of about two days between the IR and radio signals has been observed. This would indicate that the radio emission takes place only about 1.3 x 1015 cm away from the radio emitters, if we assume that the same matter generally propagates from the IR jet to the radio jet. The X-ray spectrum yielded double Fe line profiles corresponding to red and blue components of the relativistic jet. [S. K. Chakrabarti et al. (11 investigators from 5 institutions including **R. Sagar** and **J. C. Pandey)]**

Optical and X-ray studies of chromospherically active stars: FR Cnc, HD 95559 and LO Peg :

A multiwavelength study of three chromospherically active stars, namely, FR Cnc (BD +16°1753), HD 95559, and LO Peg (BD +22°4409), including newly obtained optical photometry and low-resolution optical spectroscopy for FR Cnc, as well as archival IR and X-ray observations was done. The BVR photometry carried out from 2001 to 2004 has found significant photometric variability to be present in all three stars. For FR Cnc, a photometric period of 0.8267+/-0.0004 days has been established. The strong variation in the phase and amplitude of the FR Cnc light curves when folded on this period implies the presence of evolving and migrating spots or spot groups on its surface. Two independent spots with migration periods of 0.97 and 0.93 yr, respectively, are inferred. The photometry of HD 95559 suggests the formation of a spot (group) during the interval of our observations. It is concluded that there exist two independent spots or groups in the photosphere of LO Peg, one of which has a migration period of 1.12 yr. The optical spectroscopy of FR Cnc carried out during 2002-2003 reveals the presence of strong and variable Ca II H and K, Hβ, and Hα emission features indicative of a high level of chromospheric activity. The value of 5.3 for the ratio of the excess emission in Hα to Hβ, EHα/EHβ, suggests that the chromospheric emission may arise from an extended off-limb region. A search for the presence of color excesses in the near-IR JHK bands of these stars using Two Micron All Sky Survey data has been

done, but none of them appear to have any significant color excess. The archival X-ray observations of HD 95559 and LO Peg carried out by the ROSAT observatory were analyzed. The best-fit models to their X-ray spectra imply the presence of two coronal plasma components of differing temperatures and with subsolar metal abundances. The inferred emission measures and temperatures of these systems are similar to those found for other active dwarf stars. The kinematics of FR Cnc suggest that it is a very young (35-55 Myr) main-sequence star and a possible member of the IC 2391 supercluster. LO Peg also has young disk-type kinematics and has been previously suggested to be a member of the 100 Myr old Local Association (Pleiades moving group). The kinematics of HD 95559 indicates that it is a possible member of the 600 Myr old Hyades supercluster. **[J. C. Pandey,** K. P. Singh (TIFR Mumbai), S. A. Drake (USRA and NASA, USA) and **R. Sagar]**

HD 81032- A new RS CVn Binary :

BVR photometric and quasi-simultaneous optical spectroscopic observations of the star HD81032 have been carried out during the years 2000-2004. A photometric period of 18.802±0.07d has been detected for this star. Figure 2 shows the power spectra of the entire data of HD 81032 taken during 2000-2004. A large group of spots with a migration period of 7.43±0.07 years is inferred from the first three years of the data. Hα and CaII H and K emissions from the star indicate high chromospheric activity. The available photometry in the BVRIJHK bands is consistent with the spectral type of K0IV previously found for this star. It also examined the spectral energy distribution of HD81032 for the presence of an infrared colour excess using the 2MASS JHK and IRAS photometry, but found no significant excess in any band above the normal values expected for a star with this spectral type. The X-ray emission properties of this star using data obtained by the ROSAT X-ray observatory during its All-Sky Survey phase have also been analyzed. An X-ray flare of about 12 hours duration was detected during the two days of X-ray coverage obtained for this star. Its X-ray spectrum, while only

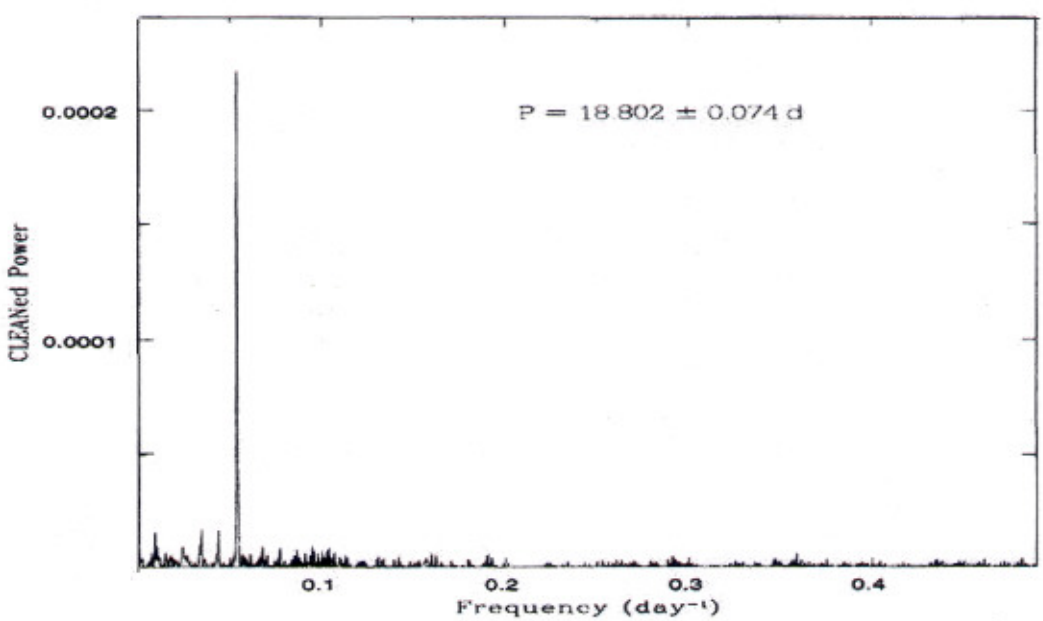

Figure 2. Cleaned power spectra of the entire data of HD 81032 taken during 2000-2004.

containing 345 counts, is inconsistent with a single-temperature component solar-abundance coronal plasma model, but implies either the presence of two or more plasma components, non-solar abundances, or else a combination of both of these properties. All of the above properties of HD81032 suggest that it is a newly identified, evolved RS CVn binary. **[J. C. Pandey,** K. P. Singh (TIFR, Mumbai), S. A. Drake (USRA and NASA, USA) and **R. Sagar]**

Discovery of pulsations in the Am star HD 25515 :

Pulsation is a common phenomenon among chemically normal A-type stars, but comparatively a rare phenomenon among chemically peculiar stars of the same temperature range. A survey for search for pulsations in chemically peculiar stars has been under taken at ARIES. This survey is structured to reveal high overtone roAp type pulsations as well as low overtone δ - Scuti type pulsations in chemically peculiar A - F stars.

The metallic line Am star HD 25515 was observed on several nights. It is discovered that the light variation of about 0.07 mag with pulsation period of about 2.44 hour is present in the star. Figure 3 shows the frequency spectrum and the light curve of the observed data taken on JD 2453012. A detailed analysis of the pulsations in this star is in progress. The co-existence of pulsation and metallicism in Am star is important for our understanding of abundance anomalies in the A-type stars and of diffusion processes in general. **[U. S. Chaubey]**

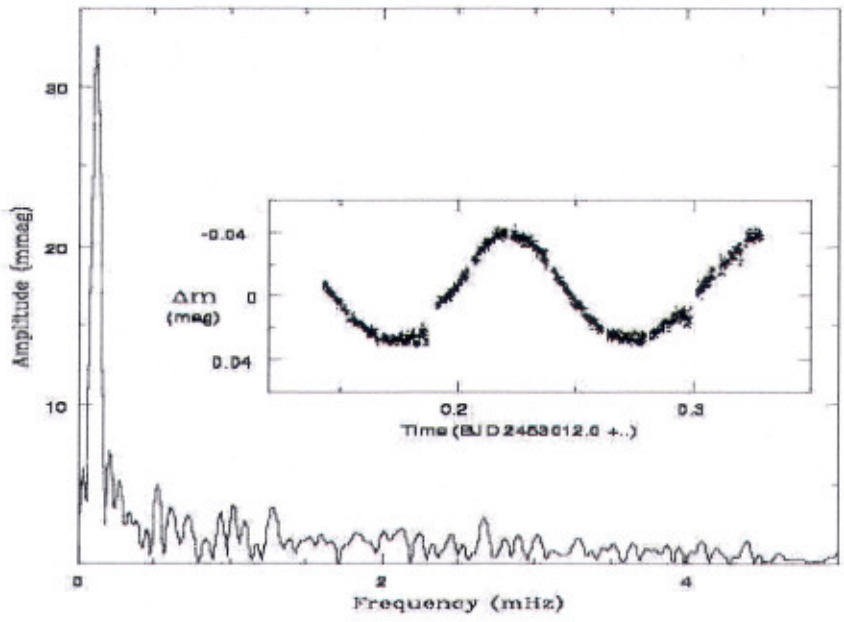

Figure 3. Discovery light curve and its amplitude spectrum of the chemically peculiar Am star HD 25515.

WET Asterosiesmic data set for the roAp star HR 1217 :

HR1217 is one of the best-studied roAp stars, with a frequency spectrum of alternating even- and odd-l modes that are distorted by the presence of a strong, global magnetic field. Several recent theoretical studies have found that within the observable atmospheres of roAp stars the pulsation modes are magneto-acoustic with significant frequency perturbations that are cyclic with increasing frequency. To test these theories a Whole Earth Telescope extended coverage campaign obtained 342 h of Johnson B data at 10-s time resolution for the star over 35 d with a 36 per cent duty cycle during November-December 2000. The precision of the derived amplitudes is 14 μmag, making this one of the highest precision ground-based photometric studies ever undertaken. Substantial support has been found for the new theories of the interaction of pulsation with the strong magnetic field. In particular, the frequency jump expected as the magnetic and acoustic components cycle through 2p rad in phase has been found. Additionally, comparison of the new 2000 data with an earlier 1986 multisite study shows clear amplitude modulation for some modes between 1986 and 2000. The unique geometry of the roAp stars allows their pulsation modes to be viewed from varying aspect with rotation, yielding mode identification information in the rotational sidelobes that is available for no other type of pulsating star. Those rotational sidelobes in HR1217 confirm that two of the modes are dipolar, or close to dipolar; based on the frequency spacings and Hipparcos parallax, three other modes must be either l = 0 or 2 modes, either distorted by the magnetic field, or a mix of m-modes of given l where the mixture is the result of magnetic and rotational effects. A study of all high-speed photometric Johnson B data from 1981 to 2000 gives a rotation period Prot= 12.4572 d, as found in previous pulsation and photometric studies, but inconsistent with a different rotation period found in magnetic studies. It is suggested that this rotation period is correct and that zero-point shifts between magnetic data sets determined from different spectral lines are the probable cause of the controversy over the rotation period. This WET data set is likely to stand as the definitive ground-based study of HR1217. It will be the baseline for comparison for future space studies of HR1217, particularly the MOST satellite observations. [D. W. Kurtz et al. (46 investigators from 29 institutions including **S. Joshi**)]

Extremely energetic 4B/X17 flare and associated phenomena :

A solar flare 4B/X17.2 observed on 28 October 2003 at ARIES in Hα with 15 cm Coude Solar Tower Telescope was studied. Figure 4 shows the evolution of this mega flare in H-alpha. This was one of the largest flare of the solar cycle 23, which occurred near the Sun's center and produced extremely energetic emission almost at all wavelengths from gamma-rays to radio-waves. The flare was associated with a bright/fast full-halo earth directed CME, strong type II, type III and type IV radio bursts, an intense proton event and GLE. This flare was also well observed by SOHO, RHESSI and TRACE. Our Hα observations show the stretching/de-twisting and eruption of helically twisted S shaped (sigmoid) filament in the south-west direction of the active region with bright shock front followed by rapid increase in intensity and area of the gigantic flare. The flare shows almost similar evolution in H-alpha, EUV and UV. [**W. Uddin,** R. Chandra and S. S. Ali]

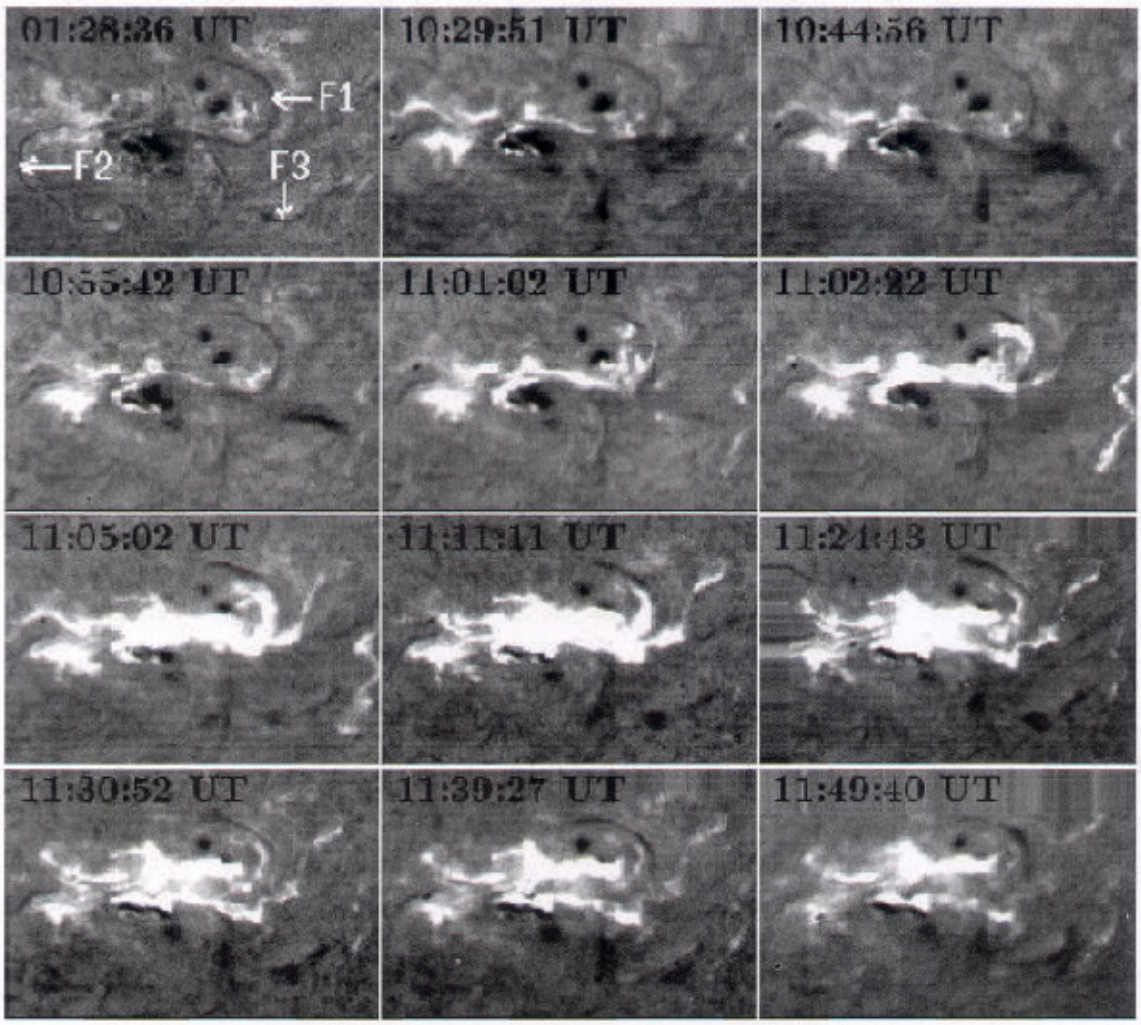

Figure 4. Evolution of historical 4B/X17.2 flare in Hα on 28th October 2003. North is up and West is to the right and the field of view is 505" x 384".

Study of a large helical prominence eruption on 21 April, 2001 :

A large helical prominence eruption, observed in Hα at ARIES on 21 April, 2001 was studied. Usually this eruption was associated with a double CME. The spatial correlation between prominence and CMEs has been studied with the help of Hα filtergrams, EIT 195 A difference image and SOHO/LASCO observations of CMEs . A comparison of the position of the prominence eruption with the position angle of CMEs suggests that these events are spatially correlated. Our analysis shows that the prominence and first CME started simultaneously from the limb and that the prominence carries sufficient energy to feed both the CMEs. It is also concluded that CMEs are magnetically driven and internally powered. [S. S. Ali, **W. Uddin** and R. Chandra]

Energetics and Dynamics of an impulsive Flare on March 10, 2001 :

The HXT, SXT/Yohkoh observations as well as radio observations from the Nobeyama Radio Observatory of an impulsive Flare on March 10, 2001 were analysed to derive the energetics and dynamics of this impulsive flare. The unusual feature of HXR and Hα sources, observed for the first time, is the rotation during the impulsive phase in a clockwise direction. It is proposed that the rotation may be due to asymmetric progress of the magnetic reconnection site or may be due to the change of peak point of the electric field. In MW emission, two sources were found. The main source is at the main flare site and another is in the southwest direction. It appears that the remote source is formed by the impact of accelerated energetic electrons from the main flare site. From the spatial correlation of multi-wavelength images of the different sources, it is concluded that this flare has a three-legged structure. [R. Chandra et al. (8 investigators from 5 institutions including **W. Uddin**)]

North-South Distribution and asymmetry of solar flares during solar cycle 23 :

A solar cycle is not symmetric considering the distribution of various solar active phenomena such as flares, sunspots, filaments, etc., separately in northern and southern solar hemisphere. This intrinsic feature (N-S asymmetry) poses a challenge for dynamo model calculations.

The spatial distribution of solar flares that occurred during the period 1996 to 2003 has been analyzed to investigate the N-S asymmetry. This period of investigation includes the ascending phase, the maximum and part of descending phase of solar cycle 23. It is revealed that the flare activity during this cycle is low compared to previous solar cycle, indicating the violation of Gnevyshev-Ohl rule. This study indicates that the activity dominates the northern hemisphere in general during the rising phase of the cycle (1997-2000) (Figure 5.). The dominance of northern hemisphere shifted towards the southern hemisphere after the solar maximum in 2000 and remained there in the successive years. Although the annual variations in the asymmetry time series during cycle 23 are quite different from cycle 22, they are comparable to cycle 21. **[B. Joshi** and **P. Pant]**

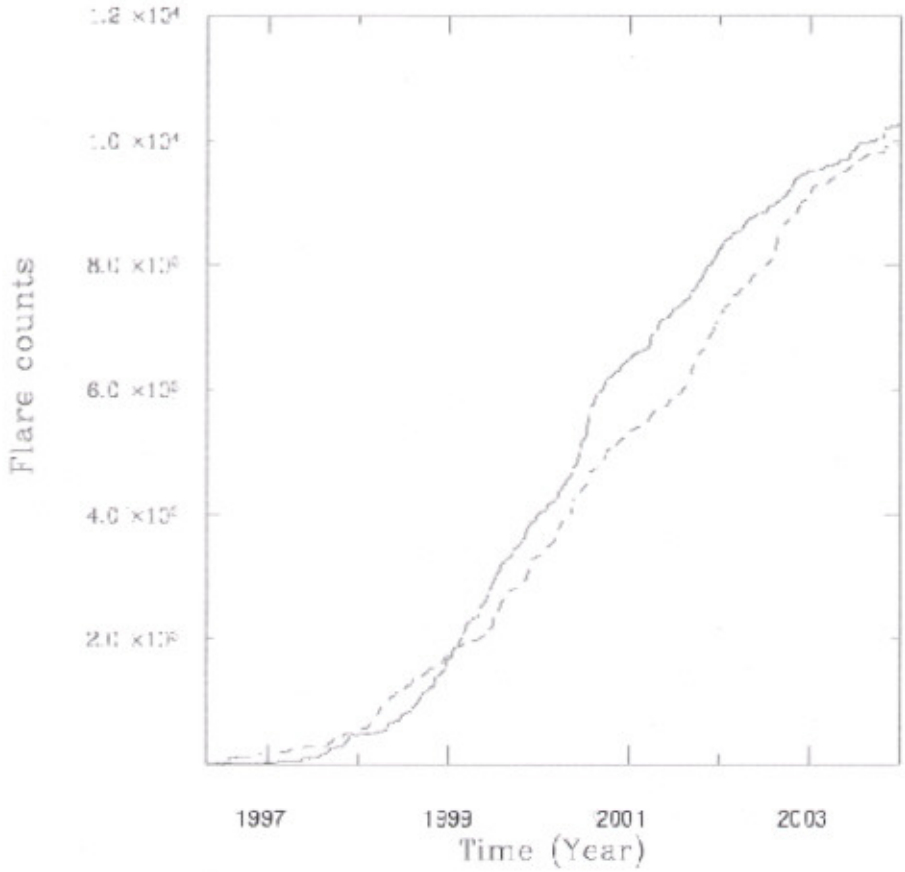

Figure 5. Cumulative counts of flares occurring in the northern (solid line) and southern hemisphere (dashed line). The vertical spacing between the two lines is a measure of the northern/southern excess of flares up to that time. The northern hemisphere excess increases during 1999-2001 and starts decreasing in later years (after mid 2001).

Intermediate-term periodicities in soft X-ray flare index during solar cycles 21, 22 and 23 :

The intermediate-term periodicities in soft X-ray flare index (FIsxr) during solar cycles 21, 22 and 23 have been analyzed. Power-spectral analysis of daily FIsxr reveals a significant period of 161 days in cycle 21, which is absent during cycles 22 and 23. It has been found that in cycle 22 periodicities of 74 and 83 days are in operation. A 123-day periodicity has been found to be statistically significant during part of the current solar cycle 23. The existence of these periodicities has been discussed in the light of earlier results. [**B. Joshi** and A. Joshi]

ATMOSPHERIC SCIENCES

Current research activities in Atmospheric Sciences at ARIES are focused on the lower and middle atmospheric probing. In lower atmosphere, prime focus of study are the various characteristics of aerosols (physical, chemical and optical), which are tiny suspended particles (liquid or solid) in the atmosphere. These aerosols have direct and indirect impact on the radiative forcing in the atmosphere as they scatter and absorb solar and infrared radiation in the atmosphere and indirectly affect the size distribution of cloud droplets (i.e. cloud condensation nuclei, CNN). In lower atmosphere, aerosol and trace gases are considered to be the more important entities in the radiation budget and climatic variability. As the Atmospheric Science Research is an emerging area of interest at ARIES, the research is being carried out actively using the sophisticated instruments such as Multi Wavelength Solar Radiometer (MWR), Aerosol Spectrometer (Optical Particle Counter), Microtop-II Sun Photometer and Ozonometer, Aethalometer, High Volume Air sampler (HVS), Atomatic Whether Station and scores of manual ones for characterizing the atmospheric aerosols' parameters. In addition, ARIES participated actively in various field campaigns (comprehensive and coordinated) organized by ISRO-GBP for evaluating the physical, chemical and optical characteristics of aerosols.

As lower atmospheric disturbances and local orography seed variety of waves, which can propagate through middle atmosphere, the study of these waves and their properties are main objectives of middle atmospheric research at ARIES. Long-term changes in the mesosphere carry signatures of global weather changes also and therefore, prolonged observations of middle atmospheric temperature and densities would help tracking the same. The main results obtained in these areas during the year 2005-2006 are:

Aerosol characteristics at a high altitude location in central Himalayas: Optical properties and radiative forcing :

Collocated measurements of aerosol black carbon (BC), composite aerosols near surface were carried out along with spectral aerosol optical (AOD) during an intensive aerosol field campaign as a part of ISRO-GBP Land Campaign II during December 2004. These experiments barring AODs, were made for the first time at ARIES, Nainital. The monthly mean AOD at 500 nm was found to be 0.059 (0.033) and total suspended particulate (TSP) concentration was in the range 15 - 40 μg m-3 (mean value of 27.1 8.3 μg m-3). Interestingly, a mean concentration of 1.36 ± 0.99 μg m-3, contributed of aerosol BC ~5.0 ± 1.3% to the composite aerosol mass. This large abundance of BC is found to have linkages to the human activities in the adjoining valley and to the boundary layer dynamics. Consequently, the inferred single scattering albedo lies in the range of 0.87 to 0.94 (mean value of 0.90 0.03), indicating significant aerosol absorption. The estimated aerosol radiative forcing was as low as -4.2 W m^{-2} at the surface, +0.7 W m^{-2} at the top of the atmosphere, implying an atmospheric forcing of +4.9 W m^{-2} (Figure 6). Though absolute value of atmospheric forcing is quite small, which arises primarily from the

very low AOD(or the column abundance of aerosols), the forcing efficiency (forcing per unit optical depth), was ~88 W m^{-2}, which is attributed to the high BC mass fraction. [**P. Pant** et al. (6 investigators from 3 institutions including **P. Hegde, U. C. Dumka, Ram Sagar**)]

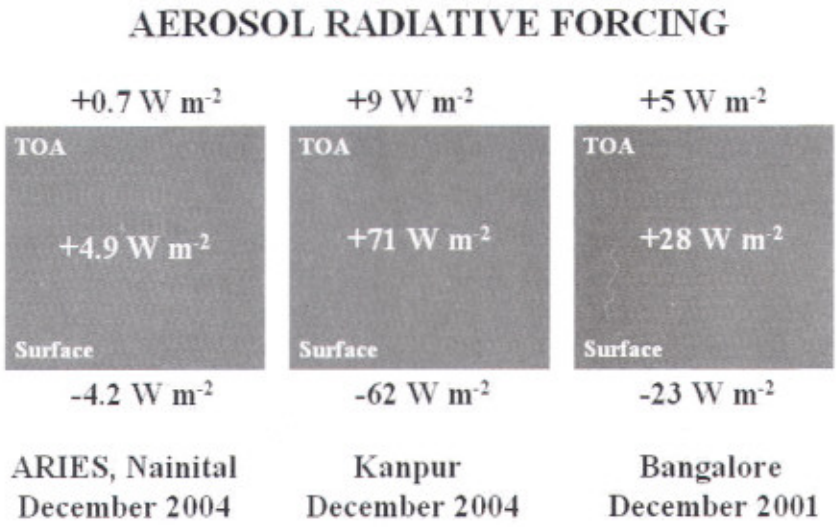

Figure 6. Comparison of aerosol radiative forcing observed over Manora Peak, Kanpur and Bangalore.

Aerosol number concentration (NT) and aerosol black carbon (BC) show a well-defined diurnal variation with extremely low values during night and early morning which, gradually increases after sunrise and peaks at afternoon (between 14:00 to 16:00 hrs local time). The afternoon peak could very well be due to vertical transport of aerosols

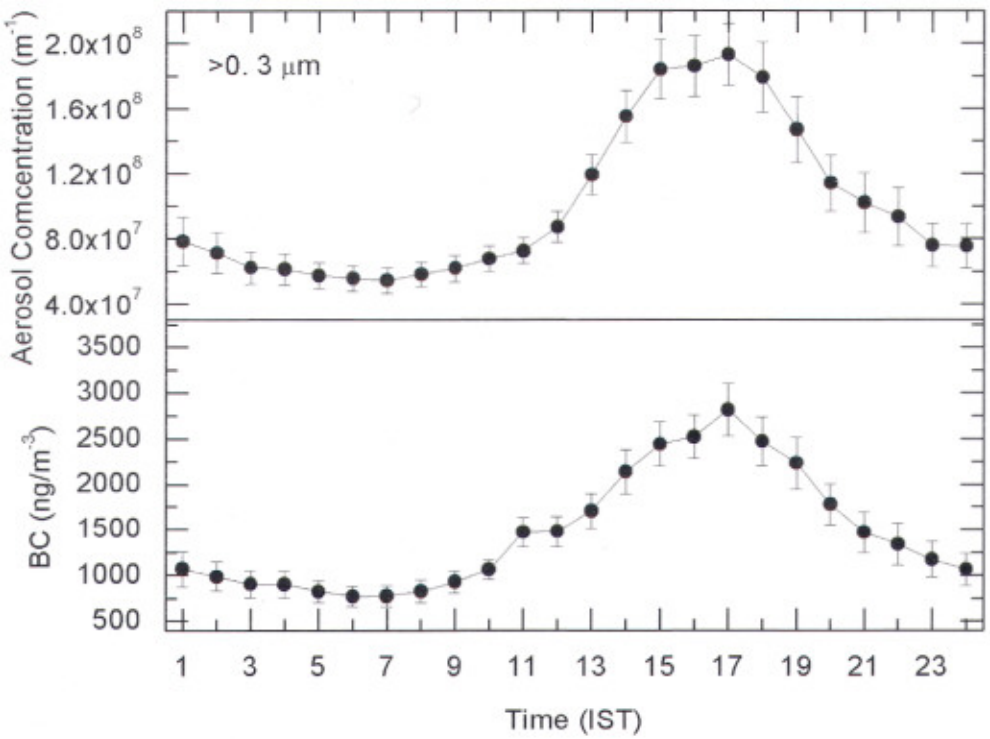

Figure 7. Monthly mean diurnal variation of aerosol number concentration (dia >0.3 m) and aerosol black carbon mass concentration over Nainital.

from the near-by polluted urban and valley regions, which were initially confined to lower heights in the night and early morning because the inversion layer is situated at lower altitudes which rises to greater heights as the boundary layer evolves (Figure 7).

Characteristics of wave induced oscillations in mesospheric O_2 emission intensity and temperatures :

The upward propagating gravity waves originating at lower atmospheric altitudes can be characterized with the help of airglow monitoring by using the Krassovsky analysis. The amplitude of this quantity is a ratio of percentage intensity to their associated temperature amplitudes while, the phase difference between intensity and

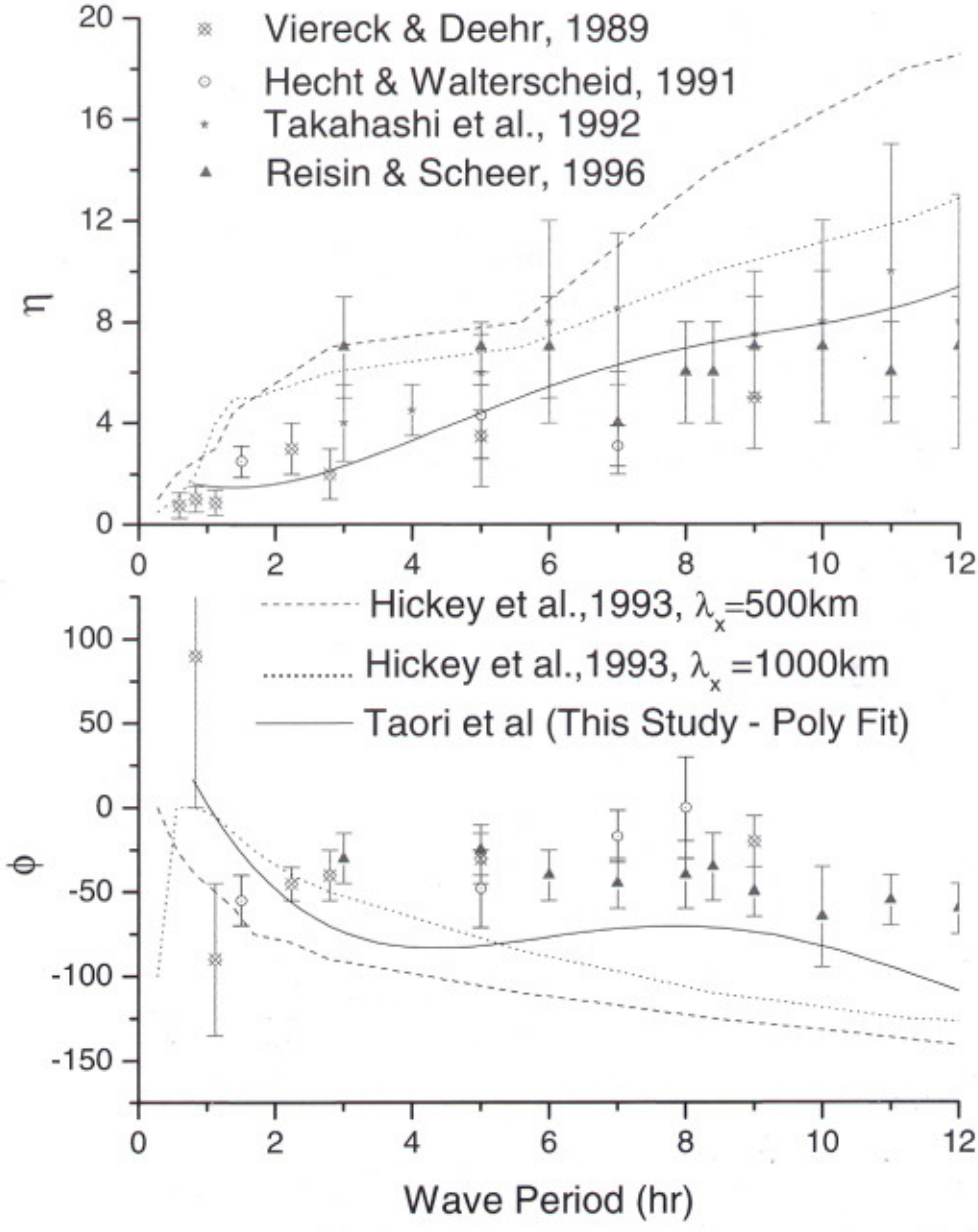

Figure 8. Comparison of the resultant polynomial fit (solid lines) by Taori et al. [2006] with other similar measurements of Krassovsky analysis. Dashed and dotted lines represent the analytical model of Hickey et al. [1993] for 1000 and 500 km horizontal gravity wave wavelengths.

temperature wave is the imaginary quantity. A combination of best fit and residual analysis was carried out on the Hawaiian airglow data. The results were compared with existing model values and significant differences were observed. Lack of data and hence a poorer understanding in the mesospheric dynamics are attributed for such large deviations (Figure 8). [**A. Taori** and M. J. Taylar (Utah State Univ., USA)]

Developmental Works :

There are several developmental works going on in the Atmospheric Science Division. The most important of them are:

a) Fabrication of a Multiwavelength Airglow Photometer for the study of coupling processes in the middle and upper atmosphere. This is a long-term project for middle atmospheric climatology studies and we expect the fabrication and installation of this photometer to be completed by the end of August 2006. (PI: Alok Taori)

b) Project start-up to build a powerful Lidar system, capable of having Mie and Rayleigh capabilities for the study of aerosol characteristics and middle atmospheric temperature studies. The fabrication and installation time for this Lidar is five years. (PI: P. Pant, Co PIs: Alok Taori and S. V. Sunil Kumar)

Ongoing Collaborative Campaigns :

A) ISRO-GBP Land Campaign -II

During December 2004 to April 2005, a Land Campaign-II was organized by Indian Space Research Organization (ISRO) in which ARIES participated successfully. The main results of AOD measurements during the campaign are:

1) Typical diurnal variation of aerosol number concentration (dia > 0.3 m) exhibited high values during the afternoon hours and extremely low values during the mid night or early morning. These variations are attributed to the atmospheric boundary layer dynamics (Figure 6).

2) Average share of BC mass concentration to the total aerosol mass concentration at Manora Peak, Nainital has been estimated to be 6.5%, which is significantly lower than the values reported for west coast location Trivandrum where 12% share of BC was reported during December.

3) The aerosol radiative forcing at the surface is as low as - 4.2 W m^{-2} and at the TOA is + 4.9 W m^{-2} during December 2004 to April 2005. (PI: P. Pant)

B) Integrated Field Campaign ICARB under ISRO-GBP

An integrated campaign for aerosol, gases and radiation budget (ICARB) under ISRO-GBP, was conducted during 15th February to 30th April 2006. During the ICARB campaign the spatio-temporal distribution of aerosols and trace gases over Indian subcontinent and adjoining oceans, their regional radiative forcing and possible climate impact, using fixed network stations on the mainland, island observatories, measurements on moving ship platforms and profiling using aircrafts (mobile) and LIDARS (quasi-stationary) are proposed. During this campaign, the aerosol characteristics will be studied using a set of complementary measurements carried out at ARIES, Manora Peak (29.40 N, 79.50 E, ~1951 m above mean sea level (asl)), Nainital, Aerosol number concentration measurements using GRIMM Aerosol Spectrometer, columnar aerosol optical depth using MWR and absorbing particle concentration using a seven channel Magee Aethalometer. The integrated campaign results are expected to provide a new insight in the radiative processes in the earths atmosphere. (PI: P. Pant)

FACILITIES

1. Observing Facilities

1.1. Stellar Observing Facilities

The 104-cm Sampurnanad reflecting telescope is the main observing facility at ARIES for optical astronomers. During the period 2005-2006, 166 photometric clear nights were scheduled. A 2k x 2k Wright CCD camera was mounted on around 70 percent of the nights. For the remaining nights, three channel fast photometer, ARIES polarimeter, Puntino SH sensor and 1k x 1k Pixel CCD camera were mounted. Some of the scientific observing programs conducted during the year 2005-06 are AGN variability, RoAp stars survey, optical counterpart of the X-ray sources and Gamma-ray transient events, SN monitoring, photometry and imaging of star forming H II regions, stellar clusters, Gamma-ray star bursts, WR galaxies and clusters of galaxies.

During 2005- 2006, an 1k x 1k Pixel CCD camera system was acquired. It will be devoted for narrow band imaging and photometric works of the star forming H II regions, WR galaxies and clusters of galaxies.

1.2. Solar Observing Facilities

Institute has two telescopes of 15-cm aperture equipped with H-Alpha, Ca II K and CN filters and CCD cameras for carrying out observations of solar activity phenomena namely sunspots, faculae, plages, flares, prominences, etc. with a time resolution of 25 ms. A GPS clock is connected to Sun Sparc-20 computer to record on the header of the picture frames with an accuracy of one second of time.

1.3. Atmospheric Observing Facilities

The main observational facilities for atmospheric science group of ARIES are Multi Wavelength Solar Radiometer (MWR), Aerosol Spectrometer, Microtop-II Sun Photometer and Ozonometer, Aethalometer, Solid State Photometer (SSP) and Automatic Weather Station.

The MWR is used to make continuous spectral extinction measurements of the transmitted solar flux in ten narrow spectral bands (FWHM 6 - 10 nm) centered at 380, 400, 450, 500, 600, 650, 750, 850, 935 and 1025 nm. The output of the detector is digitized using a 12 bit ADC and is stored in the PC along with other information such as time of data acquisition, the filter identification and the system noise. The SSP (for night time AOD measurements) has been attached with the 56-cm reflector telescope. The telescope has an equatorial fork mounting. During 2005-06 56-cm telescope was used to study the atmospheric extinction coefficients.

Aerosol Spectrometer (Model 1.018, GRIMM Aerosol Technique. GmbH, Germany), is an optical particle counter (OPC). The OPC is a portable battery operated particle

counter which classifies particles into 15 size bins in the diameter range between 0.3 to 20 micro meter. It gives the number concentration of composite aerosols in the size range from 0.3 to 20 micro meter. It works on the principle of optical counting of particles by detecting the pulses of radiation scattered (90°) by individual particles in the sampling flow.

Microtops II Sunphotometer and Ozonometer (Solar Light Co. USA), are hand held photometers, measure direct solar radiations and give instantaneous AODs (at 380, 440, 500, 675, 870 nm and 1020 nm), columnar water vapour content (W) and total columnar ozone (TCO).

The aethalometer (Magee Scientific, USA) uses a continuous filtration and optical transmission technique to yield BC mass concentration in near real time. It aspirates ambient air using its inlet tube and pump. The mass concentration is estimated by measuring the change in the transmittance of its quartz filter tape on which the particles impinge.

High Volume air Sampler (Envirotech Inc. model APM 430) measures mass loading of total suspended particulates (TSP).

2. Support Facilities

In order to meet the requirements for maintenance, design and fabrication of astronomical instrumentation as well as for research support, ARIES has an electronics workshop, a mechanical workshop, aluminizing unit, optics workshop, a computer section, civil works section and a fairly well equipped library.

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, capable of taking the jobs up to 124-cm diameter. 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 X 10-6 torr. The smaller unit is also used for evacuating the deewars of CCD systems and IR photometer.

Recently, the primary mirror realuminization of the 104 cm telescope was done in September 2005. The image quality optimization of the telescope was performed using Puntino SH sensor. The secondary mirror was adjusted according to the SH analysis results and an acceptable quality well below the seeing limit was achieved.

2.2. Computer Centre

The Institute has a modern computer centre. There are five work stations and 90 PC's. Image processing software packages MIDAS, IRAF, STSDAS, IDL, SM and other general

utility packages have been installed on the computer systems of the institute. All the systems have been networked together. A VSAT facility has also been installed which has linked the Institute with the rest of the world through internet and e-mail services.

During the year 2005-2006, the computer centre developed new website with latest information. The institute has acquired industrial computers for various instruments of telescope with required ISA, PCI and USB slots. The data archival capacity in the institute has been increased by several folds. DLT, DAT, DVD and CD storage devices are used for backup. The latest LaserJet B/W printers and multi functional device were also acquired. The VSAT uplink bandwidth was increased to 268.8 Kbps. The computer section has also developed ARIES intranet website for local area network.

2.3. Library

Ever since the inception of the Observatory in 1954, its library has been steadily building up. 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 a 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. The ARIES library is a member of FORSA (Forum for Resource Sharing in Astronomy and Astrophysics), which has been established by Astronomy Librarians in 1979.

During the period 2005 - 06, the following information resources were added: -

Books	:	220
Bound Volumes of Journals	:	200
Subscription of Journals (Print + Online)	:	91
ARIES Publications	:	31
ARIES Theses	:	5

The collection at the end of the period is

Books	:	Around 9360
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.

During 2005-06, for upgrading the facilities of the library, the LIBSYS software added with new features is being used. 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. The stack of Books and Periodicals, etc. are re-arranged in the ARIES Library.

2.4. Civil Works Section

The civil works section looks after the routine maintenance, and modifications/ renovation of the ARIES office and residence buildings and roads. During 2005-06, some of the works done by the civil work section at Manora Peak are:

(i) Demolition of old walls of optics lab of ARIES,
(ii) Construction of sub-station/generator hall,
(iii) Construction of the retaining walls at main office building and residential campus of the ARIES,
(iv) Construction of car parking for visitors, and
(v) Jungle clearance and making drains along foot-paths of the ARIES campus.

At Devasthal, regarding the Jarapani- Devasthal Motor Marg, hill side cutting for full width of road has been done. At present, on this road, large vehicles can go up to 2.4 km approximately. However, small vehicles can go up to the top car parking. To protect the kuchcha cut surface of the road, a tender for soling with stone aggregate has been finalized.

2.5. Electronics Workshop

The Electronics workshop supplemented by an electrical wing looks after the routine maintenance, testing, modifications, design and fabrication of electronics/electrical equipments. In 2005, a new electronics lab which includes embedded systems, computers and sophisticated tools and instruments has been installed. A digital EPABX was installed in July 2005. A 60 KVA centralized UPS distribution for the computers and instruments was established. A 15 KVA three phase UPS for 104 cm telescope system was established. New 300 KW substation is being installed to meet the growing power requirement.

On 29th March 2006, a team from ARIES made successful observations of the total solar eclipse at Manavgat, Turkey. Electronics section provided the necessary engineering support during this event. Software was developed to capture sequential images and support was provided in customizing a 15 cm telescope used for photometry. Electronics section, also integrated and tested the electronics modules and developed software and additional hardware required for the instrument. Some of the software support provided/developed by the electronics section are:

a) A 512 x 512 Photometrics PXL Camera was installed after it was up-graded by Roper Scientific USA. Its software was developed here in VC++ and Visual Pascal and all the features were implemented as required by the user.

b) Software for 1K x 1K Pixel CCD was customized to include certain essential features. Its source code which came along was developed in VC++.
c) Macros were written for 1K x 1K photometrics camera to use it for fast photometry.
d) Software for Solid State Photometer was customized to include certain features which are essential to properly use the instrument. The source code was developed in Liberty Basic and provided along with the instrument.

During the year 2005-06, three apprentice trainees completed their one year training successfully. Four diploma students completed their 15 days vocational training in February 2006. Two apprentice trainees joined for one year training in January 2006.

2.6. Mechanical Workshop

The fabrication, maintenance and modifications of various equipments, telescope houses and other miscellaneous jobs are 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 done as and when required.

During 2005-2006, for upgrading the facilities of workshop, a digital portable welding machine which is capable of welding mild steel, stainless steel, aluminium and its alloys was procured.

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 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, testing and modifications of the optical equipments of the institute.

During 2005-06, for upgrading the facilities of the optics workshop, ZEMAX , software for designing and testing the optical instruments was procured.

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