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ABSTRACTS OF TALKS

Oral Presentations

Sun: structure and dynamics of the solar atmosphere

3-d structure of sunspots

Shibu K. Matthew
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Abstract. The magnetic field at the solar surface manifests itself most prominently in the form of sunspots. In spite of significant advances in the observations of the sunspot magnetic structure a completely coherent picture still has not emerged. A well established observational description of vector magnetic field and thermal structure could greatly benefit the sunspot modeling efforts. Considerable advances have come from the inversion techniques, where one obtains the atmospheric stratification of various physical parameters by fitting the synthetic to the observed Stokes profiles, and thus by creating a three dimensional structure of sunspots. Here, I present the results obtained from the inversion of a data set recorded in a sunspot in two nearby IR lines at around 1.56 microns. The inversion provides the atmospheric stratification of various physical parameters, the results are used to infer the three dimensional structure of the observed spot.

Is the chromosphere always hot, or mostly cold ?

Wolfgang Kalkofen
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Abstract. The quiet, nonmagnetic chromosphere of the sun is described by an empirical model that responds to the question 'What must the temperature structure be in order to explain the emergent chromospheric spectrum', and by a dynamical model that responds to the question 'How does the chromosphere get its structure'. The empirical model is based on the equations of radiative transfer and statistical equilibrium, and the temperature structure is adjusted by trial and error in order to achieve agreement between observed and predicted emergent intensities. That model has a positive temperature gradient upward and is always hot. The dynamical model is based on the solution of the

hydrodynamic equations for an observed acoustic velocity spectrum. It assumes plane waves but otherwise contains no adjustable parameters. Except for excessively strong shocks, the model has a negative temperature gradient and is mostly cold.

The two models tell us about different aspects of chromospheric heating and dynamics, but only the empirical model achieves quantitative agreement with the observed solar spectrum. The empirical model implies that the chromosphere is heated continually by weak shocks. In contrast, the cell flashes which are described by the dynamical model are due to intermittent, strong shocks; the model shows, furthermore, that acoustic waves in the stratified atmosphere propagate as spherical waves, not as plane waves, and that much more energy is radiated by the chromosphere than is accounted for by the input velocity spectrum. The source of that energy, which must be acoustic, remains unknown.

Dynamics of the magnetized solar atmosphere

S.S. Hasan
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Abstract. Observations have revealed the presence of a rich spectrum of waves with different periods in regions of the solar atmosphere called the "magnetic network" that are dominated by strong magnetic fields. This network is believed to be heated by dissipation of magneto-hydrodynamic (MHD) waves, but the MHD processes involved in wave generation, propagation and dissipation are poorly understood. In this talk we attempt to identify some of the processes that occur in the network and contribute to its dynamics and heating.

We model the network as consisting of individual magnetic elements or flux tubes, rooted in intergranular lanes, with a typical horizontal size of 100 km. They expand upward and merge with their neighbours at a height of about 600 km. Above this height the magnetic field becomes uniform. An equilibrium configuration based on the above model is constructed by solving the magnetostatic equations in 2-D.

Waves are generated in this medium by means of motions at the lower boundary. We focus on transverse driving which generates fast waves within the flux tubes and acoustic waves at the interface of the tubes and the field-free medium, but not otherwise in the field-free gas. The acoustic waves at the interface are due to compression of the gas on one side of the flux tube and expansion on the other. These waves travel upward along the two sides of the (2D) flux tube and enter it, where they become longitudinal waves. For impulsive excitation with a time constant of 120 s, we find that a dominant feature is the creation of a vortical motions that propagates upwards. We have identified a new and efficient mechanism for the generation of longitudinal waves and shock formation in the chromosphere. We examine the observational implications of our results and their broad applications to chromospheric heating and activity.

Transition region dynamics

Dipankar Banerjee
Indian Institute of Astrophysics, Bangalore

Abstract. High spectral, spatial and temporal resolution UV observations of the quiet Sun transition region from SOHO show a highly structured and dynamical environment where transient supersonic flows are commonly observed. Here I present recent observational results from different spectrometers, namely CDS and SUMER on-board SOHO. Strongly non-Gaussian line profiles are the spectral signatures of these flows and are known in the literature as explosive events. An estimate of the kinetic and enthalpy fluxes associated with these events shows that explosive events are not important as far as solar coronal heating is concerned. The relationship with the underlying photospheric magnetic field is also studied, revealing that explosive events generally occur in regions where the magnetic flux is very weak, near simple (unipolar) configurations. Structure and dynamics of the network versus internetwork as seen by different temperature lines will be also presented. Wavelet time series analysis will be used. Finally an attempt is made to interpret various observed oscillations in terms of different types of wave modes.

Imaging solar coronal mass ejections from Sun to 1 AU: predicting their arrivals at earth

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Abstract. We investigate the propagation of coronal mass ejections (CMEs) in the Sun−Earth distance range using SOHO/LASCO white-light images, Ooty Interplanetary Scintillation (IPS) measurements, and spacecraft data. The IPS images of CMEs, obtained from the Ooty Radio Telescope at heliocentric distances 0.2 to 1 AU, provide a better understanding of the propagation of CMEs before their arrival at 1 AU. For a given initial speed of the CME, the IPS measurements are crucial to determine the effects of influence of the ambient solar wind on the CME as well as 'CME−CME' interaction when the CME encounters preceding slow CME(s). The results on the radial dependence of CME speed between the Sun and Earth have been used to empirically predict the arrival of CME at 1 AU. The observed arrival times of CMEs at the Earth are in good agreement with the predictions. The results on the CME travel time also confirm that the IPS technique detects the sheath between the shock and the CME.

Stars/ISM/galaxies

Infrared studies of novae

N. M. Ashok
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Abstract. Novae are binary systems that give rise to spectacular outbursts with typical brightness increase ranging from 10 to 15 magnitudes. The binary system is in a semi-detached configuration containing a white dwarf and a late type main sequence star. The nova outburst is caused by run away thermonuclear reactions in the hydrogen-rich matter accreted on the surface of the white dwarf from its companion. Infrared observations of novae have revealed specific trends like pseudo-photosphere, free-free, nebular and coronal phases as the ejecta expands in the interstellar medium. Infrared observations have also established that dust grains condense in the ejecta.

A programme to monitor novae at near-infrared bands has been underway at the Mt. Abu Infrared Observatory for last several years. This programme has led to the observational evidence for first helium nova, namely, V445 Puppis. The infrared spectra of V445 Pup are unusually rich in carbon lines and have also confirmed the absence of hydrogen lines reported by optical observations. Subsequent theoretical work and observations have confirmed that V445 Pup is the first example of a helium nova.

After summarising the infrared properties of novae, the temporal evolution of recently discovered nova V574 Puppis bringing out the changing spectral characteristics will be presented.

Recent results from infrared and radio observations of massive star forming regions

Anandmayee Tej
Tata Institute of Fundamental Research, Mumbai

Abstract. As part of a multiwavelength study of massive star forming regions, we have studied few such complexes in the near infrared and radio continuum wavelengths. We have obtained NIR mapping in the rotational-vibrational line of molecular hydrogen (H_2 (1-0)S1, 2.12 μm) and in narrow band Brγ (2.16 μm) hydrogen recombination lines from HCT, UKIRT and TNG. Radio continuum observations in three frequency bands (325, 610 and 1280 MHz) were carried out at GMRT. Complemented with archival data (2MASS, MSX and JCMT) we have aimed at studying these regions in detail. This talk summarises the results of four massive star forming regions - IRAS 06055+2039 (Tej et al. 2005, in prep.), S201 (Ojha et al., 2004, A&A 415, 1039), NGC 7538 (Ojha et al., 2004, ApJ 616, 1042) and IRAS 19111+1048 (Vig et al., 2005, submitted). NIR

data of IRAS 06055+2039 show the presence of an embedded cluster whose K-band luminosity function is consistent with other young clusters. Narrow-band H_2 images and Brγ envelope correlate well with the radio continuum maps and also show presence of H_2 knots. The radio maps of S201 display a striking cometary morphology and diffused molecular H_2 emission is seen at the location of the photo-dissociation region. H_2 knots are also detected in this region. Deep JHK images of NGC 7538 taken with SIRIUS using the University of Hawaii Telescope, show a rich population of Young Stellar Objects. The slope of the K-band luminosity function is found to be lower than that of other young clusters. The 1280 MHz map of this region shows an arc-shaped structure arising due to the interaction of the ionized and the molecular gas. For the star forming region associated with IRAS 19111+1048, a number of radio sources are seen whose spectral types are consistent with those obtained from the near infrared images. A cluster of OB stars is found to power this HII region.

Brown dwarfs: the missing link between stars and planets

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Abstract. Brown dwarfs inhabit the realm intermediate between less massive stars and more massive planets. They could ignite deuterium burning at their core but fail to ignite tritium burning and hence fail to sustain nuclear energy production due to insufficient mass. The radiation from brown dwarfs is generated by the release of gravitational potential energy. The discovery of the first brown dwarf Gl 229B led to the discovery of a large number of ultra-cool dwarfs with distinct spectral characteristic which in turn led to the introduction of two more classes L and T in the spectral classification of stars. L dwarfs are comparatively hotter objects with effective temperature ranging between 2400 K to 1400 K and all L dwarfs having clear signature of lithium doublet in their spectrum are considered to be brown dwarfs. T dwarfs are characterised by the presence of methane in their atmosphere. The rapid decline of the red spectrum of L dwarfs indicated the presence of dust in their atmosphere although it has been argued that the collisionally broadened red wing of alkaline metal could also explain it. It is proposed that the presence of dust in the atmosphere of L dwarfs could be confirmed through the observation of photometric variability. However, only a few L dwarfs show variability in I and J bands. Theoretical investigations predicted that the presence of dust grain would lead to detectable amount of linear polarization and the net polarization over the disc would not be cancelled out because of the departure from sphericity owning to high rotational velocity of the objects. This was observationally confirmed and the observed linear polarization of several objects has been explained by single dust scattering. Hence the presence of dust in the atmosphere of L dwarfs is confirmed making these objects as limiting cases for dust formation. The surface gravity of L dwarfs is poorly constrained at present and the high peculiar velocities of these objects are not explained. Further work on the formation of brown dwarfs and their evolution may solve these two problems.

Cygnus X-3: a phenomenological perspective

Manojendu Choudhury
National Centre for Radio Astrophysics, TIFR, Pune

Abstract. Cygnus X-3 is one of the most enigmatic X-ray binary systems with an undetermined compact object and a Wolf-Rayet companion, persistent in the X-ray, infra-red and radio regimes of the electromagnetic spectrum. In the hard X-ray state of this source, the recent results of the radio X-ray correlations, in analogy with similar features from the confirmed black hole sources, suggest the possibility of the compact object being a black hole candidate. Quite a few theoretical paradigms exist as to the physical mechanism and geometrical structure of the accretion phenomena in this class of astrophysical sources, giving rise to the complex X-ray spectral evolution. The various physical mechanisms chiefly consist of Comptonisation of the seed thermal photons by a hot energetic plasma with various possible geometrical frameworks, although synchrotron emission at the base of the outflowing jets is also gaining popularity as a possible explanation of the X-ray emission. Here we summarize the reported lagged anti-correlation (Choudhury & Rao 2004) of the hard X-ray (20-50 keV) w.r.t. the soft X-rays (2-7 keV), with a typical delay $\lesssim$1000s in Cygnus X-3, in the hard state of X-ray emission (corresponding to the nearest analogue of the canonical low-hard state). These observational features provide phenomenological signatures of a truncated accretion disc geometry in the system, with the delay time scale associated with the viscous flow of matter in the disc, which is the time required for the adjustment of the size of the disc and the Comptonizing plasma cloud. In a radiation pressure dominated advective flow, the delay time scale may correspond to an inner truncation radius of 25 Schwarszchild radii.

Wide field multi-object cluster spectroscopy

Brijesh Kumar
Aryabhatta Research Institute of Observational Sciences (ARIES), Nainital

Abstract. We present preliminary results of the spectroscopic studies for a sample of 428 stars (9-15 mag in B) in a field of 2 deg diameter containing a sample of 7 fairly young (100-500 Myr) galactic open clusters. The sample includes 93 field stars. Spectral classification, radial velocity and metallicity measurements have been carried out for all the stars. Using these data the spectral types of stars can be determined with accuracies 1 to 2 sub spectral types while the radial velocity uncertainties lie between 15 to 30 km/s. Metallicities accurate to 0.3 dex can be determined. These parameters help us to determine cluster membership and metallicities simultaneously for a large number of stars with wide field multiobject facility such as 2dF. Past studies were primarily involved with single object spectroscopy and were only limited to brighter end. Therefore we conclude that such studies are highly useful and contribute towards deciphering the astrophysical problems related to star clusters in general.

Planetary transits: a first direct view of extrasolar planets

Alain Lecavelier des Etangs
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Abstract. Although the search for extrasolar planets via planetary transits is relatively straightforward as a technique, the scientific implications of such studies are profound. We review the status of this young, exciting field and discuss the methodology for finding planetary transits and the prospects of success using ground-based and space-borne optical telescopes. The techniques involved in estimating the planetary radii, the detection probability of extrasolar planetary rings, satellites and atmospheres are also discussed. We finally highlight the important role which 1-2 metre class optical telescopes located at good sites can play in this rapidly developing branch of astronomy.

The effect of non-thermal protons on the high energy spectra of black hole binaries

Ranjeev Misra
Inter University Centre for Astronomy and Astrophysics, Pune

Abstract. A brief overview of the physics and theoretical models for accretion disks around black holes will be presented. In the inner regions of such accretion disks, the presence of non-thermal protons, would via p-p collisions, produce electrons, positrons and γ-rays. The effect of such processes on the high energy spectra of black hole X-ray binaries will be discussed.

Is the Large Magellanic Cloud a double barred galaxy?

Annapurni Subramaniam
Indian Institute of Astrophysics, Bangalore

Abstract. The bar of the Large Magellanic Cloud (LMC) is studied using red clump stars identified by the OGLE II survey. The relative distance estimates determined using mean magnitudes of de-reddened red clump stars in the bar indicated that the bar of the LMC is warped and showed the presence of structures in the bar. These indicated the bar to be dynamically perturbed. The presence of a mis-aligned inner secondary bar can explain the observed structures as well as the warp of the bar. This suggests that the LMC could be the nearest double-barred galaxy.

Abundance survey of Galactic disk: thin versus thick disks

B. Eshwar Reddy
Indian Institute of Astrophysics, Bangalore

Abstract. I discuss our recent results on 27 elements from carbon to europium in around 200 F-G dwarfs from a differential LTE analysis of high-resolution and high signal-to-noise spectra. Stellar space motions (U, V, W) and a Galactic potential were used to estimate Galactic orbital parameters. These show that the vast majority of the stars belong to the Galactic thin disc. By combining our results with various published studies we infer that thin disk chemical evolution is different from that of the thick disk.

Variability of active galactic nuclei

Alok Chandra Gupta
Harish Chandra Research Institute, Allahabad

Abstract. Blazar is a class of radio-loud active galactic nuclei (AGNs). Now a days, simultaneous multi-wavelength variability study of blazars is an interesting research topic. Several groups all around the globe are involved in the project. These observations will be useful to understand the emission mechanism of blazars. In the present talk, I mainly discuss the results based on our observations in optical and NIR bands. These observations were made by me and my collaborators from ground based telescopes in India and abroad.

Results based on intra-night monitoring of Radio Quiet QSOs (RQQSOs) in optical bands to search for intra-night optical variability in RQQSOs using 1.2 meter PRL telescope at Gurushikhar, Mount Abu will be presented.

Statistical results based on intra-night variability in optical bands for different subclasses of AGNs will be also presented.

The 2SLAQ luminous red galaxy survey

Russell Cannon
Anglo Australian Observatory, Australia

Abstract. The 2dF-Sloan LRG And QSO Survey (2SLAQ) is a survey for Luminous Red Galaxies (LRGs) and QSOs which extends the original 2dFGRS and 2QZ. For the LRGs, we use SDSS colours to select elliptical galaxies with redshifts in the range 0.45 to 0.7. These are being compared with the low redshift galaxies in the GRS and a sample of intermediate redshift LRGs found in the Sloan survey, to look at the development of clustering and the evolution of the galaxies themselves since z $\sim$ 0.6.

Radio astronomy mini symposium

Pulsar studies with GMRT: some recent results

Yashwant Gupta
National Centre for Radio Astrophysics, TIFR, Pune

Abstract. The GMRT is a powerful and versatile instrument for the study of radio pulsars. This talk reports on some of the interesting new results in this area that have come out in the past 2-3 years, and discusses their significance. These include (i) the discovery of the first pulsar with the GMRT : an interesting binary, millisecond pulsar, (ii) new techniques and results for localisation of radio emission regions in pulsar magnetospheres, (iii) implications for the radio emission mechanisms from studies of pulsars with drifting subpulses, (iv) studying the interstellar medium using pulsar dispersion measures and pulse broadening as probes.

Multifrequency observations of double pulsar J0737-3039 using GMRT

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Abstract. Recently discovered PSRs J0737−3039A and J0737−3039B provide a unique laboratory to test theory of relativity and a probe of pulsar magnetosphere. The mildly eccentric tight orbit together with a significant advance of angle of periastron lead to a rich phenomenology of radio emission. The results of new multi-frequency multi-epoch GMRT observations of these pulsars in the last two months will be presented illustrating the phenomenology of their radio emission. The implications of these results for theoretical models will be discussed followed by an update on recent results on this system from other observations.

Radio studies of supernovae

Poonam Chandra[1,2], Alak Ray[1] and Sanjay Bhatnagar[3]
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[2]*Joint Astronomy Programme, Indian Institute of Science, Bangalore*
[3]*National Radio Astronomy Observatory, Socorro, USA*

Abstract. Till date there are only few dozens of supernovae detected in radio wavebands. Radio emission from supernovae, which is essentially synchrotron emission due to the relativistic electrons in the presence of high magnetic field, depends mainly on the density of the circumstellar medium, and the mass loss rate of the progenitor star. Hence radio studies of supernovae are extremely useful to estimate the density and structure of the circumstellar material and give information about the evolution of the pre-supernova star. Phenomenon of synchrotron aging in young radio supernovae leads to the determination of energetics of the plasma and information about magnetic field. Here, we present the radio studies of two very famous supernovae: a type IIb SN 1993J and a type Ic SN 2003bg, with the Giant Meterwave Radio Telescope (GMRT). Combining the low frequency GMRT spectrum of SN 1993J with that of the high frequency VLA spectrum, 8 years after the explosion, we detect a synchrotron cooling break. The cooling break leads to the determination of the magnetic field independent of equipartition between relativistic energy density and the magnetic energy density. We also find that the plasma is dominated by the magnetic energy density by at least a factor of 10,000. We also determine the evolution of magnetic field, size and mass loss rate with time. From the combined GMRT and VLA spectrum of SN 2003bg, we establish synchrotron self absorption as the dominant absorption mechanism of the radio emission.

High frequency carbon recombination lines as a probe to study the environment of ultra-compact HII regions

D. Anish Roshi
Raman Research Institute, Bangalore

Abstract. Observations of molecular lines towards ultra-compact HII (UCHII) regions have shown that the natal clouds harboring the HII regions have densities $> 10^5$ cm^{-3} and temperatures between 100 – 200 K. The presence of such dense clouds has other observable effects. In particular, the far-ultraviolet photons from OB stars embedded in the UCHII regions will produce photo-dissociation regions (PDRs) in these clouds. The physical conditions in these PDRs are ideally suited for producing observable carbon recombination lines (RLs) at high frequencies (> 8 GHz). We made a survey of carbon RLs near 8.5 GHz with the Arecibo telescope toward 17 UCHII regions. Carbon RLs are detected in 11 directions, indicating the presence of dense photodissociation regions (PDRs) associated with the UCHII regions. Further we made multi-frequency (42, 14, 8 and 5 GHz) carbon RL observations with the VLA toward one of the UCHII regions (W48A) in the survey. We show that such multi-frequency data can be used to :

(1) estimate the physical properties of the PDR material; (2) study the kinematics of the PDR material relative to the HII region gas; (3) address the lifetime problem of UCHII regions by investigating whether the HII regions are pressure confined and (4) constrain the magnetic fields in the vicinity of UCHII regions.

Galactic halo HI clouds: recent GMRT results

K. S. Dwarakanath
Raman Research Institute, Bangalore

Abstract. A high latitude HI 21 cm-line absorption survey towards extragalactic sources was completed during 2000−2001 using the Giant Meterwave Radio Telescope (GMRT). A histogram of the random velocities of these absorbing clouds showed two populations of clouds with velocity dispersions of 7.6 ± 0.3 km s^{-1} and 21 ± 4 km s^{-1} respectively around a mean velocity of ∼ 0 km s^{-1}. The former population ('slow' clouds) can be identified with the 'standard' clouds while the latter population (∼ 20% in number) represents a new population of 'fast' clouds. For an assumed thickness of the 'slow' cloud population of ∼ 250 pc, the 'fast' cloud population is expected to have a thickness of ∼ 2.5 kpc – making them a halo population of clouds. Independent evidence for the existence of a population of HI clouds in the halo has recently emerged from the Green Bank HI 21 cm-line emission survey (Lockman 2002; Lockman & Pidopryhora 2004). The median values of the HI column density and of the velocity dispersion of the 'fast' clouds are consistent with those of the halo HI clouds detected in the Green Bank HI emission survey. Furthermore, the GMRT observations provide an estimate of the optical depth and of the spin temperature of the 'fast' clouds. A discussion of these issues and the details of the GMRT observations can be found in Mohan, Dwarakanath & Srinivasan (2004). The formation, the energetics, and the stability of the halo HI clouds are still open questions.

The magnetic field in the Milky Way

Dipanjan Mitra
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Abstract. Though study of the Galactic magnetic field is an old subject, little is known about the global as well as small scale structure of the magnetic field in our Galaxy, the Milky Way. This is particularly so because we are located inside the Galaxy and any observational scheme to study the magnetic field samples both local and global fields simultaneously making it difficult to disentangle these effects. However significant progress has been made in the observational front which gives us several useful constraints. In this talk my focus will be to discuss the recent observational developments that have taken place in trying to unveil the nature of the Galactic magnetic field.

Dwarf galaxies

Ayesha Begum
National Centre for Radio Astrophysics, TIFR, Pune

Abstract. I present the results of deep, high velocity resolution (1.6 km s^{-1}) Giant Meterwave Radio Telescope (GMRT) HI 21 cm observations of extremely faint (MB > -13.0) dwarf irregular galaxies. We find that all of our sample galaxies show systematic large scale velocity gradients, unlike earlier studies which found chaotic velocity fields for such faint galaxies. For some of the sample galaxies the velocity fields are completely consistent with ordered rotation, though the peak circular velocities are comparable to the observed random motions. These are the faintest known galaxies with such regular kinematics. I also present the "asymmetric drift" corrected rotation curves, Tully-Fisher diagrams and mass models (including fits for Isothermal and NFW halos) for our sample galaxies and discuss the implications for hierarchical models of galaxy formation. The results of the HI study of dwarf irregular galaxy NGC 3741 are also presented. Our GMRT observations show that HI disk of this galaxy extends to $\sim$8.3 times its Holmberg radius - this makes it probably the most extended gas disk known. From the derived rotation curve we find that NGC 3741 has a dynamical mass to light ratio of $\sim$107, hence is one of the "darkest" irregular galaxies known. The implications of such extended HI envelopes of dwarf galaxies are discussed.

Galaxy evolution in low density environments

Amitesh Omar
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Abstract. It is well known from the observations that in the high galaxy density environments (e.g., clusters), morphological, gaseous, and other properties of galaxies are distinctly different from galaxies in the isolated regions. We show here based on recent observations with various radio telescopes including the GMRT that significant evolution of galaxies can take place in a low density environment typical of a group. The main evolution process in the group seems to be tidal interactions. Other alternate scenarios will also be discussed. However, it still requires many more detailed studies of groups to come to any firm conclusion.

Cosmology

CMBR anisotropies: from WMAP to Planck

Shiv Sethi
Raman Research Institute, Bangalore

Abstract. Recent years have seen major advances in understanding CMBR anisotropies. WMAP has measured CMBR temperature anisotropies with unprecedented precision for angular scales above 20 arc minutes. This made possible the determination of cosmological parameters with precision comparable to other measurements and demonstrated consistency of the underlying theoretical model. WMAP gave the first large-scale measurement of CMBR polarization anisotropies, which provided crucial insights into the re-ionization of the universe. Future all-sky observatory Planck is likely to give more precise determination of the CMBR polarization anisotropies and might also detect the B-mode polarization, which will give important clues about the tensor and vector perturbations in the early universe.

CMB polarization

T.R. Seshadri
Delhi University, Delhi

Abstract. A non-zero degree of polarization can be induced in the Cosmic Microwave Background Radiation (CMBR) if the incident radiation has a quadrupole anisotropy and undergoes Thomson scattering from charged particles. There are two kinds of polarizations, namely E-type and B-type. They differ from each other in the polarity. Their relative power and their angular dependence is related to the nature of the anisotropy of the incident radiation. Scattering can be from the charged particles at the surface of last scatter as well as from a more recent epoch if the Universe had undergone a phase of re-ionization. Polarization measurements of CMBR can give us information about different physical processes and effects in the Universe like ionization history, the nature of cosmological magnetic fields, etc.

Probing dark energy

Tarun Deep Saini
Indian Institute of Science, Bangalore

Abstract. I discuss observations which indicate that the expansion of the Universe is accelerating at the present epoch. This is usually explained by invoking dark energy, which is usually modelled as an ideal fluid with an unknown equation of state. The interpretation of observations is complicated due to a lack of theoretical knowledge about

the equation of state. Various approaches for probing the properties of dark energy in a model independent manner are also discussed.

Does the fine-structure constant vary?

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Abstract. Some of the modern theories of fundamental physics, in particular SUSY, GUT and Super-string theory, suggest the possibility of the variation of the fine-structure constant (α), thus motivating an experimental search for such a variation. The absorption lines seen in the quasar spectra can be used as an effective tool to test the variation of the fine-structure constant, as they allow one to measure its value at different redshifts. We will present the results of our analysis to detect the variation of the fine-structure constant, applying the "many multiplet" as well as the "alkali doublet" method to a homogeneous and very high quality UVES/VLT data sample. Besides the summary of various measurements to detect the α variation, the new preliminary results from high resolution spectroscopy $R \sim 100000$ (using HARPS) and the prospect of future improvements will also be discussed.

Active galaxies and 'entropy floor' in galaxy clusters

Suparna Roychowdhury
Raman Research Institute, Bangalore

Abstract. Galaxy clusters harbour large amounts of hot gas which make them X-ray luminous. The temperature of this gas is mostly thought to be determined by the gravitational potential of the background dark matter. Recent detailed X-ray observations have, however, also determined its entropy, and found evidence of the importance of non-gravitational processes in this gas. The sources thought to be responsible for heating this ICM are supernovae and active galaxies. It is mostly believed from numerical simulations and theoretical estimates that the mechanical energy delivered by a supernova driven galactic wind falls short of the amount of energy required to satisfy the cluster gas observations. Thus there has been a valid interest for long to investigate the influence an active galaxy can have on the ICM. In this regard, we have also investigated the effect of buoyant bubbles of relativistic plasma from a central active galaxy on the entropy evolution of the cluster gas. Such bubbles have been recently observed by *Chandra*. We find that it is possible to explain the recent X-ray observations of the intracluster gas with the help of active galaxies.

Future facilities

The Indian multiwavelength astronomy satellite 'ASTROSAT'

P. C. Agrawal (On behalf of the Astrosat collaboration involving TIFR, ISAC. IIA, RRI, IUCAA, PRL and Canadian Space Agency.)
Tata Institute of Fundamental Research, Mumbai

Abstract. Astrosat will be the first full-fledged Indian astronomy mission aimed at multiwavelength studies in the optical, near and far UV and a broad X-ray spectral band covering 0.5 - 100 keV. This mission will have the capability of very high temporal resolution X-ray studies, low and medium energy resolution spectral studies and high angular resolution (about 2 arc sec) imaging observations in the UV and optical bands simultaneously. This is realized by using a set of 3 coaligned X-ray astronomy instruments and one UV imaging telescope consisting of 2 similar instruments. Detection and timing studies of X-ray transients and persisting sources will be done by a Scanning Sky X-ray Monitor. This mission will enable Indian astronomy community to carry out a variety of studies of different classes of galactic and extragalactic sources in the frontier area of high energy astronomy. Scientific objectives of the mission will be discussed in detail in this talk and a brief summary of the design and characteristics of the X-ray and UV instruments and their expected sensitivities will be presented.

Future spacebased IR spectrometer

S. K. Ghosh
Tata Institute of Fundamental Research, Mumbai

Abstract. A simple and reliable Near Infrared Spectrometer for astronomical observations, is proposed for a future Indian space mission. The proposal exploits the gap (2-6 micron) in the spectroscopic capabilities of current / near-future space borne instruments. The major technical challenges for the proposal includes: active and passive cooling of the detector (80 K) and the detector system itself. Spectroscopic survey of selected regions of the Milky Way in a few interstellar atomic / molecular lines is one of the attractive scientific goals for such an instrument.

Virtual observatory capabilities

A. K. Kembhavi and Jayant Gupchup
Inter University Centre for Astronomy and Astrophysics, Pune

Abstract. A virtual observatory (VO) is a collection of interoperating data archives and software tools which utilize the internet to form a scientific research environment in

which astronomical research programmes can be conducted. In much the same way as a real observatory consists of telescopes, each with a collection of unique astronomical instruments, the VO consists of a collection of data centres each with unique collections of astronomical data, software systems and processing capabilities. The need for the development of a VO is driven by two key factors. Firstly, there is an explosion in the size of astronomical data sets delivered by new large facilities like the ESO VLT etc. The processing and storage capabilities necessary for astronomers to analyze and explore these data sets will greatly exceed the capabilities of the types of desktop systems astronomers currently have available to them. Secondly, there is a great scientific gold mine going unexplored and underexploited because large data sets in astronomy are unconnected. The International Virtual Observatory Alliance (IVOA) is addressing these issues and comprises of more than 12 participating countries.

We will discuss the concept of Virtual Observatories (VO), and the facilities which are being created through VO projects in various countries. We will discuss the projects which have been undertaken and completed by Virtual Observatories - India, and plans for the future. We will illustrate with some examples the use of VO tools for making new astronomical discoveries.

Preparing for new UV space missions at IIA

Rekhesh Mohan
Indian Institute of Astrophysics, Bangalore

Abstract. TAUVEX is an ultraviolet imaging instrument, to be launched into a geo-synchronous orbit as a part of ISRO's GSAT-4 in 2006. This instrument will image large parts of the sky in the wavelength region between 1400 and 3200 Å. The limiting magnitude will be 25 for the deep pointings. UVIT, on board ASTROSAT is expected to be launched by 2007-08. The software required for both these missions is being developed at the Indian Institute of Astrophysics. In this talk, I present a summary of these instruments and the sky simulation software which is designed to familiarize prospective users with the instrument capabilities.

One-meter class optical telescope for early and fast observations of GRB afterglows

Ram Sagar
Aryabhatta Research Institute of Observational Sciences (ARIES), Nainital

Abstract. Optical observations of GRB afteglows provide valuable information about its progenitor. Such observations have been obtained by us under a long term international collaboration since 1999. However, most of the observations obtained so far are about an hour after the trigger of the burst. In order to get observations within a few seconds of

localisation of the burst, we plan to procure a meter-class optical telescope. Details of the telescope and back-end instrument will be presented in the talk.

Experiments and design activities for the multi application solar telescope

P. Venkatakrishnan
Udaipur Solar Observatory, Physical Research Laboratory, Udaipur

Abstract. Contemporary solar physics requires telescopes that produce low instrumental polarization as well as provide large angular resolution. These two seemingly mutually exclusive requirements have been combined in a new optical design, which is presented. High angular resolution from the ground needs the deployment of adaptive optics. Given a site with a certain level of seeing, there is a limit to which adaptive optics can work. The results of simulations are presented that provide an estimate of the diameter of the largest telescope which can optimally use adaptive optics. The experiments in developing a prototype adaptive optics system are also described.

Poster Presentations

Sun and solar system

Statistical study of $H\alpha$ flares during the current solar cycle

Bhuwan Joshi[1], P. Pant[1] and P. K. Manoharan[2]
[1]*Aryabhatta Research Institute of Observational Sciences (ARIES), Nainital*
[2]*Radio Astronomy Centre, TIFR, Ooty*

Abstract. We investigate the statistical variations of solar $H\alpha$ flares for the interval 1996 to 2003. This period of investigation includes the ascending phase, the maximum and part of descending phase of solar cycle 23. It is confirmed that the flare activity during this cycle is low compared to previous solar cycles, indicating the violation of Gnevyshev-Ohl rule. The pattern of N−S distribution of flare occurrence shows that after the minimum phase of activity in 1996, the northern hemisphere has shown more activity in producing flares than the southern part. The dominance of northern hemisphere is shifted towards the southern hemisphere after the solar maximum in 2000 and remained there in the successive years. Although the asymmetry in the E−W distribution of flare events is low, a consistent western dominance has been found.

Colour and correlation analysis of shadow-bands observed during total solar eclipse of 23 November 2003 at the Indian Antarctic Station, Maitri

Hari Om Vats
Physical Research Laboratory, Ahmedabad and The Indian solar eclipse team

Abstract. The observing geometry of the total solar eclipse of 23 November 2003 in which the path of totality passed over Indian Antarctic Station "Maitri" was predicted to be a rare opportunity for the observations of shadow-bands. These predictions were made on the basis of diffractive refractive scattering calculations of wave propagations in the lower atmosphere. The Department of Ocean Development (DOD, GOI) made elaborate arrangements to send a special experimental team to Maitri for observing this event. This event was successfully recorded and really turned out to be unique. Though the experiment was simple, the weather on the observing location was one of the harshest conditions on the Earth. The phenomenon of shadow bands was observed for 4 minutes before the totality and 7 minutes immediately after the totality. These are the longest duration of shadow-bands formed and clearly recorded ever. The recording was done in full real colour by digital video camera, thus providing an opportunity to investigate shadow bands in R, G, and B bands. The cross-correlograms along the direction of motion showed a gradual fall with the increase of spatial lag and a sudden decrease in

the transverse direction. The full correlation analysis has been used to derive scales of atmospheric turbulence as a function of time. The experimental values will be compared with the predictions of diffractive-refractive scattering theory.

Relationship between speed of CME and GOES X-ray peak flux

B. Ravindra
Udaipur Solar Observatory, Physical Research Laboratory, Udaipur

Abstract. We have studied the relationship between the speed of halo CMEs and the GOES X-ray peak flux of associated flares. The result shows that there is a good correlation between the two. The close relationship suggests that the CME and the associated flare might have occurred from a common source.

On the correlation between He II 304 Å and He I 10830 Å network cells

B. Ravindra
Udaipur Solar Observatory, Physical Research Laboratory, Udaipur

Abstract. The morphological correlation between He II 304 Å and He I 10830 Å network cells have been studied. The scatter plot between He II 304 Å and He I 10830 Å intensities shows that there is a good correlation between the two, but one is in emission and other is in absorption. We have also compared the sizes of the network cells and network elements observed in these two wavelengths. The comparison shows that the sizes of network elements and network cells are almost matching suggesting that both the network elements form at a similar height.

A study of the effect of flare on acoustic oscillations using wavelet analysis

B. Ravindra and Brajesh Kumar
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Abstract. Detection of variations of magnetic fields associated with flares and CMEs is becoming one of the most important and fascinating problems in solar physics. Many researchers have looked into the changes in the p-mode oscillation frequencies as well as power during flare or CME. Fast Fourier Transform (FFT) is not suitable for studying the transient and quasi-periodic oscillations. Wavelet analysis is suitable in those conditions, since this provides localized frequency and temporal information of any fluctuations. We have used GONG+ dopplergrams to study the flare induced acoustic oscillations. The large active region NOAA 10486 produced several X-class flares during its passage through

the solar disk. We have studied the effect of Oct. 29, 2003 X10 flare and Nov. 02, 2003 X8.3 flare in this active region on acoustic oscillations using wavelet analysis technique. The preliminary results showed reduced power in 5-minute band and enhanced power in higher frequency band in the active region as compared to the quiet Sun in the absence of flare. We observe flare induced oscillations which are localized at some portions, mostly in the hard X-ray producing regions. There is enhancement in 5-minute acoustic power in the active region during flare. It is also observed that there is excitation of high as well as low frequency oscillations during these large X-class flares. Further, the active region NOAA 10488 did not show induced oscillations as it did not produce flares during the observing time. It is not clear whether the observed flare induced oscillations are real or an artifact of flare (broadening of line profile) or due to the high energetic electrons bombarding the foot points of magnetic field lines. In any case, these observations may give an exciting clue to the mechanism of flare production in active regions.

Solar abnormal activity during Oct.-Nov. 2003

K. M. Hiremath[1], M. R. Lovely[2] and R. Kariyappa[1]
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[2]*Sree Krishna College, Bangalore*

Abstract. The positional measurements of sunspots from the Kodaikanal observatory and Solar Geophysical data are used to study the association between occurrence of the abnormal activities of big sunspot groups that occurred during the period of 2003, Oct.-Nov., and occurrence of the flares. The following activity variations during the course of evolution of the sunspot groups are investigated : the areas, rotation rates, number of small spots produced in a spot group and longitudinal extents. Among all these activity variations, we find that the spot groups that have abnormal rotation rates during their life times eventually trigger the flares. This study suggests that the occurrence of abnormal rotation rates of the sunspot groups can be considered as precursor of the flare occurrences.

H_3^+ in Jovian aurorae

Koshy George and T. Chandrasekhar
Physical Research Laboratory, Ahmedabad

Abstract. The near infrared emissions from Jovian aurorae are dominated by the collisionally excited H_3^+ molecular ion, which plays a crucial role in determining the physical conditions of Jovian auroral region. These H_3^+ emissions are due to the rotational-vibrational transitions in Jupiter's auroral ionosphere. H_3^+ is a major coolant in Jupiter's upper atmosphere having spatially and temporally variable emissions and is also believed to be the key source for keeping equatorial plasma sheet in partial corotation with Jupiter.

Hence H_3^+ is a good probe for monitoring Jupiter's upper atmosphere from ground based telescopes.

At the 1.2m telescope of Physical Research Laboratory located at Gurushikar ($72^d47'$ $47''$E, 24^d $39'$ $10''$ N, 1680 m) Mt.Abu, India, using the NICMOS IR spectrometer/imager we have successfully detected the H_3^+ emission at 2.093 micron and several other lines in the northern auroral zone of Jupiter. The nearby H2 emission at 2.122 micron has also been detected.

Observations started in the last observing season 2003-2004 are being continued. Spectral imaging at many points in Jovian aurora are being attempted. Details of observations and results are presented.

MST radar observations of Perseid meteor shower 2004

K. Chenna Reddy, D. Venkata Phani Kumar and G. Yellaiah
Osmania University, Hyderabad

Abstract. Results of a systematic study of Perseid meteor shower observations carried out during 11 - 15 August 2004 using Indian MST radar are presented. Based on over 27 hours of observing time, we detected 860 meteor echoes occurring between 80 km and 120 km with a mean height of 95 km. The peak activity of the shower occurred at 01:30 hours LT on 12 August with a maximum rate of 150 echoes per hour. Simultaneous observations of sporadic-E during the shower period, showed that a strata of sporadic-E occurring between 99 km and 120 km altitude with a spread of about 15 - 20 km. Average wind velocity profiles were obtained at meteoric height region during pre and post-midnight period on the peak day of the shower. A considerable variation was found in the estimated wind velocities during the shower period. The variation of the shower with respect to solar longitude are also presented and discussed.

Contribution functions for Stokes vector profiles

K. Nagaraju and K. E. Rangarajan
Indian Institute of Astrophysics, Bangalore

Abstract. The contribution functions for the Stokes vector profiles of the Zeeman split spectral lines are calculated for different types of atmospheric conditions. In this study, anomalous Zeeman lines are also included. It is found that in many cases, the line depression contribution function (CR) indicates clearly the nature of the emergent line profiles compared to the total contribution function (CT). The interesting case of magneto-optical oscillations in the contribution functions is discussed.

Spectrophotometric study of the comet C/2001 Q4 (NEAT)

Mahendra Singh, Brijesh Kumar and B.B. Sanwal
Aryabhatta Research Institute of Observational Sciences (ARIES), Nainital

Abstract. The spectrophotometric observations of the comet C/2001 Q4 (NEAT) which was discovered by NEAT (Near Earth Asteroids Tracking programme) team on Aug 24, 2001 were taken on three nights of May 13, 18 and 19, 2004 near its perihelion distance with 104 cm telescope of ARIES, Nainital using HR-320 spectrograph having a linear dispersion of 100 Å/mm and 1k × 1k CCD camera as the detector in the wavelength region 3500 - 7000 Å. The standard star HR 4534 was observed for standardization of the comet spectra. Data reduction is done using IRAF spectroscopic package. The details of the observational methods and reduction techniques are given in our previous paper (Sanwal et al., 2002, BASI 30, 943). The prominent emission features seen in the spectra are due to CN ($\Delta v = 0$) at 3888 Å and $C_2(\Delta v = +1, 0, -1)$ at 4695, 5165 and 5538 Å respectively. The area of strong emission bands were measured and converted into the total flux.

The number of molecules of each species, contained in a cylinder of radius defined by the diaphragm used was evaluated using the expression (Millis et al. 1982, AJ 87, 1310) which is given as,

$$\log M(\rho) = \log F(\rho) + 27.449 + 2\log(\Delta r) - \log g$$

where F is the observed flux in cgs units, ρ is the projected radius of circular region in the sky at Δ, r and Δ are the heliocentric and geocentric distances of the comet respectively in AU and g the fluorescence efficiency (in cgs units) per molecule at 1 AU.

The column densities thus calculated were converted into production rates (Q). It was observed that the activity was maximum on 13 May when the comet was nearest to the perihelion distance which is reflected in the production rates of molecules and dust on May 13. The activity decreases when comet goes away.

Solar rotation and geomagnetic field variability: low solar activity periods

Vivek Gupta and Badruddin
Aligarh Muslim University, Aligarh

Abstract. Planetary geomagnetic index, Kp, has been subjected to superposed epoch analysis with respect to start time of Carrington rotation. Simultaneous solar plasma and interplanetary field parameters have also been analyzed by the Chree method. Regression analysis between the geomagnetic activity index and solar wind parameters has also been done. These analyses have been performed during the periods of low solar

activity to avoid the effects of solar transients; these transients are frequently observed during high solar activity periods. Results of our analyses provide more insight about the relative effectiveness of various solar wind parameters, and the cause of variations in the geomagnetic activity during the course of solar rotations.

Solar wind plasma and field variations during solar wind streams and their role in modulating geomagnetic activity

Munendra Singh, Y.P. Singh and Badruddin
Aligarh Muslim University, Aligarh

Abstract. We have analyzed the solar wind streams to determine their plasma/field characteristics and their geoeffectiveness. We have studied, during high-speed streams, the relationship between the magnetospheric auroral electrojet intensity index (AE) and various parameters characterizing the solar wind plasma and magnetic field. Two more geomagnetic indices, one representing the intensity of planetary geomagnetic activity at subauroral latitude (Kp) and other that measures the ring current magnetic field (Dst), have also been considered in this analysis. We have used hourly data of geomagnetic indices to study their modulation during high speed solar wind streams. Interplanetary plasma and field data such as solar wind velocity, IMF strength, its variance and north-south component, plasma density, temperature and various combination of these parameters have been subjected to superposed epoch analysis with respect to corotating and transient streams along with geomagnetic indices AE, Kp and Dst. Corotating and transient streams have been divided into different categories according to polarity of the north-south component (Bz) during streams as this parameter is thought to play a key role in the development of geomagnetic storm. Interplanetary parameters characterizing corotating and transient high speed streams are remarkably different. It is observed that transient streams are more effective than corotating streams in modulating geomagnetic activity. Further, speed of streams and north-south component of magnetic field during streams plays important role as regards the effectiveness of streams in enhancing the activity. Geomagnetic activity is, in general, enhanced - and related to speed of the stream - during the extended periods of negative Bz within the streams and speed of the stream is enhanced when Bz is negative. However, though smaller in magnitude, significant enhanced geomagnetic activity may be observed during very high speed streams even when Bz is fluctuating.

Spectral characterization of solar active region NOAA 8242 in quiet and sunspot locations

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Abstract. We present results from the analysis of simultaneous Stokes I profile measurements in Fe I twin line in 6302 region and Ca II K 3934 line over NOAA 8242 on 13th June 1998. Advanced Stokes Polarimeter(ASP) instrument of the Vacuum Tower Telescope (VTT) of Sac Peak, NSO, U.S.A was used for obtaining these observations. Along with the spectral data simultaneous filtergrams in G-band, H & #945; 6562.8 and 6118.7 continuum were also obtained using the UBF filter. The slope corrected spectral data was used to construct spectroheliograms, and the maps of spectral asymmetry, velocity, FWHM, equivalent width by a Gaussian fitting of spectral line profiles for both the quiet and sunspot regions. The implications for strong and weak magnetic field locations have been discussed.

Some aspects of the solar core magnetic field

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Abstract. It is expected that the Sun might have retained the large scale (both poloidal and toroidal parts of) magnetic field structure in the radiative core from its initial birth. This is mainly due to a very large diffusion time scale (τ 10 billion yrs, for the poloidal field see Hiremath and Gokhale (ApJ, 448, 437, 1995) and references there in). In order to know the structure and strength of such a field of primordial origin, we use incompressible axisymmetric MHD equations (Chandrasekhar's (ApJ, 124, 231,1956). In the radiative core, we use the information of the angular velocity inferred from the helioseismology. Assuming that similar form of the surface meridional flow extends even below the base of the convective envelope and using Hiremath's (BASI, 29, 169, 2001) solution of the toroidal part of the magnetic field structure in the convective envelope as initial condition at the base of the convective envelope, we solve both the poloidal and toroidal parts of the steady magnetic field. We find that the solar core is pervaded by a weak (1 G) poloidal and moderate (1000 G) to strong (10^4 to 10^6 G) toroidal fields. Implications of such field structures on the unexplained two bumps of the sound speed difference (that inferred from the helioseismology) and on the origin of the solar activity and cycle phenomena are briefly discussed.

Anisotropy of solar wind density turbulence caused by the transients

P.K. Manoharan
Radio Astronomy Centre, NCRA, TIFR, Ooty

Abstract. A high degree of anisotropy of the density fluctuations in the solar wind is caused by the sufficiently strong magnetic field carried by the solar wind. The anisotropy is more prominent in the near-Sun (i.e., in the solar wind acceleration region at distances less than 15 solar radii) and it vanishes at greater distances. We study the large variations in the two-dimensional anisotropy of the interplanetary scintillation pattern caused by the propagating transient magnetic clouds at distances greater than 50 solar radii. The non-linear interaction between the slow and fast magneto-sonic waves seems to play a major role in shaping the density turbulence spectrum. The results are useful to identify the distance/region at which the slow and fast magneto-sonic waves interact with each other.

Study of properties of coronal mass ejections from AR 9393 and AR 9415

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Abstract. The NOAA active regions AR 9393 and AR 9415 dominated the solar disk between late March and mid April 2001. These regions produced a large number of intense flares and associated coronal mass ejections (CMEs), which were responsible for a number of severe geomagnetic storms. We study the characteristics of these mass ejections using data from the Large Angle and Spectrometric Coronagraph (LASCO) on SOHO and Interplanetary Scintillation measurements from the Ooty Radio Telescope. These CMEs show large variations in size, speed, acceleration, and in the radial dependence. A detailed comparison of magnetic field observations of the active regions with the corresponding 'latitude-longitude' maps of the solar wind speed and density fluctuations obtained from the Ooty measurements suggests that the energy involved in the mass ejection is likely to be controlled by the magnetic configuration at and near the mass ejection site. The scintillation measurements have also been useful to explain the large variations seen in the large-scale structure of the solar wind speed and density.

How similar are starspots to sunspots ?

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Abstract. Despite a lack of deductive magnetohydrodynamic explanation for the formation and the equilibrium of a sunspot, extensive observations in combination with magnetohydrostatic models have provided reasonable understanding of the thermal-magnetic structure of sunspots in the observable layers. A key property of a sunspot is the Wilson depression – geometrical depression of the observable optical depth unity level within a sunspot – that results from the cooler temperature and reduced gas pressure. Here we examine how such a thermal-magnetic relationship scales with the stellar parameters, viz. the effective temperature $T_{\rm eff}$ and surface gravity g as well as the associated changes in the opacity of the stellar photospheric gas. Combining some recent helioseismic results concerning the sub-surface structure of sunspots, we then discuss the implications for activity related photospheric brightness variations and their correlation with other activity measures for stars across the cool-half of the H-R diagram.

Complex variations in line-intensity ratio of coronal emission lines with height above the limb

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Abstract. We obtained spectroscopic observations simultaneously in two coronal emission lines, one [Fe X] 6374 Å and the other line being [Fe XI] 7892 Å or [Fe XIII] 10747 Å or [Fe XIV] 5303 Å, and studied the variations in intensity and FWHM ratios of these lines with respect to those of 6374 Å as a function height above the limb. We find that the intensity ratio of 7892 Å and 10747 Å lines with respect to 6374 Å line increase with height and that of 5303 Å to 6374 Å decreases with height above the limb. This implies that the temperature in coronal loops will appear to increase with height if we consider intensity ratio of 7892 Å and 6374 Å, and 10747 Å and 6374 Å while the temperature will appear to decrease with height if we consider intensity ratio of 5303 Å to 6374 Å line. The normalized FWHM (with respect to wavelength) ratio of 6374 Å to all the other coronal lines observed increases with height. The FWHM ratio at the limb depends on the pair of emission lines chosen; it is about one in the case 6374 Å and 7892 Å emission lines, indicating a common temperature and nonthermal velocity in the coronal loops near the limb; it is about 0.7 at the limb in the case 6374 Å and 5303 Å lines and becomes about one at a height of 120″. The varying FWHM ratios with height indicate that hotter and colder plasmas in coronal loops interact with each other. Therefore, the observed increase in FWHM of coronal emission lines, which are associated with plasma at about 1

MK with height may not be due to an increase in nonthermal motions caused by coronal waves but due to an interaction with relatively hotter plasma.

Solar wind effects on cosmic ray modulation at 1AU

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Abstract. Solar wind is an ionised magnetised gas which continuously emanates from the Sun. When Galactic cosmic rays (GCRs) enter our solar system, this solar wind impedes the incoming GCRs, reducing their low energy ones from reaching earth. A long-term relationship has been observed between the cosmic rays and solar wind speed in antiphase with solar activity. It is now well establish that high-speed solar wind streams (HSSWS) a most dynamical feature in interplanetary medium carry large amount of plasma and magnetic field into interplanetary medium, which modulate the cosmic ray particles. In this work, we have identified eighty six events of high speed solar wind streams for the period of 1996 to 2002, using the space craft data near the earth. Chree analysis of superposed epoch methods have been adopted to derive the average influence of high speed solar wind streams on geomagnetic field variation of earth as well as cosmic ray intensity variation. It has been investigated that the high speed solar wind streams produce short-term transient decreases in cosmic ray intensity. In further analysis, these streams in association with major solar flares are found to be more effective in geomagnetic disturbances.

Spectral properties of two electron ions of astrophysical interest under strongly coupled plasma

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Indian Association for the Cultivation of Science, Jadavpur

Abstract. Isoelectronic ions of helium atom are abundant in solar photosphere where these ions are under plasma environment. The effect of plasma on ionic spectra, in general, is to produce screening effect on the potential felt by the bound electrons. Depending upon the strength of the plasma, different screening is produced which can be mimicked by a potential function different from that felt by the electrons of the free ion. Pilot calculations have been performed for the energy levels, oscillator strengths and transition probabilities for the radiative transitions in helium isoelectronic ions for a few low lying energy levels in plasma environment. Ion sphere model has been used for incorporating the effect of strongly coupled plasma. Interesting results have been obtained which may have their relevance in obtaining the spectral properties of stellar atmospheric ions.

Magnetic evolution of super-active region NOAA AR 10486 and the large 4B/X17.2 class flare observed during October 28, 2003

Ashok Ambastha
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Abstract. Extensive flare activity was observed in super-active region NOAA10486 during its disk passage of October 22-November 04, 2003. An extremely energetic 4B/X17.2 flare on October 28, 2003/11:10 UT was observed from USO when the active region was located at S16E08, i.e., close to the disk-centre. This flare was rated the third largest X-ray flare recorded by GOES satellite, and the largest in the optical class (4B) observed so far from USO. Chromospheric H-alpha filtergrams were obtained before, during and in the decay phase of the two-ribbon flare at a cadence of 3-4 seconds. The temporal and spatial structure evolution was analyzed with the help of a movie constructed using more than 4000 images. Magnetograms from NASA-MSFC showed large magnetic shear around the flare site which was delineated by a large active filament. The filament erupted as the flare progressed. In the decay phase of the flare, a system of post-flare loops developed at the site of the erupted filament. Observation from TRACE also exhibited these loop structures. Associated with this flare, a fast Earthward moving halo CME was also detected by SOHO, which initiated a major geomagnetic storm on October 29, 2003 at 06:13 UT, i.e., within a record time of 19 hours after the flare. This large flare was followed by another 2B/X11 event on October 29, 2003/20:49 UT, not observed from USO as it occurred in our night-time. We have used white light full disk images and line-of-sight magnetograms obtained from SOHO-MDI for determination of proper motion of the main sunspots and corresponding magnetic fluxes in order to understand rapid magnetic energy build-up in the active region, giving rise to the two large flares within such a short time.

Contribution of solar chromospheric features to UV irradiance variability

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Abstract. We have determined the time series data of the different parameters like the intensity, area, the full-disk intensity (spatial K index), and the Full Width at Half Maximum (FWHM) for the segregated features (the plages, magnetic network, and intranetwork + the background regions) of the chromosphere from the CaII K spectroheliograms of 1992 and 1980, observed at the National Solar Observatory at Sacramento Peak, using their histograms taken for the full-disk. The spatial K index, FWHM, and the intensity of various features have been compared to the UV irradiance measured in the MgII h and k lines by the Nimbus7 and NOAA9 satellites and it has been found that they are well correlated with the MgII h and k c/w ratio. We established, for the first time, from the

results of 1992 and 1980 images (Kariyappa and Pap, 1996 and Kariyappa and Dame, 2004) that the FWHM can be used as a good index for measuring and describing the chromospheric activity in the K-line. Our study shows that besides the plages, a significant portion of the variation observed in UV irradiance is related to the changing emission of the network and intranetwork + background regions. This indicates that in addition to plages and network, the intranetwork + background regions may also play a significant role in their contribution to the variation in UV irradiance. Our result indicates that the intensity values of the intranetwork + background regions are not constant as assumed in the current irradiance models. On the contrary, they are changing in a fashion similar to the plages and the magnetic network. We estimated the contribution of various chromospheric features to the total CaII K flux from the intensity time series data and found that about 50% of the CaII K solar cycle variability results from plages, about 32% from network, and about 18% from intranetwork + background features.

The power spectrum analysis on the time series of intensity of plages, network elements, and intranetwork + background regions show a strong 27 and 13-day rotation modulation. It is interesting to note that the network and intranetwork + background regions behave similar to the plages in their rotation modulation.

Variability of CaII K emission flux over the solar cycle

R. Kariyappa and K. R. Sivaraman
Indian Institute of Astrophysics, Bangalore

Abstract. We have analyzed the CaII K line profiles obtained with a high spectral resolution in integrated Sun-light (Sun as a star) from a scattered light free system, Double Pass Spectrograph, of the Indian Institute of Astrophysics, Bangalore for the period 1989 - 1993. This spectrograph has been developed and installed in 1988 for the observations of the solar chromosphere in CaII K line (Kariyappa, et al. 1993). The various parameters of the K-line profiles have been extracted. The total K-emission flux centered around 1 A pass band has also been derived from all the line profiles. This flux has been compared with 1 A K Index of NSO/Sac Peak and UV irradiance measured in MgII h & k lines, and found that they are well correlated with each other. It would enable us to construct a model of the chromosphere using the line profile parameters and would serve as a reference for inferring the chromospheric variations in other Sun like stars as a function of stellar activity.

Extreme level solar activity during decay phase of solar cycle 23 in October-November 2003

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Abstract. In the decay phase of current 23rd solar cycle, during October-November, 2003, there was a sudden increase in solar activity. In this period many powerful and historical solar flares and majestic Coronal Mass Ejections (CMEs) occurred on the Sun. Here we present the preliminary results of our H-alpha observations of some major solar flares observed from ARIES, Nainital during the above period. These flares were produced by naked eye super-active regions NOAA AR 0484, 0486, 0488 and 0501 (return of AR 0484). Our observations include the major solar flares of 26th October (3B/X1.2), 28th October (4B/X17.2) and post flare loops of 4th November 2003 3B/X28 mega flare from AR 0486. This active region was one of the largest, magnetically most complex and highly flare productive of the solar cycle 23. These events were associated with energetic CMEs, proton events, GLE, strong gamma ray, X-ray, MW and strong radio bursts.

The above studied events were observed by various ground based observatories and space missions i.e. RHESSI, SOHO, TRACE,SOXS, Nobeyama Radio Observatory etc. Our study shows that the possible cause of energy build-up and release is the fast emergence of magnetic flux. Most of the flares and associated phenomena support the Tether-cutting and helically twisted magnetic flux rope models.

Preliminary results of Venus transit of June 8, 2004 observed in $H\alpha$ 6563 Å

B. Ravindra, Ashok Ambastha and Sanjay Gosain
Udaipur Solar Observatory, Physical Research Laboratory, Udaipur

Abstract. The rare cosmic event of Venus transit of June 08, 2004 was observed at Udaipur Solar Observatory using full-disk, as well as, small field-of-view high resolution solar telescopes in H-alpha 6563 Å. High resolution solar images were taken at a cadence of 3 seconds during the period 05:10 - 05:30 UT of Ist and IInd contacts and during the period 11:10 - 11:30 UT covering the IIIrd and IVth contacts. We have compared our observations with the multi-wavelength data obtained from TRACE satellite. We studied the optical effects that cause the "black-drop" and the "atmospheric-glow" around Venus at the time of its I - II, and III - IV contacts, and compared the differences in contact timings observed in different wavelength bands. Preliminary results are presented in this paper from analysis of over 4000 $H\alpha$ filtergrams obtained for this transit event.

Effects of coronal mass ejection associated with eruptive flares of the Sun

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Abstract. Coronal Mass Ejections (CMEs) are associated with non-recurrent geomagnetic storms and long-lived solar energetic particle events and thus play a vital role in understanding the Sun-Earth connection. Coronal Mass Ejections (CMEs) are large expulsions of mass and magnetic field from the Sun into the inter-planetary medium. CMEs are multithermal structures in general, carrying magnetized plasma into the inner heliosphere by the solar wind. The solar wind consists of particles, ionized atoms from the hot solar corona, and fields in particular magnetic field. Solar flares release energy from the magnetic loops in the corona, heating the gases of the corona and sending particles and radiation out into the solar system. The frequency of occurrence of both solar flares and CMEs follows the pattern of the 11-year sunspot cycle (as the number of sunspots increase, so does the number of solar flares and CMEs). Earth is affected by radiation and particles that solar flares and coronal mass ejections release. We discuss CME propagation into the interplanetary medium and the resultant interplanetary counterparts like Solar Energetic Particles (SEPs) and Energetic Solar Particles (ESPs).

Brightness variations in Comet Hyakutake (C/1996 B2)

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Abstract. The behaviour of the intrinsic brightness of a bright comet Hyakutake is studied. The results are based on the analysis of the available observations collected from various sources in the literature. We have compared the predicted brightness with the observed one.

Stars and galaxies

On observational detection limits in asteroseismology: a comparison between Manora Peak and Devasthal

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Abstract. This work attempts a simplified evaluation of the statistical detection performances of stellar variability using fast photometry, at Manora Peak (existing 104cm telescope) and Devasthal (future 1m automated telescope, and 3m telescope project). The

overall noise in the light curve is shown to follow a mixed Poisson process (photon noise mixed by scintillation). These statistics, further results from atmospheric physics, and extensive site measurements at Manora Peak and Devasthal allowed us to quantify the respective contribution of the noise for these sites. The results presented are best possible detection performances. Depending on the magnitude of the pulsating star and/or the astronomical site, 3 regimes appear for the detection (scintillation; scintillation and photon noise; photon noise and sky's background). The corresponding frontier magnitudes are $\sim$10 mag and $\sim$15 mag. For bright stars ($\lesssim$10.5 mag), $\sim$260-280 micromag oscillations can be detected at a 95% confidence level with a 1m telescope. This falls to $\sim$1 mmag for magnitude 15 stars. With a 3m telescope at Devasthal, $\sim$130 micromag variations would be detected at a 95% confidence level up to magnitude 12 stars. At m=15, 400 micromag oscillations would still be detected. A 3m telescope would thus allow one to probe quite faint objects with a high precision. This makes such a project attractive for asteroseismology in general, and in particular for the survey of rapidly oscillating A peculiar (roAp) stars, such as the Nainital-Cape roAp stars survey currently monitored at ARIES.

Observation of R-band variability of L dwarfs

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Abstract. We report, for the first time, photometric variability of L dwarfs in R band. Out of three L1 dwarfs (2MASS 1300+19, 2MASS 1439+19, and 2MASS 1658+70) observed, we have detected R band variability in 2MASS 1300+19 and 2MASS 1439+19. The objects exhibit variability of amplitude ranging from 0.01 mag to 0.02 mag. Object 2MASS 1658+70, turned out to be non-variable in both R and I bands. However, more observations are needed to infer its variability. No periodic behaviour in the variability is found from the two L1 dwarfs that are variable. All the three L1 dwarfs have either negligible or no $H\alpha$ activity. In the absence of any direct evidence for the presence of sufficiently strong magnetic field, the detection of polarization at the optical favours the presence of dust in the atmosphere of L dwarfs. We suggest that the observed R band photometric variability is most likely due to atmospheric dust activity.

Long-term spot activity variation in FK Comae Berenices

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Abstract. FK Com (HD 117555) is the prototype of active FK Comae stars, which are single, rapidly rotating, late-type giants with strong and variable H-alpha emission, strong chromospheric UV emission and high X-ray luminosity. A commonly accepted interpretation of the brightness variation of FK Com is due to rotation modulation of

extended cool spots on the stellar surface i.e. changing spot area and longitudinal motion of the spotted regions relative to each other. Jetsu et al. (1991, IAU Coll. 130, 381; 1993, A&A, 278, 449) reported that the active regions of FK Com show a "flip-flop" behaviour, in which the dominant part of the spot activity shifts by 180 degree in longitude over a short period of time and remains at this new active longitude for some time. We have modeled V band light curves collected from the published photometric observations during the period 1966-2003 in the frame work of star-spot model. We have taken two circular spots distributed on the stellar surface and another one on the pole for the purpose of starspot modeling. We used integrated magnitude, amplitude, minimum, maximum and mean magnitude, total spot area and polar spot area as different photometric diagnostics to examine any periodicity in long term photometric V band data for FK Com. In our analysis two dominant types of activity cycles were found. The long-term activity cycle of about 28 years were seen in integrated, mean, maximum magnitudes and polar spot area. The short-term activity cycle of about 6 years were noted in amplitude of light variation and minimum magnitude. Mean and maximum magnitudes showed activity cycle of about 5 and 12 years, respectively. The long-term activity cycle corresponds to the time scale of variations in the total spottedness, while the short-term activity cycles correspond to the cycle of "flip-flop" behaviour. Correlations between different activity tracers reveal that the light variations in FK Com are caused by rather symmetrical rearrangement of a more or less constant amount of dark spots, which in turn supports the hypothesis of two active longitudes on the stellar surface of FK Com.

Evolution of emission line activity in intermediate mass young stars

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Abstract. One of the most important observational characteristics of young pre-main sequence (PMS) stars is the presence of a variety of emission lines like the the Balmer lines of hydrogen, CaII triplet as well as many metallic lines and forbidden lines such as [OI] and [NII] in their spectra. Emission line activity in these stars is widely believed to be accretion driven. During the pre-main sequence evolution, the accretion rate is expected to go down gradually and eventually the inner disk is dissipated. This evolution should manifest observationally as the weakening of the emission line activity and the continuum near-infrared excess emission of the young stars. From a study of these observational tracers as a function of the pre-main sequence ages of the stars, one should be able to follow the evolution of accretion disks during the pre-main sequence phase.

We have studied the evolution of emission line activity in intermediate mass Herbig Ae/Be (HAeBe) stars. The equivalent width of the Hα line was taken as an indicator of emission line activity and the pre-main sequence ages were obtained by placing the stars in the HR diagram and comparing with the theoretical evolutionary tracks. We find the equivalent width of Hα emission in HAeBe stars to fall by a factor of more than two on a

timescale of about 2-3 Myr and the emission in young stars disappears in about 5-6 Myr. We also find a general decline of the magnitude of near-infrared colour excess with the PMS age of the star, indicating a gradual dissipation of the inner accretion disks during the PMS evolutionary phase. Further, we find a strong correlation between the strength of the emission line activity and the magnitude of inner disk emission. The results of the study and its implications for the evolution of accretion and disk dissipation in young stars will be discussed.

Angular diameters and effective temperatures of 19 evolved stars by lunar occultations

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Abstract. We present the new angular diameters of 19 evolved stars by lunar occultations in the near-infrared wavelengths using the 1.2m telescope at Mt. Abu. These include three Mira variables, three semiregular variables (SRVs) and 11 giants of spectral type K0 - M6 and two M supergiants. Simultaneous lunar occultations at K (2.2 micron) and L′ (3.8 micron) for two SRVs are reported first time. We find the evidence of asymmetric structure in the atmosphere of Mira star U Ori. Another Mira star U Ari shows substantially larger (20%) size at K-band compared to earlier measurement at H-band (1.65 micron) at nearly same photometric phase. This size enhancement in U Ari is evidence of variable opacity effect in the Mira atmosphere. Fundamental stellar parameters like angular sizes, linear radii and effective temperatures are determined for those variable stars and discuss the mode of pulsation of Mira and semiregular variables. We determine the effective temperatures of the sources in the spectral range K0 - M7 giants, and show that our measured values agree well with the established empirical calibration scale of the spectral types versus effective temperatures.

Post-outburst phase of the McNeil's nebula (V1647 Orionis)

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Abstract. We present a detailed study of the post-outburst phase of McNeil's nebula (V1647 Ori) in Orion using the optical V, R, I, Hα and near-infrared (NIR) J, H, K observations with the HFOSC, NIRC and TIRCAM cameras on HCT 2m and PRL 1.2m telescopes in the period February - November 2004. The optical observations show that the McNeil's source that had gone into outburst is fading away whereas McNeil's nebula remains bright after the post-outburst. The optical/IR comparison of McNeil's nebula

shows that the optical nebula is more widely and predominantly extended to the north, while the IR nebula is relatively confined but definitely extended to the south, too. The large colour gradient from north to south and the sudden absence of optical nebula to the south is suggestive of a large scale disk-like structure (envelope) surrounding the central source which hides the southern nebula. New optical/NIR photometric data show a significant variation in the magnitudes (> 0.15 mag) of the source of McNeil's nebula within a period of ten months, that is possibly under the phase of eruptive variables like FUors or EXors.

Discovery of pulsations in Am star HD25515

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Abstract. Using 104-cm Sampurnanand telescope of Aryabhatta Research Institute of Observational Sciences, erstwhile State Observatory, Nainital equipped with three channel fast photometer, the chemically peculiar Am star HD 25515 was observed during January and February, 2004 to search for pulsations in chemically peculiar stars. All the data were acquired as continuous single channel 10s integrations through a Johnson B filter. A diaphragm of 2 mm in diameter which corresponds to 30 arcsec was used to minimize the light losses arising due to the seeing effect and the telescope tracking drifts. The observations were interrupted, nearly every $15-20$ minutes, for sky background measurements to take account of changes of sky brightness during the night. These observed data were corrected for coincidence counting losses due to the dead time of the photon counting electronics, sky background and atmospheric extinction.

The light curves of the Am star HD 25515, taken on six nights, ranging from January 07 to February 10, 2004 show that the brightness of the star vary with time and the amplitudes of these light variations are different to each other. The corrected data of HD 25515 for each night were used to identify the component frequencies using Deeming's Fourier Transform. The amplitude spectra of our observed light curves for this star on all these six nights show a strong peak of about 30 mmag within the accuracy of 5 mmag at 0.10 mHz within the accuracy of 0.02 mHz. This corresponds to a period of about 2.8 hours. On the basis of the critical examinations of the period of light variation, the shape of the light curves and amplitude variation during our entire observational period along with its spectral type and Stromgren indices, we announce that HD 25515 is a new pulsating variable star with Am star peculiarities.

Atmospheric extinction at the Indian Astronomical Observatory, Hanle and at the Vainu Bappu Observatory, Kavalur

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Abstract. In order to determine the atmospheric extinction at the Indian Astronomical Observatory (IAO), Hanle and at the Vainu Bappu Observatory (VBO), Kavalur, we observed the stars in the field of the well-known open cluster M 67 using the Himalayan Chandra Telescope (HCT) and the Vainu Bappu Telescope (VBT) respectively. The standard UBVRI filters were used with HCT while only UBV filters were used with VBT. For the HCT observations, obtained on 1 and 2 February 2004, a total of 11 frames of each filter were used, while 12 frames of each filter had been used for the observations at VBT, obtained on 1 March 2001. The value of the coefficient of atmospheric extinction k generally appears to be following the Rayleigh scattering law at both observatories with a systematic higher extinction at VBO as compared to IAO. This difference is to be expected mainly because of the vast difference of about 13000 ft in the altitudes, with IAO being located at about 15000 ft altitude above mean sea level in the Himalayas. However, it was found that the k value obtained through V filter at IAO showed a higher value by about 0.04 mag than what it could have been in the normal case, based on the Rayleigh scattering. This may possibly be attributed to the seasonal enhancement of ozone at this spectral region.

Study of young open cluster NGC 1624 (OCl 403, Cr 53)

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Abstract. We present the first CCD photometric UBVRI observations of the not-so-well-studied open cluster NGC 1624 (OCl 403, Cr 53; $\alpha 2000$ = 04h 40m 36s; $\delta 2000$ = + 50° 27′ 42″; Trumpler class I2pN). This cluster was observed on 01 February 2004 with the 2m Himalayan Chandra Telescope at Hanle using a LN2 cooled 2k × 4k CCD. The colour excess E(B-V) is estimated to be 0.65 mag which could be mainly due to the presence of the nebulosity in the line of sight of the cluster. It is found to be at a distance of 3.13 ± 0.4 kpc and as the age of this cluster is estimated to be 3.98× 10^6 years, it can be considered as a young enough cluster located in the direction of the Perseus constellation with the galactic coordinates of l=155°.35 and b=N 02°.58. Thus it could also be used as a suitable candidate for tracing the outer Perseus spiral arm of our Galaxy.

HD 81032: a newly discovered RS CVn binary

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Abstract. In a first detailed observational study of HD 81032 since its identification as an X-ray source in 1996, differential BVR photometric and quasi-simultaneous optical spectroscopic observations have been carried out from the year 2000 to 2004. A photometric period of 18.802 ± 0.07 d has been detected for this star. The amplitude and the phase of the photometric light curves of HD 81032 are observed to be changing from one epoch of observation to another. The change in the amplitude is mainly due to a change in the minimum of the light curve, and this may be due to changes in the dark spots on the surface of the star. A single large group of spots migrating on the surface of the star with a period of 7.32 ± 0.04 years is inferred. Hα and Ca II H and K line emission from the star indicate high chromospheric activity. The equivalent widths of Hα, Ca II H and K emission lines in the spectra of HD 81032 appear more intense close to the photometric light minimum, probably due to the presence of cool spots on the surface of the star.

An examination of the spectral energy distribution of HD 81032 based on our photometry and the 2MASS JHK and IRAS photometry, does not reveal any infrared colour excess, thus showing normal values expected for a star of this spectral type. X-ray emission properties of this star have been obtained by analysing the data obtained by the ROSAT X-ray observatory during the All-Sky Survey. An X-ray flare of about 12 hours duration was detected during the two days that this star was on view. Its X-ray spectrum, while only containing 345 counts, is inconsistent with a single-temperature component solar-abundance coronal plasma model. The spectrum requires either the presence of two or more plasma components with solar abundances or a single temperature component with non-solar abundances. All of the above properties of HD 81032 suggest that it is a newly identified, evolved RS CVn binary.

On the behaviour of chemically peculiar star HR2095

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Abstract. The chemically peculiar (Ap Si) star HD 40312 (HR 2095 = Theta Auriga, R A (2000): $05^h\ 59^m\ 43^s.3$ Dec (2000): $+37^\circ\ 12'\ 45''$) was observed with the 1 meter telescope using the Universal Astronomical Grating Spectrograph (UAGS) at the Vainu Bappu Observatory, Kavalur, during the period of 29th January 2004 to 4th February 2004. A total of 120 spectrograms of this star were obtained in the wavelength region of 3900 Å to 4400 Å at a resolution of 0.5 Å per pixel with the help of a 1800 lines/mm

reflection grating in the first order. Variation could be caused either by the rotation of the star having surface patches with concentrations of elements producing these features or by some diffusion mechanism which selectively and periodically enriches the stellar surface with the respective elements.

In addition, there were short duration appearances of the absorption features at the wavelengths of 3949 Å on 3rd February 2004 (JD 2453039.43 to JD 2453039.51), at 4056 Å on 31st January 2004 — (JD 2453036.31 to 2453036.43) and at two other wavelengths of 4030 Å and 4082 Å on 2nd February 2004 (JD 2453038.30 to 2453038.50). These features did not show up on any other night during the period of our observations.

We present the variations of these features along with the variation of the three features at 4077 Å, 4128 Å and 4131 Å.

Li-rich K giants: a few new cases

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Abstract. We present results from spectroscopic analysis of three Li-rich K giants: IRAS12327−6523, IRAS13539−4153, and IRAS17596−3952. High-resolution spectra and the LTE model atmospheres are used to derive the stellar parameters: $T_{\rm eff}$, log g, [Fe/H]), elemental abundances, the isotopic ratio $^{12}C/^{13}C$. IRAS 13539−4153 shows an extremely high Li abundance of log ϵ(Li) $\approx$ 4.2, a value ten times more than the present Li abundance in the local interstellar medium. This is the third highest Li abundance yet reported for a K giant. Infrared photometry which shows the presence of an IR excess from cold dust but no near-IR excess from hot dust suggests the likely absence of on-going mass-loss.

FIP effect in RV Tauri stars

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Abstract. Analysis of the surface composition of the suspected cool RV Tauri star CE Vir shows no systematic trend in depletions of elements with respect to condensation temperature. However, there is a significant depletion of the elements with respect to the first ionization potential of the element. In that an element with lower FIP is more depleted than an element that has high FIP. Such effect is seen in the case of solar coronal abundances.

X-ray spectroscopy of AM Her

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Abstract. We have analysed the high resolution X-ray spectrum of AM Her taken with Chandra HETG. The spectra were taken when AM Her was in a high state. Emission lines of O VII, O VIII, Ne IX, Ne X, Mg XII, Si XIV, S XVI, Ar XVIII, Ca XX and Fe lines are seen in the spectra. The strongest lines seen in the spectra are O VII, O VIII and Fe k lines. The relative intensities of the triplet emission lines suggest a high density photo ionized plasma and possible presence of significant UV radiation in the accreting region. We also compare the HETG spectrum of AM Her with that of intermediate polars for a better understanding of the accretion processes in the two systems.

Chandra HETG observations of intermediate polars

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Abstract. High resolution X-ray spectra of four Intermediate Polars (IPs) namely, EX Hya, V1223 Sgr, AO Psc and GK Per, obtained from the *Chandra* High Energy Transmission Grating (HETG) observations are presented. IPs constitute a subclass of magnetic cataclysmic variables in which a magnetic white dwarf (magnetic field strength B<10 MG) accretes matter from red dwarf companion star that fills its Roche Lobe. The accreting matter forms a partial accretion disk around white dwarf before being channeled by the magnetic field lines producing X-rays from the accretion column. Strong emission lines from various elements like O, Ne, Mg, Si, S, Fe and Fe L-shell have been observed, indicating the multi-temperature nature of plasma in the post shock region near the white dwarf surface. A wide range of temperature distribution (0.5–10 keV for EX Hya and 0.2–12 keV for V1223 Sgr) in the post-shock region has been indicated using (a) the emission measure (EM) distribution curves of individual lines and (b) the intensity ratio of H to He-like lines of different elements. Line intensity ratios G=(f+i)/r and R=f/i, where 'r' is resonance line, 'i' is intercombination line and 'f' is forbidden line, for O VII suggest electron temperature $T_e \sim 1 \times 10^6$ K and electron density $n_e > 10^{13}$ cm^{-3} for EX Hya and $T_e \sim 3 \times 10^6$ K and $n_e \sim 5 \times 10^{11}$ cm^{-3} for V1223 Sgr using theoretical curves from Porquet & Dubau (2000). Similar work for AO Psc and GK Per is in progress.

Near infrared analysis of nearby main sequence stars

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Abstract. A near infrared colour-magnitude diagram for main-sequence stars in the solar neighbourhood along with some distant early type stars has been constructed and compared with that of the optical one. As there is no calibrated ZAMS for the NIR region at present, a standard main sequence has been constructed using the isochrones for metallicities 0.02 & 0.05 of young clusters of age log t = 6.6 of Bertelli et al. (1994) and a mean line for these metallicities is drawn and used as a standard main sequence (Priya 2004). A mere comparison of these optical and infrared diagrams shows that there is a slight deviation in the distribution of stars in NIR region compared to that of optical region. The possible reasons for the deviation are, if the reddening correction which we have applied is wrong, the deviation due to this will be more in the optical region that in the NIR region as the interstellar reddening is much more in the visible region compared to that in the infrared region. Alternatively, if the shift in NIR region is due to the presence of shell structure around these stars, since the deviation is not an isolated one but it represents all the earlier stars, the question arises whether it is possible to have shell structure in all these stars ? If so, how long the shell structure will be retained by the stars, and is the shell structure a common phenomenon for all early type stars?. Probably not. So, finally we may presume that the theoretical standard main sequence given from the models in the NIR region probably needs further modification or refinement especially at higher temperatures.

Search for variable stars in intermediate and old age open clusters

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Abstract. A CCD photometric survey for the search of variable stars in four intermediate and old age open clusters is presented.The observations were carried out between October 1998 - November 1999 which led to the discovery of some new variable stars in the clusters. Two new δ Scuti variables are discovered whereas one star is suspected to be W Uma type and one as Algol type variable. Position of these variables in the identification chart and a composite colour−magnitude diagram for the clusters is also presented. Period could not be determined for most of the detected variables due to the small observing span. More time series observations are needed to study these newly detected variables in detail.

CCD photometric study of the open cluster NGC 6611

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Abstract. We present a deep BVR_cI_c CCD photometry of the extremely young open cluster NGC 6611 up to $V \sim 19$ mag. The radial distribution of the stellar surface density indicates that the cluster radius is extended up to about 7.9 pc having a peak density of 22 star/pc^2 around the centre. The cluster shows non-uniform extinction ranges from 0.64 to 1.05 mag with a mean value of $E(B-V) = 0.74$. The 2 MASS JHK data in combination with the optical data yield $E(J-K) = 0.26 \pm 0.01$ and $E(V-K) = 1.51 \pm 0.03$ mag. The colour-magnitude diagrams of the cluster indicate a distance of ~ 2 kpc by comparing it with the zero age main sequence and an age of ~ 6.3 Myr from the fitting of theoretical stellar evolutionary isochrones of metallicity 0.02.

Mass function study of six open clusters Be 10, Be 67, To 5 , Be 15, Be 71 and King 1

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Abstract. In the present study, we have used CCD data to determine luminosity and mass function of six open clusters. Using photometric and statistical criteria we have tried to obtain probable members of clusters. From these members, we have constructed luminosity functions and determined the mass function slopes for the clusters under study.

Wide field CCD photometry of open clusters

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Abstract. The nucleus and the corona (extended region of the star cluster) are two main regions in open cluster. The nucleus of clusters contains relatively bright and massive ($\geq$ 3 solar mass) stars and consequently it is a well-studied region of the clusters. However, the coronae of star clusters, which generally contains a large number of faint stars, has not been studied in detail. In fact the spatial distribution of these faint and low mass stars

($\leq$ 1 solar mass) defines actual boundary of the clusters. Consequently coronal regions have very important bearing on studies related to the MF, the structure and evolution of open clusters.

Extensive studies of the coronal regions of clusters have not been carried out so far mainly because of non-availability of photometry in a large field around open star clusters. We have embarked on extensive studies of the coronal region of star clusters using the 2K X 2K CCD mounted on the Kiso Schmidt telescope (Japan) which gives a $\sim$ 50 arcminute square field. We present a preliminary study of 10 clusters.

Study of emission line stars in young open clusters using slit-less spectra: NGC 663

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Abstract. The young open cluster NGC 663, rich in Be stars is studied using slit-less spectra. The emission line stars are identified in the region of this cluster and the spectra of Be stars as well as suspected emission line stars are presented. 22 stars were found to show Hα emission and 16 were found to belong to spectral range B0 – B3. The Be stars were found to be located within a radius of $\sim$ 11 arcmin, where the cluster radius is $\sim$ 17 arcmin, indicating that the Be stars are located closer to the centre of the cluster. The central region of the cluster was observed in two epochs which resulted in the identification of 5 stars which show variation in the Hα line strength. The Be stars were found to be selectively more reddened than normal stars by more than 0.15 mag. Thus the emission and the increased reddening may be due to the material coming out of the star, either due to faster rotation or an increased mass loss. The fraction of Be stars present in the cluster is found to decrease with respect to the assumed cluster radius. The fraction of Be stars inside the cluster core is estimated to be 35% which reduces to 22%, when the whole cluster is considered.

NGC 146: a young open cluster with different ages for the low and high mass stars

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Abstract. The young open cluster NGC 146 is studied using UBV CCD photometry obtained using the 2m HCT. The cluster is found to show differential reddening across the cluster. After the removal of field stars, we identified a good number of pre-main sequence stars in the cluster colour-magnitude diagram. The age of the cluster as estimated from

the upper part of the main-sequence is found to be more than 10 Myr. The age as estimated from the pre-MS stars is found to be less than 5 Myr. Thus the cluster shows different ages for the high and low mass stars. Two Be stars are found to be present in the cluster.

Wide field CCD photometry around open cluster NGC 1912

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Abstract. We present CCD UBVI$_c$ photometry in a wide field around open cluster NGC 1912. Stellar surface density profile indicates that the radius of the cluster is about 14 arcmin, whereas core of the cluster cannot be defined due to its significant variation with the limiting magnitude. The colour-colour diagram indicates a mean reddening E(B-V) = 0.25±0.02 mag across the cluster. The cluster is situated at a distance of 1400±70 pc. The age of the cluster is estimated as 300±80 Myr. The mass function slope is derived by applying corrections of field star contamination and data incompleteness. The mass function for the cluster is quite noisy, however in the mass range 1.0 ≤ solar mass ≤ 3.1 the slope of the mass function, within error, is equal to Salpeter value. The age of the cluster is much higher than the relaxation time-scale, therefore dynamical relaxation may be one of the reasons for the observed mass segregation in the cluster.

Incidence of planetary nebulae in star clusters

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Abstract. Planetary nebulae (PNe) are rarely found in star clusters. Only a few are known in the globular clusters of our Galaxy and perhaps none are present in open clusters. We make an estimate of the likely incidence of PNe in clusters. For a cluster with coeval star formation and a given Initial Mass Function (IMF), a simple expression is derived for n_{PN}, the expected number of PNe in the cluster, as a function of the mass M of the cluster, its age a, the lifetime of the PN phase. Assuming canonical values for some of these parameters, and taking others from available data on clusters, we find that PNe are unlikely to be found in open clusters. Our estimate for the number of PNe in the Globular cluster (GC) population and the stellar halo of the Galaxy are 7 and 48 respectively. 4 PNe are found in the GC population of the Galaxy and 11 are known to be halo PNe. Massive Young clusters (MYC) have good prospects as sites for PNe occurrence in cluster environment.

Optical spectroscopy of the classical nova V5114 Sgr 2004

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Abstract. We present optical spectroscopy of the classical nova V5114 Sgr 2004, obtained using the 2m Himalayan Chandra Telescope (HCT). The observations were made between 2004 March 19 and August 14, in the wavelength region of 3600-9200 Å. Nova V5114 Sgr was discovered on its rise to maximum on 2004 March 15.82. It reached maximum around March 17.5, and subsequently declined with a rate of 0.23–0.15 mag day^{-1}. The spectral development of nova V5114 Sgr 2004 is very similar to that of the "FeIIb" novae. These novae evolve to the "He/N" type either during the permitted phase, or they develop nebular spectra typical of "neon" novae. From the spectral development, it is seen that V5114 Sgr evolved to the "He/N" type during the permitted phase. It is interesting to note that while no coronal lines were clearly detected in the optical spectra of 2004 June 23 and August 14, the near-IR spectra obtained on June 22.4 (D. Lynch et al. IAUC 8368) indicated the nova to be well into its coronal phase.

Chandra X-ray observations of SN 1995N

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Abstract. X-rays from a supernova explosion arise from the interaction of the supersonic ejecta with the circumstellar medium (CSM). When the ejecta collides with the CSM, it creates two shocks: blast-wave shock and a reverse-shock moving into the expanding ejecta. Initially the X-rays come from the forward-shocked shell, but later on X-rays arise also from the reverse-shock. We present the spectroscopic and imaging analysis of a type IIn supernova SN 1995N. We observed SN 1995N from 2004 March 27 UT 17:55 to 2004 March 28 UT 10:00 with the Advanced CCD Imaging Spectrometer (ACIS-S) instrument of Chandra X-ray observatory as a part of GO observations (Obs ID 5191). Comparison of Chandra spectrum with that of previously observed ASCA in 1998 shows the presence of Neon lines which were not reported in the ASCA observation. The observed absorption column depth indicates an extra component over and above the Galactic absorption component and is possibly due to a cool dense shell between the reverse-shock and the contact discontinuity in the ejecta. The ASCA and the ROSAT observations suggested a non-linear behaviour of the X-ray light curve. However, with the higher spatial resolution and sensitivity of Chandra, we separate out many nearby sources in the supernova field-

of-view that had additionally contributed to the supernova flux due to the large Point Spread Function of the ASCA. Taking out the contribution of those nearby sources, we find that the light curves are consistent with a linear decline profile. We consider the light curve in the high energy band separately. We also discuss our results in the context of models of nucleosynthesis.

Multiband optical photometry and bolometric light curve of Type Ia Supernova SN 2004S

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Abstract. We present BVRI broad band CCD photometry of the Type Ia supernova SN 2004S which appeared in the galaxy MCG-05-16-021. This supernova (mag 16 on red CCD images) was discovered on 2004 February 3.54 UT at Perth Observatory with the 0.61-m Perth/Lowell Automated telescope in the course of the Perth Automated Supernova Search. The SN was located $47''.2$ W and $2''.5$ S of the centre of the galaxy MCG-05-16-021. We observed the SN at 27 epochs during 2004 February 12 to March 22 using a 1024×1024 pixel^2 CCD camera attached to the f/13 Cassegrain focus of the 104-cm Sampurnanand Telescope. Several bias and twilight flat frames were taken with the CCD camera to calibrate the supernova images using standard techniques. Data reduction was carried out using IRAF and MIDAS softwares. We have constructed UBVRI light curves and the bolometric light curve using our observations in combination with other available data reported in the literature. Peak magnitudes in different bands have been estimated by fitting light curve templates and colour curves. Peak magnitudes estimated by using template fits in B, V, R_c and I_c bands are 14.45 ± 0.05, 14.36 ± 0.07, 14.39 ± 0.07 and 14.52 ± 0.09 mag respectively. A pronounced second maximum in I_c band is displayed by SN 2004S which occurs nearly 26 days after the B maximum. The magnitude of the secondary I_c maximum, derived from template fitting, is 15.02 mag. We estimate the characteristic parameter Δm_{15}, the number of magnitudes in B band by which the SN declines in the first 15 days after maximum, to be 1.26 ± 0.061. The integrated flux in UBV$R_c I_c$ bands provides a meaningful estimate of the bolometric luminosity, which is directly related to the amount of radioactive nickel synthesized and ejected in the explosion. We derive a peak bolometric luminosity of $L = 8.7 \times 10^{42}$ erg sec^{-1} which yields the ejected mass of nickel to be 0.41 $M_\odot$.

Low frequency radio observations of low mass X-ray binary - Sco X-1

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Abstract. We have performed extensive low-frequency radio observations of the low mass X-ray binary, Sco X-1 during different X-ray spectral states using Giant Metrewave Radio Telescope (GMRT) at 1.28 and 0.61 GHz. The low frequency image of Sco X-1 shows a compact structure. The source is highly variable and was always detected during our observations. The radio light curves of our observations indicate slow flux density variations suggesting an emission of a blob of plasma with a life time of few hours.

Orbital evolution and apsidal motion in HMXB pulsars

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Abstract. The orbits of the X-ray binaries evolve due to tidal interaction between the two stars, mass transfer from the normal star to the neutron star and mass loss from the system. Hence the orbital parameters of the binary systems change with time as the orbit evolves. The pulses received from the neutron star allow determination of orbit parameters. We have made new and precise measurements of the orbital parameters of accreting X-ray pulsar systems Cen X-3, SMC X-1 and 4U1538-52 using data obtained with the proportional counter array (PCA) onboard the Rossi X-ray Timing Explorer (RXTE) observatory.The precise timing possible with RXTE allowed us to determine the very small eccentricity of the orbits of CenX-3 and SMC X-1. We have also measured the orbital parameters of another one transient and eccentric Be X-ray pulsar system 4U 0115+63 during an outburst in 1999. 4U 0115+63 is a good candidate for measurement of the rate of apsidal motion which is related to the internal structure of the companion star. We present the preliminary results for 4U 0115+63 and the orbital period evolution of the three other HMXBs.

A novel technique of accurate estimation of pulsar dispersion measures

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Abstract. We describe and present results from a novel experiment for accurate estimation of pulsar dispersion measures (DM) using the Giant Metre-wave Radio Telescope (GMRT). Simultaneous multi-frequency observations with the GMRT are used to obtain DM estimates that have an accuracy of 1 part in 10000 or better, at each epoch. The experiment was carried out for a sample of twelve pulsars, over a period of more than one year, with observations about once every fortnight. These enable us to carry out several interesting studies, both of the interstellar medium (ISM) properties and of the pulsar radio emission mechanism.

Some highlights of the results are as follows. Most of the sample pulsars, show significant temporal DM variations on time scales of weeks to months, which are likely to be due to the fluctuation of the electron density in the ISM. A comparison of the mean DM values from these data show significant deviations from catalog values (as well as from other estimates in literature) for some of the pulsars, with PSR B1642-03 showing the most notable changes. From our analysis results it appears that constancy of pulsar DMs (at the level of 1 in 1000 or better) can not be taken for granted. For PSR B2217+47, we see evidence for a large-scale DM gradient over a one year period, which is modeled as being due to a blob of enhanced electron density sampled by the line of sight. For some pulsars, including pulsars with fairly simple profiles like PSR B1642-03, we find evidence for small changes in DM values for different frequency pairs of measurement, a result that can be used to estimate radio emission heights at different frequencies, in the pulsar magneto-sphere. Another interesting result is that we find significant differences in DM values obtained from average profiles and single pulse data.

To fathom a better understanding of the above results, we have carried out extensive simulations of simultaneous dual-frequency pulsar signals. Results from these studies are also presented.

Detailed study of the emission properties of PSR B0826−34

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Abstract. Study of wide profile drifting pulsars provides us with an opportunity to probe emission properties of radio pulsars in detail. In this context, PSR B0826−34 – in which emission occurs for nearly 350 deg of longitude – is a unique pulsar. This pulsar

exhibits remarkable drifting behaviour including multiple (at least 5) drift bands and sign reversals of drift rate. We have observed this interesting pulsar with the GMRT at 318 MHz, 610 MHz, 1060 MHz and simultaneously at 325 MHz and 610 MHz. Here we present new results from our studies.

An accurate estimate of the dispersion measure (DM) value is not available for this pulsar. From our simultaneous dual frequency observations, we are able to find a precise value of the DM. Analysis of our data at 610 MHz and 1060 MHz shows a very interesting pattern of drifting subpulses. The drift rate shows wide variation including sign reversals. In addition to the 5−6 drifting bands in the main pulse region, reported in earlier studies, we report on the clear evidence for 2−3 drift bands in the inter pulse region. We find that the subpulse separation appears to be dependent on pulse phase, and we report on the trend of this variation. This pulsar is reported to exhibit pulse nulling for 70 per cent of the time. A recent study by Esamdin et al. 2004 claims weak emission during the null state of the pulsar. From our long stretches of data at different frequencies, we have investigated this aspect in detail. We will also present preliminary results from polarization studies of this pulsar.

Determination of orbital parameters of binary pulsars

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Abstract. In this work we present a novel method for determining Keplerian orbital parameters of binary pulsars. This method can be useful for getting an early determination of the orbit which is useful for planning further observations. There are five parameters (apart from the inclination) that define the orbit precisely : orbital period, projection of semi major axis on the sky plane, orbital eccentricity, longitude of the periastron and the epoch of periastron passage. Conventionally, determining these requires a simultaneous fit to many parameters. In our method, we conduct two one-dimensional searches to determine the orbital period and epoch of periastron. The other three orbital parameters follow from the hodographic property that the Keplerian orbit is a circle in velocity space. We have implemented this method to find out the orbital parameters of the first binary pulsar discovered with the GMRT. The results from this work will be presented in this paper.

Self lensing effects for compact stars and their mass-radius relation

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Abstract. During the last couple of years astronomers and astrophysicists have been

debating on the fact whether the so called 'strange stars' - stars made up of strange quark matter, have been discovered with the candidates like SAX J1808.4-3658, 4U 1728-34, RX J1856.5-3754, etc. The main contention has been the estimation of radius of the star for an assumed mass of $\sim$1.4 $M_\odot$ and to see whether the point overlaps with the graphs for the neutron star equation of state or whether it goes to the region of stars made of strange matter equation of state. Using the well established formulae from general relativity for the gravitational redshift and the 'lensing effect' due to bending of photon trajectories, we relate the parameters M and R with the observable parameters, the redshift z and the radiation radius R_∞, thus constraining both M and R for specific ranges, without any other arbitrariness. With the required inputs from observations, one ought to incorporate the effects of self lensing of the compact stars which has been otherwise ignored in all of the estimations done so far. Nonetheless, these effect of self lensing makes a marked difference and constraints on the M-R relation.

Radio afterglow of SGR 1806-20

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Abstract. Soft Gamma Ray Repeaters (SGRs) are high energy transients, and are Galactic sources in nature. They are thought to be originating from the neutron stars with very high magnetic fields (10^{15} Gauss), named magnetars. On 2004 Dec. 27, a giant flare with a fluence of 0.3 erg/cm^2 was detected from SGR 1806-20. Here we report the fading radio afterglow observations of this SGR with GMRT, VLA and ATCA. We started monitoring the SGR from day 6 since explosion to day 80 at frequencies ranging from 0.2 GHz to 100 GHz. Radio emission can be described by two components: a rapidly decaying component and slowly decaying component. We also obtained a very high resolution radio spectrum at 21 cm, which enabled us to restrict the source distance within 6 kpc to 10 kpc, contrary to previously believed distance of 15 kpc. This newly modified distance reduces the total energy released as well as the rate of such events. This also puts a question-mark on the association of the SGR 1806-20 with a star cluster along the same line of sight. Therefore, the claims that magnetars originate from more massive stars than normal neutron stars need to be revised. The energetics and the rapid decay model of the SGR is not compatible with the generally invoked GRB afterglow models. We suggest that the rapidly decaying component arises from the reverse shock and hence it allows us to probe the ejecta.

Pseudo-potential approach for astrophysical fluid dynamics study

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Abstract. In astrophysical problems it is often advantageous to use Pseudo-potentials instead of full General Relativity. A well known example is the so-called Paczyński-Wiita potential in which the gravitational potential of the star of mass M namely, $\left[-\frac{GM}{r}\right]$ is replaced by

$$\Phi_{PW} = -\frac{GM}{r-\frac{2GM}{c^2}}.$$

We propose a potential which adequately describes the space-time around a rotating black-hole. We name it 'Pseudo-Kerr potential'. We present the results of fluid dynamics by first obtaining the sonic point conditions and then obtaining the parameter space in which the transonic solutions are possible. We find the topologies of the flow in the Pseudo-Kerr potential and compare with the general relativistic results. The results obtained from our potential matches with the general relativistic results for the values of the Kerr parameter $-1 < a < 0.8$. Detailed results are presented elsewhere (Chakrabarti, Samanta and Mandal, 2005, Classical and Quantum Gravity, submitted; Mandal, Samanta and Chakrabarti, in preparation; Samanta et al., in preparation).

We generally find that the results agree very well provided an error (typically, less than 3%) is allowed in angular momentum or energy. This is well within the limits of uncertainties in the knowledge of the viscous processes. In future, this approach will be used for performing numerical simuations as well as in studying magnetohydrodynamic flows and the results will be reported elsewhere.

Pseudo-Kerr geometry

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Abstract. Pseudo-potentials are useful in the study of particle and fluid dynamics around neutron stars and black holes. It is common to use a Pseudo-Newtonian scalar potential (Paczyński-Wiita potential) to study around a Schwarzschild black hole. We suggest a suitable scalar (Pseudo-Kerr) potential which is expected to replace a rotating Kerr black hole which can be used as one uses the gravitational potential in a Newtonian space-time. Here we include the coupling between the spin angular momentum of the black hole with the orbital angular momentum of the rotating matter as well and the potential is generalized to handle off-equatorial plane flow dynamics as well.

Our potential not only reproduces the effective potential profile, the radii and the angular momenta of the marginally bound and stable orbits, and the binding energy of the particle at these orbits, it also reproduces behaviour of a test particle in equatorial and off-equatorial planes at least for $-1 \leq a \leq 0.8$. The effect of dragging could be seen very clearly. We believe that further studies of black hole physics with radiative transfer, multi-dimensional numerical hydrodynamics could be done using our technique. Detailed results are given elsewhere (Chakrabarti, Samanta and Mandal, 2005, Classical and Quantum Gravity, submitted; Mandal, Samanta and Chakrabarti, in preparation; Samanta et al., in preparation).

Gravitational wave emission from black holes surrounded by massive disks

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Abstract. Black holes, especially in the core of the proto-galaxies, are often surrounded by massive disks. These disks can distort the metric of the space-time. We consider static, axi-symmetric space times of the hole-disk systems and solve the Einstein equations to obtain metric of the resulting space-time. We show that the black hole horizon is distinctly deformed. We computed the degree of distortion as a function of the mass of the disk and the radius of the disk. The vertical oscillation of the disk causes the hole-disk system to emit gravitational waves. We estimate the power of such a wave. (Chakrabarti, S.K., 1988, J. Astron. Astrophys., 9, 49; Basu, P. and S.K. Chakrabarti, 2005, J. Math. Phys., submitted)

Galactic diffuse VHE gamma-rays flux measurements through IACT: a simulations-based feasibility study

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Abstract. The diffuse high energy gamma-ray background from the Galactic plane, as revealed by the EGRET data at energies above 100 MeV, is attributed to the decay of neutral pions produced in cosmic ray interactions with the interstellar matter. As the galactic cosmic ray spectrum extends to at least 10^{15} eV, the diffuse gamma-ray spectrum is expected to extend to the energy range accessible to imaging atmospheric Cerenkov telescope systems (100 GeV - 10 TeV). There is also going to be an additional component of diffuse gamma-ray flux from the ensemble of unresolved galactic sources and unknown sources like the EGRET unidentified objects. Both the Whipple and the HEGRA IACT's have attempted to measure the diffuse VHE gamma ray flux from the galactic plane at energies above 500 GeV using the conventional IACT technique wherein gamma-ray

initiated events are separated from hadron-initiated events through Cerenkov image and orientation parameter cuts. This technique has limited sensitivity for segregating isotropic (diffuse) gamma rays from the cosmic ray initiated events and needs to be refined if the weak galactic diffuse VHE gamma-ray flux is to be accurately measured. We show from a detailed study, based on simulations of atmospheric Cerenkov events from cosmic ray hadrons and isotropic gamma-rays, that fractal and wavelet parameters can be used to efficiently segregate hadron-initiated events from the events initiated by diffuse gamma-rays. Using test data recorded by the TACTIC IACT at Mt. Abu, we validate the inferences drawn from the simulations and provide a preliminary limit on the Galactic diffuse gamma-ray flux above 1 TeV.

An estimate of the iron group of nuclei in primary cosmic ray flux at energies $\sim 10^{15}$ eV

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Abstract. Information on cosmic ray sources and the processes accelerating them to ultra-high energies can be obtained only indirectly through studies on extensive air showers of energy $> 10^{14}$ eV. The GRAPES experiments, collecting data at the mountain altitude laboratory of TIFR at Ooty, aims to determine the composition of primary cosmic ray flux at energies $\sim 10^{14}$ - 10^{17} eV, using the observations on the muon component with the very large area muon detector. In this paper, we describe the details of the experiment and the analysis method to determine the content of the iron group nuclei in the primary flux around the 'knee' in the energy spectrum of primary cosmic rays.

A search for antiprotons in cosmic ray flux at TeV energies

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Abstract. The earth's magnetic field has been used to observe the shadow of the Moon in the high energy cosmic ray muon flux to search for the antiprotons in the cosmic ray flux at TeV energies, using the precision muon magnetic spectrometer of the L3 experiment at CERN, Geneva. The observation of the shadow of the Moon in the flux of cosmic ray protons at TeV energies has permitted the determination of the angular resolution of the spectrometer to be 0.22 deg. We present here the details of the observations and data analysis for the search for antiprotons in the primary cosmic ray flux at TeV energies and discuss the results obtained to date in relation to the observation at lower energies and theoretical expectations.

TeV energy spectrum of the Crab nebula as measured by the TACTIC γ-ray telescope

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Abstract. The Crab nebula has been observed by the TACTIC γ-ray atmospheric Cerenkov imaging telescope for a period of $\sim$103h during Dec. 03 - Feb. 04 and the results show presence of a strong signal (960 $\pm$87 γ-rays) at a statistical significance of $\sim 11\sigma$. Furthermore, the energy spectrum ($\sim 3.18 \pm 0.41 \times 10^{-11}$ (E/1TeV) $^{-2.65\pm0.11}$ photons $\mathrm{cm^{-2}s^{-1}TeV^{-1}}$) obtained with the TACTIC telescope is in good agreement with the latest measurements by the Whipple and HEGRA groups. Details of the analysis procedure followed for extracting the γ-ray signal using dynamic supercut methodology alongwith relevant Monte-Carlo simulation studies for estimating energy resolution, effective area and γ-ray retention factor will be presented in this paper.

A multi-wavelength investigation of the temperature of the cold neutral ISM

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Abstract. We present the spin temperatures (T_s) of cold neutral ISM for 18 lines of sight derived from HI 21 cm radio observations. We have compared these with the ortho-para temperature (T_{01}) available in the published literature for nearby lines of sight derived from UV observations of H_2 lines. The transverse separation of the lines of sight of corresponding UV and radio observations in the region of interest ranges from 0.4 pc to 20.9 pc. We find the spin temperature and the ortho-para temperature for corresponding lines of sight match for a molecular hydrogen column density $N(H_2)$ greater than 10^{16} cm^{-2} or for $E(B-V)$ greater than 0.1 in most of the cases. Since the errors in ortho-para temperature are not available for low $N(H_2)$ and low $E(B-V)$, with the current measurements it is not possible to make out accurately if the spin temperature and the ortho-para temperature are correlated or not for $N(H_2)$ and $E(B-V)$ less than 10^{16} $\mathrm{cm^{-2}}$ and 0.1 respectively.

Diagnostics of the Milky Way's star formation history

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Abstract. Understanding the star formation history (SFH) of a galaxy constrains models of galaxy formation, allows us to follow the evolution of the stellar and stellar-remnant populations of the galaxy, and to follow that of its chemical structure. In recent years, SFH has been determined observationally on a cosmic scale, and also over scales of individual galaxies. In this work, we attempt to constrain the SFH of our Galaxy. As it is difficult to directly determine the overall SFH of our own Galaxy (since it is not possible to observe the whole Galaxy from our position inside it because of the strong absorption along the Galactic disk), only determinations of SFH in the solar neighbourhood exist, with suggestions for the overall SFH for the Galaxy.

Our diagnostic probe for constraining Milky Way's SFH uses the populations of Low-mass X-ray Binaries (LMXB) and Millisecond Radio Pulsars (MRP) in the Galaxy, the evolutions of which follow that of star formation with an appropriate time-lag, and so serve as good 'fossil records' of SFH. We compute numerically the evolution of the populations of LMXBs and MRPs that a given SFH produces according to the standard scenario for the evolution of individual LMXBs and MRPs from primordial binaries. We compare the calculated ratios of the birthrates of MRPs and LMXBs for various suggested SFHs with the observed value for the Milky Way. We find that the local (solar-neighborhood) SFHs generally do not reproduce the observed values for our Galaxy (namely ~ 8 for rapid systems and ~ 1 for the overall population), while some suggested overall SFHs do. These results are consistent with the observation of large differences between local SFHs in various regions of our similar, neighbouring galaxy M31, and with the relation between these local SFHs and the overall SFH for typical spiral galaxies. To explain the above mentioned observed values, which represent values for the overall Galaxy, we need to have the SFH for the whole Galaxy, determination of which has not yet been possible.

Monte Carlo simulation of molecular hydrogen formation in grain surfaces

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Abstract. The recombination of hydrogen in the interstellar medium, taking place on the surfaces of macroscopic dust grains, is an essential process in the evolution of complex molecules in interstellar clouds. Grains come with various sizes in the interstellar clouds.

They are essential ingredients in converting H to H_2 which is the basic building block for the formation of complex molecules. However the efficiency of such conversion is not known with certainty, partly because the result is sensitive to the grain sizes, and the flux of H in the gas which surrounds the grain. So we must know how the production rate of H_2 varies with the site number of the grains and the accretion rate. We present the results of the Monte-Carlo simulations on the grains to show the site dependency of the exponent α (where, A_H/S^α) is the average diffusion time to combine two H to form one H_2, AH being the experimentally observed diffusion time scale and S being the number of sites in a grain) and from this, the production of H_2. We have incorporated the so-called Langmuir-Hinselwood rejection term which ensures that an H is not accreted on a site where already one H or H_2 is in place. Olivine and amorphous carbon grains are chosen to do these calculations. Temperature of the grains has been chosen to be at 10 K and 20 K respectively for these grains. Our basic result indicates that α is close to unity only for very small accretion rates. For higher rates α gradually goes down to $\alpha \sim 0.5$ (Chakrabarti et al., in preparation).

PAHs incorporating cyclopentadienyl ring and their astrophysical relevance

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Abstract. In the last decade Polycyclic Aromatic Hydrocarbons (PAHs) have emerged as strong candidates to be the carriers of the interstellar infrared emission features. Laboratory and observational studies show that these Aromatic Infrared Bands (AIB) originate from a complex mix of PAHs and their cations. A study of the IR properties of various PAHs may lead to understanding the characteristics of astrophysical sources. The PAH family contributing to the AIBs includes the more common benzenoid members, PAHs incorporating five membered rings and substituted PAHs (Hudgins et al., 2000, J. Physical Chemistry, 104, 3655). Along with astrophysical importance, PAHs also play a major role in terrestrial pollution. Burning of Carbon results in soot formation of which the PAHs are a significant constituent. Terrestrial soot contains significant amounts of Fluoranthene and Benzo-fluoranthenes (PAHs incorporating a cyclopentadienyl group) along with other PAHs. These are air and water pollutants and are known for their carcinogenic activity.

Ab-initio calculations have been performed for Fluoranthene and Benzo-fluoranthenes. IR spectra of Fluoranthene and Benzo-fluoranthenes has been computed using Density Functional Theory approach. The spectra of Fluoranthene and Benzo-fluoranthenes are more or less similar to that of the regular benzenoid PAHs. Major peaks of the spectra includes the C – H stretch mode and the C – H out of plane bend mode. In comparison to the more regular PAHs, stronger features are present in the range 1300 $cm^{-1} - 1500\ cm^{-1}$. This seems to be due to the charge accumulation at the central vertex Carbon in the five

membered ring present in the structure. The increased intensity of C-C stretch modes in comparison to PAHs show better corelation with observations.

Vibrational spectra of PAHs and the astrophysical IR bands

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Abstract. The Aromatic Infrared Bands (AIB) at 3.3, 6.2, 7.7, 8.6, and 11.2 μm are ubiquitous in different astrophysical objects. These IR bands are attributed to the presence of Polycyclic Aromatic Hydrocarbon (PAH) molecules in space. The AIB features seem to be a result of emissions from a family of PAHs consisting of neutrals, cations, anions and hydrogenated/dehydrogenated molecules. Observations show source to source variations in the IR bands related to the type of PAHs present in the surrounding medium (Peeters et al., 2004, Astrophysics of Dust, ASP Conf. Ser., 309, 141). Theoretical IR spectra for catacondensed as well as pericondensed PAHs in both neutral and ionic forms is reported. Spectral variations with shape, size and ionization state of PAHs have been studied to get a better understanding of the interstellar spectra.

Ab-initio study on PAHs is done using Density Functional Theory approach with 4-31G basis expansion. The calculated frequencies and intensities compare well with reported results. The vibrational modes show systematic variations with size in the linear polyacenes. There is drastic change in the intensities of C-H stretch, C-C stretch and C-H in plane bend modes upon ionization. The changes in charge distributions of ions causing these intensity changes have been identified. The C-H stretch intensity depends on the partial charge on peripheral Hydrogen atoms and reduces in cations as Hydrogen atoms become more positive. Compact PAHs and their cations show a better correlation with AIB (Pathak & Rastogi 2005, Chemical Physics, in press).

Near-infrared photometry and radio continuum observations of the massive star-forming region IRAS 21413+5442

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Abstract. Formation of massive stars is still not well understood; main reasons for observational constraints being their large distances and extinction and short time scales of pre-main sequence phase as compared to low mass stars. IRAS 21413+5442 is a massive star forming region with a high velocity outflow seen in CO gas by Shepherd & Churchwell (1996). It is a small core and poses lesser problems in identifying features and studying individual proto-star candidates compared to large and complex regions such as the Orion cloud. We have made near-infrared photometry in J,H,K$'$ bands of this object in a $2' \times 2'$

& $4' \times 4'$ FOV during Oct 2003 and Nov 2004, using the NICMOS Infrared camera at the cassegrain focus of the 1.2 m telescope at Mt Abu. Radio continuum observations in the 1280 MHz band were also made covering a larger region around the object using the GMRT facility at NCRA, near Pune. The aim of the present infrared and radio continuum observations is to investigate the type of massive YSO and its environment. From the position of the sources in the colour-colour diagram and colour-magnitude diagram the central source powering the ultra compact HII region was found to be a late 'O' type star. Using the unreddened H band flux combined with the radio continuum observation and following the method adopted by Comeron & Torra (2001) we obtained a distance of 5.39 kpc, which is in reasonable agreement with 7.7 kpc derived by Shepherd & Churchwell (1996). Due to the wide FOV of GMRT, the radio contour also encompasses another nearby infrared source IRAS 21407+5441. The radio continuum image shows an HII region (assuming all the emission is due to bremmstrahlung) of the size of 1.8 pc (at an assumed distance of 7.7 kpc). This value agrees well with the HII region (Stromgren sphere) size for an early B type or late O type star. Full details of the results on two IRAS sources will be discussed elsewhere.

Infrared study of the southern Galactic star forming region associated with IRAS 14416−5937

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Abstract. The southern Galactic star forming region associated with IRAS 14416-5937 has been mapped simultaneously in two far infrared bands ($\lambda_{\rm eff} \sim 150$ & 210 μm), with $\sim 1'$ angular resolution using the TIFR 1-m balloon borne telescope. This star forming region comprises of two sources designated as A [(α1950) 14:41:35.64, (δ1950) −59:36:33.0)] and B [(α1950) 14:41:19.3, (δ1950) −59 36 21.0)]. A and B are separated with respect to each other by $2.5'$. Spatial distribution of the temperature of cool dust and optical depth at 150 μm, have been obtained taking advantage of the similar beams in the two bands. The cold dust probed using the far infrared wavebands is found to have temperature in the range $20-30$ K. The peak optical depth at 150 μm (τ_{150}) is 0.01 close to source B. The HIRES processed IRAS maps at 12, 25, 60 & 100 μm have been used for comparison. The distribution of warm dust and emission in Unidentified Infrared Bands in the mid infrared, have been studied based on the MSX data at 8, 12, 14 and 21 μm. Radiative transfer modelling has been carried out for sources A and B taking into consideration all available infrared and radio measurements to obtain various physical parameters like nature of the exciting source, geometrical dimensions, dust distribution and composition etc. Sources A & B have luminosities $2.0 \times 10^5 L_\odot$ and $9.5 \times 10^4 L_\odot$, respectively. The optical depth at 100 μm as obtained from radiative transfer modelling is 0.007 and 0.02 for sources A and B, respectively. Using this model, an O5 type of star is found to power source A while an O6 star is the centrally exciting source for region B.

Radio and infrared study of the region associated with the molecular cloud complex NGC 6334

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Abstract. NGC 6334 (Bear Claw Nebula), a large molecular cloud/H II complex in the constellation of Scorpius, has been mapped at 1065 MHz using the Giant Metrewave Radio Telescope, India. The high sensitivity continuum map, which samples the ionised gas around this region, shows a number of sources as well as extended emission. A high resolution radio map (synthesized beam $\sim 13.2'' \times 7.7''$; rms noise in the map is ~ 4 mJy/beam) of NGC 6334 has been made to study the sources in detail. Five H II regions conventionally called A, B, C, D, E and F as well as the supernova remnant in the NGC 6334 complex have been clearly detected. Low resolution map (synthesized beam $\sim 29.8'' \times 17.2''$; rms noise in the map is ~ 7 mJy/beam) of this region shows extended diffuse emission to the north-west and east of NGC 6334 D. The mid infrared images from MSX are used to probe the warm dust emission in the region around NGC 6334. The modelling of emission in Unidentified Infrared Bands (UIBs) in mid infrared shows peak emission of 5.8×10^{-4} $\mathrm{Wm^{-2}sr^{-1}}$ from NGC 6334 C.

Multiwavelength study of massive star forming region IRAS 06055+2039

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Abstract. IRAS 06055+2039/RAFGL 5179 is a massive star forming region in the Gem OB1 association at an estimated distance of 2 kpc with a far infrared luminosity of $\sim 0.8 \times 10^4 \mathrm{L_\odot}$. We have done a multiwavelength study of this complex. We have mapped this source in the near infrared lines of H_2 (1-0)S1 and Brγ using the 2m HCT and 3.8m UKIRT facilities. Optical Hα observations were also carried out with HCT. Radio continuum mapping of the ionized gas associated with this HII region was carried out with the GMRT array. In conjunction with archival data from 2MASS, JCMT and MSX, we have done a detailed study of this region. From 2MASS data we have studied the nature of the NIR cluster harboured in the diffused ionized region. The K-band luminosity function derived gives a power-law slope of ~ 0.4 which is consistent with values derived for young clusters. The narrow band H_2 (1-0)S1 images show the presence of H_2 knots which lie on a line on either side of the central ionizing bright source. The images also show the presence of an H_2 arc which envelopes the radio emitting region in 1280 and 610 MHz. Brγ emission is also seen to correlate well with the radio maps.

Suggestions for an interstellar C_7H_2 search

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Abstract. Laboratory detection of the ring-chain molecule c-C_7H_2 has been reported by McCarthy et al. (1997). Two ring-chain molecules c-C_3H_2 and c-C_5H_2 of this series have already been detected in the cosmic objects. We suggest that the c-C_7H_2 may be identified in cool cosmic objects through its transitions 4_{14} - 5_{05}, 5_{15} - 6_{06}, 6_{16} - 7_{07} and 7_{17} - 8_{08} at 23.241 GHz, 21.105 GHz, 18.953 GHz and 16.787 GHz, respectively, in absorption against the CMB. Since, in the absence of the availability of collisional rates, we have used scaled values for them, we have checked the sensitivity of the results on the collisional rates, by enhancing the rates for the transitions with delta $k_a = 0$ by a factor of 10. Though the transitions are not found sensitive to the collisional rates, our results still may be treated as qualitative in nature. These absorption lines may play an important role for identification of c-C_7H_2 in cool cosmic objects.

Production of nitric oxide (NO) in hot molecular core SgrB2(M)

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Abstract. We theoretically compute the column number density of nitric oxide (NO) observed in hot molecular core SgrB2 (M) from the chemical reaction scheme involving ion-neutral and radical-radical reactions which need no activation energy. The destruction of ammonia (NH_3) by the cosmic ray generated H_e^+ and H_3^+ reactive ions produce NH_3^+ and NH_4^+ ions. Nitrogen hydrides are produced from the dissociative electron recombination of these ions. Quantitative analysis shows that the ratio of the number density of NH and NH_2 viz., n (NH)/n (NH_2) =0.05. This ratio yields the column number density of NO as 1.8×10^{16} cm^{-2} using O/NO/NH_3 in HMCs, which is close to the observed value of 1.5×10^{16} cm^{-2} in hot molecular core SgrB2 (M).

Anomalous absorption in formaldehyde in cosmic objects

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Abstract. Formaldehyde (H_2CO) is the first interstellar molecule observed in anomalous absorption through its transition 1_{10} – 1_{11} at 4.830 GHz (Palmer et al., 1969, ApJ, 156, L147). We have investigated the transfer of radiation in H_2CO where a set of 22 energy levels connected by 44 radiative transitions is considered. The set of 22 statistical equilibrium equations coupled with the equations of radiative transfer is solved through

the iterative process. The transitions $1_{10} - 1_{11}$ 4.830 GHz and $2_{11} - 2_{12}$ at 14.488 GHz are found to show in absorption against Cosmic Microwave Background (CMB).

Extra-galactic astronomy and cosmology

Gravitational collapse in an expanding background and the effect of small scale perturbations on large scales

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Abstract. We study the effect of perturbations at small scales on collapse of perturbations at large scales in gravitational clustering in an expanding universe. Earlier studies have shown that this effect is small in most cases. Our aim is to quantify this effect and to develop an understanding of cases where the effect is not small. We find that adding fluctuations at small scales affects collapse of perturbations at large scales only if a k^4 tail from small scales adds significantly to the power spectrum at large scales.

Reionization of the Universe

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Abstract. Wilkinson Microwave Anisotropy Probe observation of Cosmic Microwave Background Radiation shows that the redshift of reionization of Intergalactic Medium is 20 ± 9. On the other hand the spectra of high redshift objects like quasars show the presence of significant amount of neutral hydrogen even at $z \simeq 6$. We construct semi-analytic models of structure formation to study the various issues related to cosmological reionization. In our simple model, we have used the Press-Schechter formalism to get the structure formation history. In this poster we will present the results obtained for standard cosmological model of the universe. We will also show the dependence of redshift of reionization on various parameters viz (i) rate of UV photon production per baryon (depends on initial mass function and star formation rate), (ii) lower limit of virial temperature of the halos which can host star formation and (iii) clumpiness of IGM. Finally we consider the effects of cosmic rays on the thermal evolution of the IGM.

Probing the radio source environments using absorption lines

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Abstract. We present the results of a 21cm absorption search towards a sample of radio sources using the Giant Metrewave Radio Telescope and the Arecibo telescope. Our sample includes GPS sources (size less than ∼1 kpc), CSS sources (size ∼1-20 kpc) as well as the larger FRII and FRI sources including one giant radio source (size > 1 Mpc). These observations allow us to probe the environments of these sources on a variety of scales. We also make use of archival data at other wavebands to further constrain the physical conditions and distribution of the circumnuclear gas. We report 2 new detections (3C48 and 3C258), both of which are CSS objects, confirm 5 previous detections and present the upper limits with a mean 21cm optical depth of 0.005 for the remaining 25 objects.

Combining our results with other published 21cm absorption searches towards radio sources, we compare the occurrence of neutral gas absorption in GPS, CSS and larger objects. Our results are consistent with the results of Pihlstroem et al. 2003, A&A, 404, 871, suggesting an anti-correlation between the HI column density and source size. To a first order, higher incidence of 21cm absorption in more compact CSS/GPS sources is consistent with the high-density environment suggested by the structural and polarization asymmetries observed in these sources. The absorbing gas, indeed, exhibits a variety of line profiles, suggesting complex gas motions. For example, in our Arecibo spectrum of 3C258, the 21cm-absorption profile can be resolved into as many as six components, each having a width of 10 $\mathrm{km\,s^{-1}}$. The line-widths, however, are often broader and can extend upto several 100 $\mathrm{km\,s^{-1}}$. We discuss possible implications of these results.

The Eridanus group of galaxies : key results

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Abstract. The Eridanus group is a loose group of more than 200 galaxies at a distance of 23 Mpc. The Eridanus group was identified as a moderate size cluster as a part of a filamentary structure in the southern hemisphere. The Eridanus galaxies are concentrated in the velocity range $cz = 1000 - 2500$ km $\mathrm{s^{-1}}$. The entire group appears to be made of different sub-groups. The overall population mix in the Eridanus group is 30% (E+S0) and 70% (Sp+Irr). However, one of the sub-group, viz., NGC 1407 has a population

mix of 70% (E+S0) and 30% (Sp+Irr), which is commonly observed in the cores of clusters. It appears that the different sub-groups are in different stages of evolution, and the entire group is in an early phase of cluster formation. The HI 21 cm-line observations were carried out using the GMRT. The group was also covered in the HI Parkes All Sky Survey (HIPASS) programme using the 100-m Parkes dish. Further, some follow-up observations were carried out with the Very Large Array (VLA). The results based on the GMRT observations, VLA observations, and the HIPASS data are presented. The main results are the following: 1. The Eridanus galaxies are HI deficient up to a factor of $2-3$ compared to their counterparts in the isolated environment. The deficiency is found in all galaxy types. These are new and unexpected results for a loose group of galaxies. It is suggested that the deficiency is due to tidal interactions. 2. In some cases, long HI tidal tails and tidal debris are detected, supporting the tidal interaction scenario. 3. The Eridanus galaxies show larger scatter in the Tully-Fisher relations compared to those in the other nearby groups and clusters. The implication is that the galaxies in the Eridanus group are more dispersed in space. 4. The Eridanus galaxies follow the well-known radio-FIR correlation. The group lacks powerful radio galaxies commonly seen in clusters. However, some new low luminosity AGNs are identified in the group. 5. The star formation rates in the Eridanus galaxies are less than 1 $M_{\odot}$ yr^{-1}.

Evidence for relativistic outflow of ionized material from the nuclei of active galaxies

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Abstract. Ionized warm absorbers along the line of sight with column height up to 10^{23} cm^{-2}, are ubiquitous among type 1 Seyfert galaxies. The exact origin, location and dynamics of the warm gas responsible for high obscuration and the physical connection between X-ray and UV absorbing materials are still uncertain. Some of the diverse explanations offered in the literature include evaporation of inner torus obscuring the nucleus (Krolik & Kriss 1995), evaporation of bloated star in the BLR gas (Netzer 1996) and a wind driven of the accretion disk (Murray & Chiang 1995). Recent XMM-Newton observations of bright quasars have revealed strong evidence for intense outflows at mass rates comparable to the Eddington rate. The X-ray spectra show blue-shifted absorption lines, indicating that the outflow has high velocity (v $\sim$ 0.1 c). The X-ray absorbing columns are very large (Pounds et al. 2003), suggesting that they may be Compton thick at small radii. In one of the observations Dasgupta et al. (2005) found that the line strengths are varying in 1.5 hours. This timescale of variation suggests that the absorption feature originates from a warm absorbing material located within 100 Schwarzschild radius from the central source. A detailed analysis to investigate the variability of line strength in all three sources where such high velocities are discovered is presented here. Possible mechanisms required which can accelerate material to relativistically high velocity will also be discussed briefly.

Outflows from three active galaxies: NGC1482, NGC4438 and NGC6764

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Abstract. We present the results of a radio wavelength study of three active galaxies, namely NGC1482, which has a pure starburst superwind, NGC4438, a Seyfert galaxy and NGC6764, which has a starburst and a mild AGN. We have used both the GMRT and the VLA for radio continuum studies ranging from 15 GHz down to 325 MHz, as well as HI imaging studies. Different components of the ISM as well as relativistic particles generated in the nuclear region may be driven out of the galaxy by a starburst superwind and/or an AGN. In addition, ram pressure stripping could also enrich the IGM/ICM with interstellar material.

The radio continuum emission in NGC1482, which is prominent at the base of the bi-conical structure of outflowing gas seen in Hα and X-ray emission, is associated with the starburst which drives the outflow. Unlike NGC1482, both NGC4438 and NGC6764 exhibit extended radio emission on opposite sides of the nuclear region of the galaxy. Both the galaxies have features at other wavebands which are coincident with radio emission and are also possibly driven outwards by the nuclear activity.

In NGC1482 and NGC6764 the HI absorption spectra show signatures of the kinematics of the rotating gas being affected by the galactic outflow/superwind. In the case of NGC4438, there is 2×10^8 $M_\odot$ linear structure in HI emission, roughly parallel to the disk and located about 5 kpc from it, along with more diffuse emission to the south. This extraplanar HI emission is on the same western side as the diffuse extended emission seen at other wavebands. This feature could be due to a combination of ram pressure stripping, tidal interactions and outflowing gas from the central source.

Monitoring of the blazars from Mt Abu IR observatory

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Abstract. We have been monitoring some of the blazar sources, including 3C66A, PKS 0716+714, Mrk 421, Mrk 501 etc from Mt Abu Infrared Observatory, using optical photopolarimeter, CCD and NICMOS-3 IR array mounted at the Cassegrain focus of the 1.2 m telescope. These objects show intense variability in flux at various time scales in almost all spectral windows. The objective behind the monitoring of these sources in available windows is to detect the possible variations in flux and polarization in these sources. The variability study is aimed to understand the physical processes responsible for the

huge energy generation by the central engine. It will help to understand these enigmatic sources. Some of the results from this monitoring programme will be presented.

The nature of the peculiar QSO SDSS J153259.96–003944

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Abstract. Recent large scale optical surveys such as the Sloan Digital Sky Survey and the Two-degree Field QSO Redshift Survey have revealed a new population of quasars with featureless optical spectrum but with properties very different from the well known radio or X-ray selected BL Lac objects. Optical R and I band observations of one such high redshift ($z = 4.62$) peculiar QSO SDSS J153259.96−003944.1 was carried out using the 104 cm telescope of ARIES, Nainital. The object was found to vary with a maximum amplitude of variability ($\sim$ 0.4 mag) during a year and three months of monitoring. Combined with two other epochs of photometry available in literature the quasar has gradually faded by 0.8 mag during the period June 1998 − April 2001. This modest flux variability nature is similar to the long term variability shown by other classes of quasars as well as blazars with low optical polarization. However, this object does not fall in the region occupied by known BL Lac candidates in their X-ray-optical-radio colour-colour ($\alpha_{ro} - \alpha_{ox}$) diagram and hence is not a BL Lac. *It is uncertain whether this object belongs to the hitherto unrecognized population of lineless radio-quiet quasar dominated by optical continuum emission from an accretion disk, or a radio-quiet BL Lac with optical non-thermal emission from a relativistic jet.* The observed gradual fading of the source could well be explained as due to gravitational microlensing of the source by a solar mass lens situated midway between the source and the observer and moving at 200 $\mathrm{km\,s^{-1}}$. The derived radius of the broad-line region (BLR) of $\sim$ 1.3 pc is typical to those observed in quasars. However, comparison of photoionization model predictions of $Ly\alpha$ emission line flux to the observations shows the BLR to contain about 2 $M_\odot$ of gas which is negligible compared to the BLR mass of $10^3 - 10^4 M_\odot$ found in luminous quasars. Such a less massive BLR may possibly be either due to the intrinsically low accretion rate of the quasar or to a relatively low supply of gas to the BLR.

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

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Abstract. We present results of multiband (B, V, R and I) optical photometric monitoring of two well known blazars S5 0716+714 and BL Lacertae carried out during April/May 1996 and during 2000−01 using the 104 cm telescope of ARIES, Nainital, with an aim of studying optical variations occuring on intra-night timescales ranging from minutes to hours as well as longer timescales. Night to night intensity variations of ≥ 0.10 mag were observed in S5 0716+714 during a campaign of about 2 weeks in 1996. A good correlation between the lightcurves in different passbands was noticed (as also for the observed intra-night variations). Two prominent events (one of fading and the other of brightening) of intra-night variability were detected in S5 0716+714. Each of these flaring segments of the lightcurves are well fitted with an exponential intensity profile whose rate of variation is essentially the same in both V and R bands. From long term monitoring of S5 0716+714 a distinct flare was found around JD 2451875 and identified in B,V,R and I bands. Quasi-simultaneous multiband observations of BL Lacertae show that the flux variations were not achromatic, with the amplitude of variations systematically larger towards shorter wavelengths. The source was found to become bluer when brighter. Over the course of five nights of observations, BL Lacertae was found to vary by ~ 0.6 B mag.

Dust properties of NGC 3801

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Abstract. We present a detailed surface photometric analysis of the galaxy NGC 3801 based on multiband (BVRI) CCD imaging observed from Himalayan Chandra Telescope at Hanle. Extinction maps were obtained by dividing dust free model galaxy image from the image of galaxy. Extinction maps show extended and complicated dust distribution in all observed bands. We investigate the wavelength dependence of the dust extinction to derive the extinction curve, and compare with that of the Milky Way. Rv value for NGC 3801 turns out to be 3.8 ± 1.0 which is higher than the canonical value of 3.1 for our Galaxy. Also, the extinction curve is parallel but shifted upward as compared to

the extinction curve of Milky Way. This gives the estimate of the relative grain size of the dust particle $\langle a \rangle / \langle a_{\rm gal} \rangle$ to be 1.47 ± 0.05 following Goudfrooij (1994), Sahu et al. (1998). We calculate dust mass (following Sahu et al. 1996; Dewangan et al. 1999) to be $2.63 \times 10^6 M_\odot$ from the total optical extinction which is of the same order of the mass $2.46 \times 10^6 M_\odot$ calculated from B-V colour excess. But the mass $1.78 \times 10^8 M_\odot$ obtained from flux observed by IRAS in FIR region is higher by two orders of magnitude. This reveals that the major amount of dust in NGC 3801 is, perhaps, in the diffuse form which remains undetected in optical extinction maps and colour maps. We estimate dust temperature to be 16 ± 1 K. We also determine the star formation rate within NGC 3801 as to be $1.7 M_\odot$ yr^{-1} following Kennicutt (1998) and $3.7 M_\odot$ yr^{-1} following Thronson (1986).

A steradian of the southern sky from the Mauritius Radio Telescope

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Abstract. Mauritius Radio Telescope (MRT) is a Fourier synthesis non-coplanar ⊤-shaped array with an East-West arm of length 2048 m having 1024 fixed helices, and a South arm of length 880 m consisting of a rail line on which 16 movable trolleys each with four helical antennas are placed. We present deconvolved images covering one steradian of the southern sky, a part of the survey at 151.5 MHz carried out using the MRT. The images have a resolution of $4' \times 4'$ and span right ascension range 18 to 24 hrs and a declination range of -70° to -10°. The rms noise measured in the images is ≈ 110 mJy beam^{-1}. A source catalogue of ≈ 3000 radio sources derived from the images and a comparative study of MRT images with the other southern sky surveys is discussed. MRT with availability of short spatial frequencies and nearly complete *uv* coverage is sensitive to extended features in the sky. In this context we also present preliminary analysis related to detection of supernova remnants (SNRs) in the images.

A few challenging and interesting aspects of data processing would be also discussed. This includes the new technique developed for automatic evaluation of data quality which was essential to classify the ≈20,000 hours of astronomical observations for the survey. We highlight the techniques developed for automatic radio frequency interference (RFI) detection and mitigation. We also discuss the algorithm developed for deconvolving wide field dirty images obtained from a non-coplanar array like MRT.

VHE observations of H1426+428 using TACTIC imaging telescope: 2004 observations

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Abstract. The BL Lac object H1426+428 has a synchrotron peak lying near 100 keV and hence an extreme synchrotron blazar and a potential source for TeV γ-rays. Detections in the VHE energy regime, from this object have been reported by the Whipple , HEGRA and CAT collaborations in 2002. This BL Lac object with a redshift $z = 0.129$, now stands as a confirmed source of TeV γ-rays. Being a distant extragalactic source (large redshift), its study at TeV energies has important implications for estimating the extragalactic infra-red background radiation. We have also observed this source during the period Mar.-Apr. 2004, using TACTIC imaging element in on/off mode and 76 hours of clean data were recorded during the period. Preliminary results of data analysis on the source will be presented in the meeting.

Study of TeV photons from Mrk 421 with the TACTIC gamma-ray telescope: 2004 observations

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Abstract. The BL Lac object Mrk 421 (Markarian 421) is a confirmed TeV source at redshift of 0.031. Along with the other TeV blazars like Markarian 501, it has also been the focus of extensive study in the very high energy (VHE) gamma-ray and X-ray regions of the electromagnetic spectrum. Mrk 421 observations have shown it to be a emitter of VHE photons with variability in different timescales. In addition, results of the multi-wavelength campaign by various groups, have indicated that there may be a correlation between the gamma-ray and X-ray fluxes from the Mrk 421. Results from the VHE observations may give us clues about the production mechanism of TeV photons. The source light curve structures associated with the flaring activity are complex and more observations are required before the final picture about the TeV models of the BL Lac objects can be formulated. With this aim, we have observed the object for about 80 hours in the on- source mode using the imaging element of the TACTIC telescope at Mt. Abu Rajasthan, during January - April 2004. The preliminary results of these TeV observations are presented.

Recent TeV observations of 1ES2344+514 with the TACTIC telescope

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Abstract. 1ES2344+514 is one of the first BL Lac type objects to be reported as an extreme synchrotron blazar with synchrotron peak energy reaching up to 100 keV. This blazar is a relatively nearby object with z = 0.04 and was discovered as a source of very high energy (VHE) γ-rays by Whipple group in 1995 (Catanese et al., 1998, ApJ, 501, 616) and later on observed by HEGRA group in 1997/ 98 and 2002 (Aharonian et al., 2004, A&A, 421, 529). We have also observed this source during the period Oct−Dec 2004, using the imaging element of TACTIC telescope array and have collected data for about 47 hours in on/off mode of observations. Here we will discuss the preliminary results of the data analysis for the source. Along with this we will compare source activity in 1.5 to 12 keV energy range with All Sky Monitor (RXTE) data during the period of our observations.

Photometric study of Type Ia Supernova SN 2002hu

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Abstract. We present optical photometric study of Type Ia supernova SN 2002hu in UBVRI bands, obtained from the 2m Himalayan Chandra Telscope (HCT) at the Indian Astronomical Observatory, Hanle, India. This supernova was discovered by Boles (IAUC 8012) in the outskirts of a distant spiral galaxy MCG+6-6-12, at a redshift of 0.03. Based on the spectra taken by Macri (IAUC 8013) on November 08, 2002, it is classified as a supernova of Type Ia. We present the results of photometric monitoring of this supernova. The observation spans a time interval of ∼3 days before maximum to ∼75 days after maximum in B. The maximum in B occured at JD 2452591.78 with apparent B magnitude 16.83. From the light curve it appears that SN 2002hu is a slow declining Type Ia supernova. An estimate of reddening, absolute magnitude, bolometric luminosity and ejected Ni mass is presented.

On which scales jets are bent to Z-shapes?

Christian Zier
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Abstract. Some X-shaped radio galaxies (XRG) show Z-symmetric morphologies. In the merger scenario this has been explained to be possibly due to the ram-pressure of the gas the smaller galaxy releases to the ISM of the larger active galaxy during the merging process. Here we show that deprojection of the jets and the expected limits of the angles between them suggest that the bending of jet by the streaming gas occurs on distances between 50 and 100 kpc to the centre of the primary galaxy. We further try to confirm this finding by roughly estimating the properties of the rotational velocity field at these distances generated by the merger of the galaxies.

Intrinsic shapes of elliptical galaxies

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Abstract. We have investigated the intrinsic shapes of elliptical galaxies NGC 3379 and NGC 4589. The intrinsic shapes of these galaxies have been determined by Statler (1944a,b) by using the kinematical data along with the photometric data. He considers triaxial mass models with constant axial ratios, which do not reproduce any ellipticity variation or position angle twist. His shape estimates represent an overall shape of the galaxy. We use an ensemble of models which reproduce ellipticity variations and isophote twists and use the profile of the photometric data to study the variation in the intrinsic shapes of the galaxies. We find that both these galaxies are rounder inside and flatter outside with almost constant values of the triaxiality. Statistically significant estimates of the variation of the shapes are presented.

On the perturbation of a self-gravitating gaseous disk

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Abstract. We discuss the stability of a thin, self-gravitating, gaseous disk flattened (in a plane) around the nucleus of a galaxy. The instability criterion derived by Tassoul for a gas disk around galactic nuclei demands that it would be sensitive to star formation provided surface mass-density is larger than a critical value. We derive the expression for wavelength is larger than the radius for a typical Jeans disk. Using simple analysis, we show that a uniformly rotating, collisionless disk with finite temperature will be unstable via gravitational radial pertubations practically for all wavelengths.

Kinematic evidence of counterrotation in the central region of the Large Magellanic Cloud

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Abstract. Radial velocity of more than 1500 stars in the central region of the Large Magellanic Cloud (LMC) is used to estimate the radial velocity curve along the line of nodes, in the central region. The central part of the radial velocity curve shows a V-shaped profile, instead of a straight line profile. The radial velocity curve estimated using H I velocities also shows an s-shaped deviation near the centre within the linear profile. The slope of the inner velocity profile shows change of value as well as sign, indicative of counterrotation. Thus the evidence of the presence of a kinematically distinct inner component with counterrotation in the inner LMC is presented. To explain the observed velocity profile, we propose the existence of two disks in the inner LMC with different line of nodes. The disk 1 is modeled with the kinematics of stars and the disk 2, which has a limited extend, with those of gas. The averaged velocity of the two disks is found to match the observed velocity profile very well. Most of the observed kinematic features in the LMC are explained by this model.

The dynamics of ejecting stellar systems

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Abstract. We consider a stellar system ejected from the centre of another stellar system. Energy changes in ejection are calculated analytically using Plummer models for galaxies and impulse approximation. We also derive the differential energy changes and mass escape from the systems. We compare these with the results earlier obtained for colliding systems. It is found that the disruptive effects are considerably less in the case of ejection. If the ejected system is compact, it escapes with negligible disruptive effects.

In the case of ejection, stars are also accelerated in the direction of motion. In terms of the parameter λ defined as $\frac{\Delta V_{\parallel}^2}{\Delta V_{\perp}^2}$ (where $\Delta\, V_{\parallel}$ and $\Delta\, V_{\perp}$ are velocity changes of a star in the direction of motion of the galaxies and perpendicular to it) there is significant difference between ejections and collisions. In fast head-on-collisions of spherical galaxies the galaxies become elongated in the direction perpendicular to the line of motion, whereas in the case of ejections they also become elongated in the direction of motion. These effects are more pronounced in the outer regions of the smaller system and the inner regions of the bigger system. These effects are enhanced if the ejected system is compact.

Recent observations of GRB afterglows from ARIES, Nainital

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Abstract. Optical photometric observations of GRB afterglows are being carried out from ARIES, NainiTal using a 2048 × 2048 pixel^2 CCD camera covering a field of 13 × 13 arcminute^2 mounted at the f/13 Cassegrain focus of the 104-cm Sampurnanand Telescope (Sagar 2000). We present here some of the recent results of GRB optical follow-up observations in R_c band from the period of October to December 2004. Error boxes of GRB 041006, GRB 041015, GRB 041218 and GRB 041219 were followed up, out of which optical afterglow of GRB 041006 was detected and upper limits obtained in three other cases. Data reductions were carried out using $IRAF$, $MIDAS$ and $DAOPHOT$ softwares. GRB 041006 was an X-ray rich GRB localized by $HETE$ (redshift $z = 0.716$) with a fluence of 7×10^{-6} erg cm^{-2}. X-ray and optical afterglows were detected for this GRB but no radio afterglow. The broken power-law fit to the R_c band light curve of GRB 041006 afterglow gives early flux decay index $\alpha_1 = -0.54 \pm 0.06$, late time flux decay index $\alpha_2 = -1.30 \pm 0.03$ with a jet break time of 0.21 ± 0.05 day, $\chi^2/\mathrm{DOF} = 1.23$. Optical to X-ray Spectral Energy Distribution (SED) is governed by single power-law with spectral index $\beta = -0.62 \pm 0.06$, $\chi^2/\mathrm{DOF} = 3.11$. Observed values of flux and spectral decay indices can be well explained in terms of jetted outflow with hard electron energy distribution (power-law index $p < 2.0$) with cooling break ν_c lying below optical frequencies. GRB 041006 shows flat electron energy index, $p \sim 1.35$, similar to that observed in GRB 991216 and GRB 010222.

The implications of the upper limits are discussed for three other bursts, GRB 041015, GRB 041218 and GRB 041219. GRB 041015 was localized by $INTEGRAL$ and there was no optical transient (OT) detected for this GRB. We put an upper limit of ∼ 20 mag (2× 900sec exp) in R band for GRB 041015. GRB 041218 was localized by $INTEGRAL$ and OT was detected at R ∼ 16.5 mag on Dec 18.665 UT, but we observed upper limit of R ∼ 21 mag (5 × 300sec exp), 23.88 hours after the burst. GRB 041219 was also localized by $INTEGRAL$ and later by $SWIFT$. For this OT and radio afterglow was detected, but we observed upper limit of R ∼ 21 mag (900sec exposure).

Contribution from normal galaxies to the extragalactic γ-ray background

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Abstract. The extragalactic diffuse emission at $\gamma-$ray energies has interesting cosmological implications since the bulk of the photons suffer little or no attenuation during their propagation from the sight of origin. The emission could originate from either truly

diffuse processes or unresolved point sources such as AGNs, normal galaxies, starburst galaxies, etc. We focus on the contribution from normal galaxies. The emission from normal galaxies is basically made up of two components, a truly diffuse emission coming from cosmic-ray interaction with interstellar matter and radiation, and discrete point sources ($\sim$10%, for our Galaxy).

We assume a simple linear relationship between the total galactic infrared luminosity and γ-ray luminosity. Since the cosmic ray spectrum drives the energetics of the diffuse γ-ray emission, and the cosmic ray density is related to SN rates and hence star formation rates, it is reasonable to assume a linear relationship between IR luminosity and diffuse γ-ray luminosity in normal galaxies. The EGRET experiment on CGRO, has detected only two normal galaxies (our Galaxy & LMC) and only an upper limit from M31 at γ-ray energies. A linear relationship between infrared and γ-ray luminosity has been derived on the basis of these galaxies. The infrared integrated luminosity density has been taken from Isobe & Feigelson (1992). Here, pure luminosity evolution has been assumed. It is found that the contribution from normal galaxies to the extragalactic γ-ray background flux is $\simeq$ 1-3% of the total background flux ($>$ 100 MeV, considering infrared luminosity at 60μ scales with γ-ray luminosity at 100 MeV). So the contribution from the normal galaxies to the γ-ray background, though small, cannot be neglected. The future upcoming mission like AGILE & GLAST will be able to detect more normal galaxies and hence, a more precise value of the contribution from normal galaxies to the extragalactic gamma-ray background can be derived.

Instrumentation

Threshold energy estimates of the proposed MACE gamma-ray telescope at Hanle

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Abstract. The recent success, of the atmospheric Cerenkov imaging technique, in detection of about 15 γ-ray sources above 300 GeV, has prompted several groups to construct more sensitive ground-based telescopes to explore the 10's of GeV energy range. Although the efforts have been mainly concentrated on setting up multiple 10 m class light collectors using stereoscopic detection principle, using a single light collector of diameter $\sim$ 20 m, at an altitude of $\geq$ 4 km is also an attractive option to achieve the lowest possible threshold. In this present study we report the feasibilty of the latter option, by considering a 21 m diameter light collector for the MACE (Major Atmospheric Cerenkov Experiment) imaging telescope, proposed to be installed in the campus of Indian Astonomical Observatory at Hanle (32° 46′ N, 78° 57′ E, 598 g/cm^2). The imaging camera of the telescope will have a high resolution of 0.1° for the central region of 2.4° × 2.4°, which will be surrounded by a guard ring of 0.8° having a resolution of 0.2°. The results of the Monte Carlo simulations carried out with CORSIKA, suggest that by using the

nearest neighbour quadruplet trigger, γ-ray threshold of $\sim$ 15 GeV should be achievable by the MACE telescope.

Angular resolution of the GRAPES-3 array for UHE gamma-ray astronomy

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Abstract. Observations on cosmic sources of ultra high energy (UHE) gamma rays provide information on the origin of cosmic rays and their acceleration mechanisms. In order to detect a UHE gamma ray source with its extremely low flux against a large isotropic cosmic ray background, an Extensive Air Shower (EAS) array with very large collection area and high angular resolution is necessary. The GRAPES-3 EAS array operating at Ooty covering an area of $\sim$18000 m^2 with $\sim$300 fast scintillation detectors is being used for studies on UHE gamma-ray sources. We describe the method of reconstruction of the arrival angle (RA,DEC) of showers and determination of the angular resolution of the GRAPES array.

Methods to study the darkcount rate and spatial resolution of the ICCD

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Abstract. Image intensification systems have been used for photon counting applications in ground and space based astronomy for many years. Usually photon counting image intensified charge coupled devices (ICCD) are used for low light level imaging, especially for ultraviolet imaging. For all ICCDs the micro channel plate (MCP) image intensifier constitute's the input device with a photo cathode in the front surface. The photon hits the photocathode and ejects an electron, which is amplified by microchannel plates producing a charge cloud of electron on the output of the MCP. The resultant burst of electrons strikes a green phosphor screen gives a luminous spot of the event and a CCD camera detects these events via a reducing fiber optic taper. A single CCD frame will contain a number of spots, which then must be centroided to return the position of each incident photon. The dark counts and spatial resolution are two important characteristics of an intensified CCD camera. The dark counts are the photons recorded by the detector without source and it indicates the noise level of an image intensifier when operated in photon counting mode. The spatial resolution shows the ability to delineate image detail.

The detector we used to study the characteristics is the one from Photek. The detector consists of an image intensifier MCP225 model from Photek. It is a double stage 25 mm

diameter intensifier with a fused silica input window and P43 output phosphor screen. The active area of the intensifier is 25 mm × 15 mm and the gain of the intensifier is >106. The fiber optic taper used is a 24:11 reducer. The CCD sensor used here is Sony ICX083AL 2/3 with pixel size 11.2 μm × 11.6 μm and 768 × 576 pixel format, which effectively covers the MCP. For measuring the resolution we used the USAF 1951 test target. We report here the results of a study the variation of dark count rate and spatial resolution of the ICCD. The dark count rate that we obtained is 0.0362 photons/sec/mm^2. The spatial resolution measured in horizontal and vertical direction was 70.4μm and 79.3μm respectively. Also the spatial variation of dark photons and variation from frame to frame with time is studied and we found that dark count rate was stable with time.

Study of modulation and demodulation schemes for a two beam polarimeter

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Abstract. A theoretical study of different modulation and demodulation schemes for a two beam Stokes polarimeter were undertaken. A Mueller matrix formulation is used in these studies. We also performed few experiments in order to compare and verify the theoretical understandings. We discuss those results including the wavelength dependencies of the modulation/demodulation scheme. These studies will be used in developing the modulation/demodulation scheme of the two beam polarimeter for Kodaikanal Tower Telescope. The wavelength dependence study will be used to understand the performance of the instrument for magnetic field measurements using Zeeman as well as Hanle effect.

A two-beam spectropolarimeter for Kodaikanal Tower Telescope

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Abstract. We present here the construction and performance of a two-beam spectropolarimeter for observing the strong fields of solar active regions. It provides an improved polarimetric accuracy over the previously used single-beam spectropolarimeter (SBS) at Kodaikanal Tower Telescope. This system allows us to record simultaneously the two orthogonal states of polarization which provides an overall polarization accuracy of an order of magnitude more than the SBS. This method reduces seeing induced spurious polarization considerably. Scanning of an active region at a faster rate is possible as only three exposures are required for one set of observations. Method of observations, data reduction, corrections for cross talks and instrumental polarization are discussed. Further

we present the full Stokes profiles of the Zeeman sensitive Fe I line pair around 6302 Å for an active region.

A non planar trapezoidal structure for broad band applications in radio astronomy

A. Raghunathan and N. Udaya Shankar
Raman Research Institute, Bangalore

Abstract. A broad band feed is an essential component of modern radio astronomy installations providing multiwavelength observations. We describe the design and development of a non planar trapezoidal structure belonging to the class of frequency independent antennas. We are investigating its application as a broad band prime focus feed having a less forward spillover and reasonably symmetric E and H plane patterns in the frequency range of 0.5 to 5.0 GHz. We present the design aspects of the feed being developed and the initial results obtained.

Modal analysis and surface metrology of the RRI 12m preloaded parabolic dish

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Abstract. Conventional antennas all over the world have massive back-up structures since they have to withstand very high wind loads and thermal loads for useful operation. A 12m radio telescope adapting an innovative design based on the preloading concept has been fabricated at the Raman Research Institute. The salient features of this dish are (i) it has got a low mass backup structure and (ii) it can be easily assembled and maintained.

The poster presented describes the modal analysis and the surface metrology conducted on the dish. The modal analysis is a method to determine the structure's dynamic characteristics like resonant frequencies, damping value and their corresponding pattern of the structural deformation (Mode shapes). These are experimentally determined with the help of impact hammer and modal shaker. The experimentally determined value of resonant frequency is 2.15 Hz as against the analytically estimated value of 2.05 Hz using the NASTRAN FEM software. The rms surface inaccuracy is measured to be 2.3 mm. If l/16 is taken as the upper limit for the surface inaccuracy, the dish is expected to operate up to a maximum frequency of 8 GHz.

Design of a control system for the RRI 12m radio telescope

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Abstract. A preloaded parabolic dish antenna, which can provide a very large collecting area, over a wide frequency range, at an affordable cost is being built at the Raman Research Institute. A control system for this antenna has been developed at RRI. It incorporates 17 bit absolute encoders for position feedback and brushless DC motors driven by PWM based drives. The system consists of two redundant control paths, one using a hardware controller called Programmable Multi Axis Controller (PMAC), and the other using a Linux based PC. The main design criterion of the control system is its pointing accuracy better than one arc minute, approximately equal to one-tenth of the half power beam width of the 12m dish at 10 GHz, the highest operating frequency envisaged. The expected control system bandwidth is 2Hz. The system meets the speed requirement of 0.025 to 25 deg/min during tracking and a maximum speed of 40 deg/min during slewing. PMAC is a family of high performance servo motion controllers based on Motorola DSP 56303 processor. It is capable of controlling up to 32 axes of motion simultaneously. The main challenge in the development has been to adapt the PMAC system with functionalities suitable for CNC machines to a Radio Telescope control application. The Linux based control system built in-house provides redundancy in the control system for robustness. Being built in-house this also provides flexibility in implementation of different control system methodologies and architectures. The poster describes the design, development and testing of the control system carried out in RRI.

Comparison of FPGA-based spectrometers using conventional Fourier transform and number theoretic transforms

N. Udaya Shankar, B.S. Girish, K.S. Srivani and K.S. Manjunath
Raman Research Institute, Bangalore

Abstract. The challenges of building a radio telescope with large number of antennas have pushed radio astronomers to investigate possible alternatives to the conventional Fourier transform in the design of spectrometers / filter banks. We discuss the advantages and disadvantages of the conventional Fourier and Number Theoretic Transforms. The poster will also discuss the design aspects of filter banks required for a compact array of ten to twenty antennas. The resource requirements for FPGA-based designs using the above techniques and also the polyphase filter bank architecture, which is a variation of the conventional Fourier transform, will be compared. Computational complexities and error propagation properties of different schemes will also be described.

Phase diversity technique for high resolution solar imaging

A. Raja Bayanna, R. Sridharan and P. Venkatakrishnan
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Abstract. We demonstrate the use of the phase diversity (PD) technique in achieving high resolution in an incoherent imaging system. PD technique estimates the object and aberrations from image data obtained by the imaging system. For estimating the phase errors it needs two images, one in focus and the other out-of focus. We simulated the focused and de-focused images following Kolmogorov turbulence theory and analyzed them using the PD technique. We present preliminary results obtained by using the code for PD technique being developed at Udaipur Solar Observatory.

Preliminary results on the calibration and control of an adaptive optics system

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Abstract. The resolution of ground based telescopes is limited by the atmospheric turbulence. Adaptive optics technique is used to correct these aberrations in real-time. Such corrections are mainly achieved by using tip-tilt and deformable mirrors. The tip-tilt mirror is used to correct for the global tilts of the wave front, which cause the image motion. The deformable mirror is generally used to correct the other (higher order) aberrations. Tip-tilt and deformable mirrors are actuator driven devices. Hence, there is a need to know the response of these actuators with respect to the applied voltages. This process is known as calibration of any actuator driven system. The calibration helps us in determining the overall gain of the system. The gain of our tip-tilt system is found to be ∼105 DAC/pixel in 'channel 0' and ∼55 DAC/pixel in 'channel 1' for the current setup. We use only a PI controller in the closed loop operation of our tip-tilt control system. The value of 'I' estimated from closed loop tuning method seems to be high and hence we replace it with a very small value of the order of 0.005. We have obtained the following results in our experiments related to PID (D= 0 in our case) using Zeigler Nichols method both in closed and open loop tuning methods. Closed-Loop: (Channel 0) [P = 25.65, I = 2.19] and for Open loop: (Channel 0) [P = 22.7, I = 0.024] & (Channel 1) [P = 9.5, I = 0.021]. Presently, these values (obtained from open loop method) have been used in closed loop operation. However, we find that the system is stable for a range of P and I values given as: (Channel 0): [P = 18-30 & I = 0.02-0.05] ; (Channel 1): [P = 8-15 & I = 0.02-0.05].

Redesigning ARIES Baker-Nunn camera for wide field CCD imaging

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Abstract. An engineering project for design, development and installation of the modified BN telescope has been started recently at ARIES. Herein we are modifying 50 years old 50-cm/79-cm Baker-Nunn satellite tracking camera for the purpose of CCD imaging of astronomical objects. Existing optical design (F/1) provides a curved field of view on the focal plane. In order to remove this curvature, an 8 cm field flattener is required to be mounted near the focal plane. To register images in B, V, R and I filters, we will use 2KX2K CCD which will be capable of covering 5.0 deg angular field over the sky. The existing alt-azimuth mounting of the telescope will be replaced by an equatorial fork mounting, presently under design. By making these modifications we plan to perform wide field multicolour imaging of the astronomical objects.

An image stabilization system for solar observations

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Abstract. We have demonstrated the use of an image stabilization system for solar observations at Udaipur Solar Observatory with a 15 cm Coude-refractor. The system consists of a high speed (955 frames per second) camera and frame grabber system for sensing the global tilt of the wave-front, a piezo-controlled mirror for correcting the global tilt and an Intel Pentium 4 computer operating on Linux platform for controlling various devices. The software has two parts, a 'universal tracker' and 'control' software. The 'universal tracker' software, based on ITIFG^{TM} device driver, can operate in limb, spot and correlation tracking modes. In correlation tracking mode, it records a reference image and calculates the shift of the subsequent images with respect to the reference image using 'sum of absolute difference' algorithm. This algorithm is implemented using MMX instructions. The 'control' software shares a common memory with the universal tracking software and enables operations such as switching the system on and off, calibration, tuning and recording shift measurements. In the closed loop, a feed back voltage is applied to the mirror depending on the estimated shift. The beam reflected by the mirror tends to lock the image at the reference position. The residual shifts are estimated by the 'universal tracking' software and this cycle continues. The system has a closed loop correction bandwidth of about 100 Hz. The root mean square image motion in the closed loop is about 0.2 arcsec and is better than the open loop operation by a factor of 10 to 25.

Imaging with insolated mirrors

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Abstract. Modern solar telescope designs are quite different from the traditional designs. We review the present trend briefly and address a few issues related to the image quality. In the case of reflectors, the variation of temperature within the primary and secondary mirrors should be less than a few degrees to prevent distortion. We present limiting values of the temperature, for typical materials under best possible seeing conditions. We predict the evolution of the surface temperature of an insolated mirror using a simplified theoretical approach. We show that the prediction is compatible with the experimental values to a large extent, indicating the need for active cooling of the mirror surfaces.

Study of polarization and temporal properties of atmospheric Cerenkov light: simulations

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Abstract. In atmospheric Cerenkov technique γ-ray photons are detected against the overwhelming background of hadronic showers. In order to extract the gamma-ray signal, it is necessary to reject a significant fraction of the background events. The imaging of the shower maxima, lateral distributions and density distributions of Cerenkov photons generated both by photon and hadron primaries, are generally employed for the purpose. Here, we study the differences in polarization and temporal properties of the atmospheric Cerenkov light as a function of core distance for the Mt. Abu observational level using the Monte Carlo simulations for photon and proton primaries. For this, a database of 3200 showers, for the two types of progenitors at different energies, has been generated using the CORSIKA simulation code. The database obtained contains information of the direction cosines of electrons or muons producing the Cerenkov photons and their respective generation time. These parameters facilitate detailed study of the polarization state and temporal profile of the atmospheric Cerenkov light produced by different progenitors. We have used a hypothetical detector array of 12 $\times$ 12 with a detector spacing of 20m and a detector size of 10$\times$10 sq m for the Mt. Abu altitude of 1.3 km. The results of these simulation studies will be presented in the meeting.