2nd BINA WORKSHOP

"BINA as an expanding international collaboration"

ABSTRACTS

INVITED REVIEWS

IR01 Astrophysics and exoplanets with a 4-m class telescope
by Ignasi Ribas (Spain)

I will review current and future plans for instrumentation of 4-m telescopes. The focus of the talk will be on those instruments relevant to stellar astrophysics and exoplanet science and, particularly, on high-resolution spectroscopy. I will describe the experience of CARMENES and similar instruments and put it in the context of transiting exoplanet searches from space such as the TESS and PLATO missions.

IR02 The far-reaching impact of surveys carried out with 4m-class telescopes
by Anna Pasquali (Germany)

The goal of my presentation is to give a panoramic view of imaging/spectroscopic surveys conducted at 4m-class telescopes during recent years. Special emphasis and discussion are given to the results obtained by extragalactic surveys on galaxy evolution.

IR03 **Performance of the instruments on 3.6-m Devasthal Optical Telescope**
by Amitesh Omar (India)

The 3.6-m Devasthal Optical Telescope (DOT) is being utilized with a 4Kx4K vis-CCD (IMAGER) and a near-infrared array (TIRCAM) in imaging mode, and a Faint Object Spectrograph & Camera (FOSC)-type instrument (in commissioning stage) in spectroscopy+imaging mode using a 4Kx4K vis-CCD camera. This talk will summarize the global performance of some instruments used with the DOT.

IR04 **Current and future science instruments for the 3.6-m Devasthal Optical Telescope**
by Anamparambu Ramaprakash (India), Amitesh Omar, Devendra Ojha, Santosh Joshi & Shashi Bhushan Pandey

A number of instruments have been or are being built for the 3.6-m Devasthal Optical Telescope. These include the Imager, ADFOSC, TANSPEC, DOTIFS, etc. This invited talk will provide a review of these instruments covering their capabilities, current status and main science drivers. The talk will also mention some ideas for future instrumentation that were discussed in various forums.

IR05 **10 years of HERMES at the 1.2-m Mercator telescope**
by Hans Van Winckel (Belgium)

In this contribution I will review our approach to exploiting a small but flexible 1.2-m Mercator telescope. Its specific niche in observational astrophysics needs both a instrument development programme, a continuous technical development programme and an optimized operational model. I will review the 'lessons learned' from our exploitation of the high-resolution HERMES spectrograph mounted on the telescope in 2009.

IR06 **The High Resolution Spectrograph of the Aryabhatta Research Institute of Observational Sciences**
by Jeewan C. Pandey (India) & Yogesh Joshi

A high resolution spectrograph for recently installed 3.6-m Devasthal Optical Telescope (DOT) of the Aryabhatta Research Institute of Observational Sciences (ARIES) is envisaged as a key instrument to meet the spectroscopic requirements of the telescope. A committee of national and international experts recommended the key science program that can be taken up with the proposed instrument as asteroseisomology, Doppler imaging of spotted stars, abundances studies, spectroscopy and ground-based follow-up of exoplanets, and supernovae. The committee recommends the technical specification of the proposed instrument as follows: two mode of spectral resolution (40k and 80k), spectral coverage of 380-900 nm, and high throughput of ~20%. Further, the spectrograph should be able to record simultaneously the spectra of an object and/or sky. The spectrograph would be mounted on a vibration isolation table in a temperature controlled environment. The instrument has a fixed configuration with no moving parts ensuring a robust operation and easy maintenance. I aim to present current status of the proposed spectrograph during the talk.

IR07 **Solar system studies with the Indo-Belgian Telescopes**

by Shashikiran Ganesh (India), Kumar Venkataramani & Kiran Baliyan

Access to 2 and 4m class telescopes and sophisticated instrumentation are one of the key points of the BINA collaboration. It is expected that like other fields, the field of solar system astronomy would also greatly benefit from observations carried out with these telescopes. In this review talk I will be highlighting some of the work carried out on similar telescopes elsewhere and the gap areas that could be filled with the use of instruments that are now becoming available on the telescopes available to the BINA collaboration. It is expected that our understanding of the solar system bodies, particularly the minor bodies and other smaller objects, would be greatly enhanced in terms of statistics as well as detailed characterization of individual ones. It is also important to have a full characterization and understanding of the potentially hazardous asteroids in the vicinity of the Earth's orbit. They are generally fainter than 18th magnitude and not easily observable with the smaller telescopes. This talk will summarize the current status of the field and discuss possible science cases with the new facilities.

IR08 **Scientific potential of Indo-Belgian 3.6 m DOT and ILMT in the field of Galactic Astronomy**

by Ram Sagar (India), Annapurni Subramaniam & Brijesh Kumar

Both India and Belgium have jointly established two 4-m class optical telescopes at Devasthal, Nainital (Longitude = 79º 41' 04" E; Latitude = 29 º 21' 40" N; Altitude= 2450 m) located in central Himalayan region of Kumaon, Uttarakhand, India. After successful installation of the 3.6 meter modern new technology Devasthal Optical Telescope (DOT) in 2015, it was technically activated by premiers of both countries from Brussels on March 30, 2016 while first light from 4 meter International Liquid Mirror Telescope (ILMT) is expected soon. Since 2016, the 3.6-m DOT has been used for both optical and near-Infrared (NIR) observations for a number of research proposals submitted primarily from astronomers of India and Belgium. The best recorded value of angular resolution is 0.4 arc second indicating that the optics of the 3.6-m DOT telescope is good and capable of providing images of the celestial bodies with sub arc second resolutions. All these observations provide proof that the care taken during the construction of the telescope houses has paid a rich dividend as their thermal mass is so low that it has not degraded the natural atmospheric seeing at Devasthal measured about 2 decades ago during 1997 – 1999 using differential image motion monitor. A few preliminary scientific results obtained from recent observations will be presented in this review talk along with performance and global potential of the 3.6-m DOT in the field of galactic astronomy. The 3.6-m DOT is capable of providing internationally competitive science once high resolution spectrograph and other planned modern backend instruments become operational. Geographical location of the observatory has global importance for the time domain and multi-wavelength astrophysical studies. Both 4-m class observing facilities located at Devasthal have enormous potential as they can provide valuable optical and NIR observations for a number of front line galactic astrophysical research problems.

IR09 **Study of small bodies of the Solar System with small and large telescopes**
by Emmanuel Jehin (Belgium)

Comets, asteroids and transneptunien objects are remnants of the early stages of the Solar system and, likely, the most pristine solar system bodies. Understanding their nature and their evolution is a clue to the history of our Solar System and planet formation. Comets and meteorites contain complex organic molecules, and may have played a key role in the transfer of water and organics from the interstellar medium to the early Earth, contributing to the origin of life. This interest is well illustrated by the fact that several space missions have targeted small bodies of the solar system in the past years and comets particularly like the very successful ESA Rosetta/Philae mission that returned impressive science data that are changing our knowledge on comets. In this talk I will review the studies we are involved in my group at the STAR institute of the University of Liège using our TRAPPIST robotic small telescope in Chile and Morocco as well as large telescopes as the ESO VLT.

IR10 **Galactic sources at low radio frequency**
by Ishwara Chandra Chenakkod (India), Paula Benaglia & Michaël De Becker

We have started a programme with Giant Metrewave Radio Telescope (GMRT) to survey the Cygnus OB2 region at 325 and 610 MHz. The Cygnus OB2 region is rich with a wide variety of sources across the electromagnetic spectrum such as protostars, young massive stars, X-ray sources, unidentified VHE sources, colliding wind binaries, shells, bubbles, shocks, etc. Frequencies below 1 GHz trace the non-thermal emission and GMRT offers good resolution and sensitivity at these frequencies. This survey, in combination with available multi-wavelength data, will help us to characterise thermal - non-thermal emission in galactic radio sources.

IR11 Multi-wavelength extragalactic astronomy
by Maarten Baes (Belgium)

Galaxies are generally considered as the basic building blocks of the Universe. Besides stars, galaxies also contain a multi-phase interstellar medium that consists of molecules, atoms, ions, and dust grains. A global picture of the structure, formation, and evolution of galaxies requires observations of all these different components, and hence a multi-wavelength approach. We will describe some recent advancements of our understanding of nearby galaxies, based on multi-wavelength data from ultraviolet to radio wavelengths, combined with state-of-the-art numerical modelling.

INVITED TALKS

IT01 The diversity of Active Galactic Nuclei variability: Some highlights and challenges

by Gopal Krishna (India), Silke Britzen & Paul J. Witta

The talk will mainly focus on the variability patterns of active galactic nuclei (AGN), specially their subset (including quasars, BL Lacs, Seyfert galaxies) which manifests nuclear jets of non-thermal radiation boosted due to relativistic beaming. Many of their striking observational traits, particularly intensity variations have been extensively recorded across the electromagnetic spectrum, on time scales ranging from sub-minute to decades. In contrast, observations of structural changes in their nuclear jets are almost entirely limited to the radio/millimeter waveband, since there alone do we have the capability to image the parsec-scale nuclear structure of AGN. The existing vast amounts of observational material has revealed several interesting trends which contribute richly to the theoretical modelling of the AGN phenomenon. We shall highlight a selection of them and discuss how these intriguing results can be probed deeper using the optical telescopes recently established at Devasthal (Nainital), in addition to the studies using the existing large telescopes operating in the radio and high-energy bands.

CONTRIBUTED TALKS

CT01 Upgrading HERMES: an improved fiber link and a new wavelength calibrator

by Gert Raskin (Belgium), Dmytro Rogozin & Hans Van Winckel

After nearly ten years of successful operations, HERMES, the fibre-fed high-resolution spectrograph of the Mercator telescope is currently being upgraded. We are equipping it with a new optical fibre link and a new wavelength calibration system is under development. Three measures will increase the radial-velocity (RV) performance of the fibre link. The use of octagonal instead of circular core fibres and imaging the stellar image instead of the telescope pupil on the fibre entrance, will both help to improve the illumination stability of the spectrograph. Furthermore, the new fibre link will also allow to observe, simultaneously with the high-resolution stellar spectrum, a wavelength reference source. This makes it possible to track any instrumental drift during the exposure. High-accuracy RV measurements require very precise wavelength calibration. To overcome the insufficiencies of the standard Thorium-argon emission lamps, we are developing a wavelength calibration system based on a Fabry-Perot etalon. Illuminated with a white-light source, the etalon provides a dense comb spectrum with very regular spacing and amplitude. Using laser spectroscopy to anchor the etalon spectrum to a precisely known hyperfine transition of Rubidium, delivers sub-m/s stability over time scales of years. Both developments will increase the RV accuracy of the HERMES spectrograph and could also be of great benefit for the future high-resolution spectrograph on the DOT@ARIES telescope.

CT02 A sharp future for the 3.6-m Devasthal Optical Telescope? The power of adaptive optics for medium size telescopes

by Gilles Orban De Xivry (Belgium), Olivier Absil & Vincent Moreau

Adaptive optics (AO), by compensating in real time the blurring due to atmospheric turbulence, improves the angular resolution and the sensitivity of ground-based telescopes. AO represents an opportunity for medium size telescopes to be competitive with respect to large and very large observatories, either by being highly automatized and allowing high-yield surveys to be undertaken, or by providing very high correction up to visible wavelengths. More generally, AO can be beneficial for most scientific cases and - we think - reachable with a moderate effort investment. In this contribution, I will present the expertise we are currently building up in Liège with the SALTO project, a 1-m telescope with laser guided adaptive optics system. I will then focus on two different sciences cases, discuss how they would drive the design of the AO system, and the general benefit that AO would bring to the 3.6-m Devasthal Optical Telescope (DOT).

CT03 Size estimation of orbital debris using a zenith-pointing telescope
by Bikram Pradhan (Belgium)

The size distribution of space debris is an important input to risk analysis for current and future space missions. In preparation for future observations with the zenith-pointing 4-m International Liquid Mirror Telescope, the 1.3-m Devasthal Fast Optical Telescope was used to gain experience with zenith-pointing observations and, serendipitously, to detect, identify and characterize orbital debris. Observational data were acquired on 11 nights in May, 2015 using a 2048x2048-pixel CCD detector operating in time-delay integration mode. Twelve moving objects were detected, mostly during dawn and twilight. All were identified by correlation with two-line element sets. By modelling each of the objects as a diffuse Lambertian sphere with an albedo of 0.175, their effective diameters were estimated from the observed apparent magnitudes, altitudes, velocities and solar phase angles. Seven objects were found to be in low Earth orbit and five in mid-Earth or geo-transfer orbits. The apparent Gaia magnitudes of the identified objects range from 5.6 to 12.0 and the estimated effective diameters from 0.3 to 10.1 m. Images from the future ILMT photometric survey are expected to provide detections of objects having diameters as small as 3 cm in low-Earth orbit.

CT04 Optical characterization and radial velocity monitoring of exoplanet and eclipsing binary candidates

by Yogesh Joshi (India), Peter De Cat, Alaxender Panchal, Patricia Lampens, Aruna Goswami Goswami & Lore Vermeylen

Recently, large catalogues of exoplanet and eclipsing binary candidates are reported in the Kepler archival data. In the framework of BINA, we therefore initiated a long-term project "Optical characterization and Radial velocity monitoring with Belgian and Indian Telescopes (ORBIT)" which focuses on ground-based photometric monitoring and high-resolution spectroscopic observations of selected exoplanet candidates and low-mass eclipsing binary candidates using the Indo-Belgian telescopes. We initially focus our study on few bright candidates for which radial velocity monitoring could be possible from the recently mounted high-resolution spectrograph on 2-m Himalayan Chandra Telescope (HCT). Along with planned photometric observations using small-size telescopes at ARIES, Nainital, we aim to determine their physical parameters with a great precision. Having enough sample off such low-mass objects, we aim to understand their mass-radius characteristic which is still debated towards the lower-mass regime. Furthermore, if a transit occurs during the period of spectroscopic observations, it may also help to monitor the Rossiter-McLaughlin effect which plays an important role in the understanding of the characteristics of the secondary star, particularly in the case of a low-mass star or planetary companion.

CT05 **Eclipse mapping of Algol-type systems with oscillating δ Scuti type components**

by Patricia Lampens (Belgium), Peter De Cat & Lore Vermeylen

The oEA stars are the former secondaries of evolved, semi-detached eclipsing binaries which are (still) undergoing mass transfer and form a newly detected class of pulsators close to the main sequence (Mkrtichian et al. 2002). Their unique feature consists of mass accretion onto the atmosphere of the pulsating star. Mass accretion affects the mass, radius, density as well as the star's evolution (depending on the accretion rate). Such stars are therefore very attractive targets for asteroseismic studies. The eclipse mode identification method for EBs with pulsating components was suggested by Nather & Robinson (1974). The method uses the primary eclipse event as a spatial filter to resolve the pulsations across the stellar surface of the pulsator. It is based on the fact that, during an eclipse of the pulsating component, the occulting star acts as a screen with a timely variable shape. During an eclipse, depending on the (l,m) spatial structure of modes, different shapes of the pulsation amplitude and phase variations are observed. A comparison between the modelled and the observed amplitude and phase patterns provides the correct mode identification. The method (also called dynamic eclipse mapping method; Bíró et al. 2011) needs a geometrical model, pulsation frequencies as well as the light curves as input. The geometrical model can be obtained from a simultaneous modelling of the light (photometry) and radial velocity curves (acquired with the HERMES spectrograph). The pulsation frequencies are obtained from subtracting a binary model from the original light curves followed by a frequency analysis of the residuals. We will identify and illustrate systems where observations with a (relatively) fast CCD camera equipping the 3.6-m Devasthal Optical Telescope (DOT) could deliver the data needed for the application of the eclipse mapping method.

CT06 **Light curve parameters of Cepheid and RR Lyrae variables at multiple wavelengths: theory vs. observations**

by Harinder P. Singh (India), Susmita Das, Anupam Bhardwah, Shashi Kanbur & Marcella Marconi

We analyse the theoretical light curves of Cepheid and RR Lyrae variables at optical (UBVRI) and near-infrared (JKL) wavelengths using Fourier decomposition. A large number of models have been studied appropriate for galactic and Magellanic cloud Cepheids and RR Lyraes. We discuss the variation of light-curve parameters with different compositions and mass-luminosity levels as a function of period and wavelength, and compare our results with observations.

CT07 Rotation rates of pre-main sequence stars
by Soumen Mondal (India), Somnath Dutta, Santosh Joshi & Ramkrishna Das

Pre-main sequence (PMS) stars first came into the spotlight due to their photometric variable characteristics. Observational studies have been performed on exploring variability in young stars and the role of angular momentum in their stellar evolution. The variability in a PMS star is thought to be originated via various mechanisms like magnetically induced cool spots or magnetically channeled variable accretion flows generating hot spots on the star surface, eclipsing binary, opacity due to non-uniform dust distribution, etc. In this presentation, we like to highlight some of our results on the variability of young stellar objects in a few galactic star-forming regions.

CT08 Instabilities and mass-loss in massive stars
by Abhay Pratap Yadav (India)

Spectroscopic and photometric variabilities have been noticed in several stars. The cause and responsible mechanism for such variabilities are not yet properly understood. Among the possible origins, radial and non-radial pulsations have been proposed as a cause of these variabilities. With the help of linear stability analysis, we have found several strong instabilities in models of massive zero age main sequence and post main sequence stars. To find the final fate of the unstable models, we have followed the identified instabilities into the non-linear regime using an energy conservative numerical scheme for selected stellar models. Rearrangement of stellar structure, finite amplitude pulsations (with periods between few hours to several days) and surface eruptions have been noticed as the final consequences of these instabilities. In case of finite amplitude pulsations, our estimates for pulsationally driven mass-loss rates are of the order of 10^{-4} M_{sun}/year for few massive OB-type stars which can potentially affect the stellar evolution. Observations of massive-luminous stars such as luminous blue variables (LBVs) using BINA telescopes will provide a unique opportunity to test our theoretical predictions of linear stability analysis and non-linear numerical simulations.

CT09 Accurate estimation of effective temperature and metallicity of asteroseismic targets with BINA telescopes

by Anwesh Mazumdar (India) & Bhaswati Mookerjea

Recent data from the NASA Kepler mission has provided a big boost to asteroseismic studies of solar-type stars and red giants. It is now possible to provide strict constraints to models of such stars by comparing the observed frequencies with the theoretically predicted ones. However, the seismic constraints are only useful when the effective temperature (T_{eff}) and surface metallicity ([Fe/H]) of the observed stars are accurately known. We propose to use the telescopes under the BINA collaboration to obtain high resolution spectroscopy in order to estimate Teff and [Fe/H] of both observed and future Kepler and TESS targets. The possibility of obtaining a colour-temperature calibration curve, using photometric observations with the Devasthal Optical Telescope (DOT) will also be explored.

CT10 Complex X-ray/ultraviolet/optical variabilities of the Seyfert 1 galaxy NGC 4593

by Sachindra Naik (India) & Main Pal

We present a detailed multi-frequency analysis of an intense monitoring programme of the Seyfert 1 galaxy NGC 4593 over a duration of nearly a month with the Swift observatory. We used 185 pointings to study the variability in six ultraviolet/optical and two soft (0.3-1.5 keV) and hard X-ray (1.5-10 keV) bands. The amplitude of the observed variability is found to decrease from high energy to low energy (X-ray to optical) bands. Count-count plots of ultraviolet/optical bands with hard X-rays clearly suggest the presence of a mixture of two major components: (i) highly variable component such as hard X-ray emission, and (ii) slowly varying disc-like component. The variations observed in the ultraviolet/optical emission are strongly correlated with the hard X-ray band. Cross-correlation analysis provides the lags for the longer wavelengths compared to the hard X-rays. Such lags clearly suggest that the changes in the ultraviolet/optical bands follow the variations in the hard X-ray band. This implies that the observed variation in longer wavelengths is due to X-ray reprocessing. Though, the measured lag spectrum (lag versus wavelength) is well described by $\lambda^{4/3}$ as expected from the standard disc model, the observed lags are found to be longer than the predicted values from standard disc model. This implies that the actual size of the disc of NGC 4593 is larger than the estimated size of standard thin disc.

CT11 **Multi-wavelength studies of Zwicky's Nonet**

by Biju Koonammakkil George (India), Pratik Dabhade, Joydeep Bagchi, Joe Jacob, Ishwara Chandra Chenakkod, Shishir Sankhyayan & Santosh Joshi

We present the results of our radio, optical and infrared studies of Zwicky's Nonet, which is a compact group of nine merging galaxies, at the centre of the rich galaxy cluster A 407. Here, all the nine galaxies are packed within a radius of only 25 kpc, with the smallest projected separation between galaxy pair combinations is about 5 kpc. This group is found to be hosting a radio source 4C 35.06, which is having helically twisted and kinked radio jets and diffuse outer lobes, revealed by the Giant Meterwave Radio Telescope (GMRT) observations at 610, 235 and 150 MHz frequencies. The host of the radio source is suggested to be a low luminosity galaxy, which might have stripped of its stars in multiple tidal encounters. A consistently observed low-value of the estimated black hole mass from the K-band magnitude compared to that from stellar velocity dispersion for all the galaxies in the sample is pointing to this possibility. Optical and infrared studies show that all the galaxies in the group are of low-excitation class. We have acquired data from 3.6-m Devasthal Optical Telescope (DOT) via some deep observations for this exotic source. Preliminary results are very promising. We will present the multi-wavelength properties of Zwicky's Nonet and discuss the results from the 3.6-m DOT.

CT12 **Multi-wavelength studies of giant radio galaxies**

by Pratik Dabhade (India), Joydeep Bagchi, Huub Rottgering, Santosh Joshi, Joe Jacob & Biju Koonammakkil George

In this talk, we will present about Giant Radio Galaxies (GRGs) and highlight the importance of their studies and our efforts to solve major standing problems related to growth and evolution of GRGs and their host active galactic nucleus (AGN). They represent an extreme class of active galaxies which have linear sizes in the range of ~0.7 Mpc to 5 Mpc which places them among the largest single astrophysical objects known to us. Over the past four decades, only ~400 GRGs are known as opposed to thousands of radio galaxies (~10-700 Kpc). It is unsettled if the large sizes of GRGs indicate the high efficiency of radio jets ejected from the central AGN, or they grow to enormous sizes due to their location in sparser cluster environments. In spite of various studies of GRGs, there is still not a single tested unified model which might explain the immense physical scale and other extreme properties of GRGs. Moreover, until now only a small fraction of these GRGs have been studied in sufficient detail in multiple wavebands for achieving a good understanding of their unusual nature. This puts a restriction on carrying out statistical studies of their properties. Firstly, under our project SAGAN (Search & Analysis of GRGs with Associated Nuclei), we have successfully made a complete & uniform sample of all known GRGs from literature, which is first of its kind. Secondly, we are also carrying out large-scale searches for new samples of GRGs using existing radio and optical survey data. Thirdly, we plan to study the hosts of GRGs in multi-wavelengths to understand the nature of accretion, feedback and their excitation types. We have already observed some GRGs with the Giant Metrewave Radio Telescope (GMRT) and we plan to observe their host using the 3.6-m Devasthal Optical Telescope to study near-infrared properties of their host galaxies.

CT13 Strong lensing studies with the 3.6-m Devasthal Optical Telescope: opportunities and challenges

by Dominique Sluse (Belgium)

Strongly lensed quasars and active galactic nuclei (AGN), namely active galaxies that appear multiply imaged due to a foreground lensing galaxy, are exceptional astrophysical tools that may be used to probe the expansion rate of the Universe, study the evolution of galaxies and of their dark matter content over cosmic time, and zoom in into the structure of AGNs. We are entering a new era in observational astrophysics, not anymore limited by the number of accessible targets, but by our ability to carry out follow-up observations. In this talk, I will present two areas where a spectrograph attached to the 3.6-m Devasthal Optical Telescope (DOT) may yield to important scientific contributions. (1) Discovery of new lensed candidates: A 4-m class telescope is ideal to confirm the nature and derive the basic properties of newly discovered lensed candidates, but also support observations with larger telescope facilities (Very Large Telescope, ALMA,...). I will explain the scientific importance of such follow-up observations and discuss the number of accessible targets and observational requirements for a successful project. (2) Gravitational microlensing: the stars in the main lensing galaxy act as numerous micro-lenses that magnify the inner regions of AGN, allowing one to uniquely constrain the size and energy profile of the accretion disc. Multi-epochs and low resolution spectroscopy on a 4-m class telescope may constrain the accretion disc structure of tens of AGNs, allowing a breakthrough in the field. We will discuss the motivation and observational challenges associated to such a research project.

CT14 REMAP: REverberation Mapping of the Active galactic nuclei Program at the 2-m Himalayan Chandra Telescope

by Amit Kumar Mandal (India), Ram Sagar, Chelliah Subramonian Stalin, Suvendu Rakshit & Blesson Mathew

Active galactic nuclei (AGN) are high luminosity sources powered by accretion of matter onto super-massive black holes (SMBHs). According to the unification model of AGN, the SMBH is surrounded by a dusty torus. It is difficult to study the extent of the dusty torus as the central region of AGN is not resolvable using any conventional imaging techniques available today. Though the current optical/infrared interferometric technique could in principle resolve the torus in nearby AGN, it is very expensive. An alternative and cheap method to the interferometric technique to find the extent of the dusty torus is through the technique of reverberation mapping. Towards this we are carrying out a dedicated monitoring program since the year 2016 using the 2-m Himalayan Chandra Telescope (HCT) operated by the Indian Institute of Astrophysics (IIA) in Bangalore (India). Our sample for this program consists of about a dozen sources suitable for observations using the HCT. Observations are routinely carried out once every 5 days to monitor our sample. We have obtained good estimates of the size of the torus in two AGN in our sample. This talk will outline the importance of this program, the observational strategy that is followed, the adopted analysis procedures, the results obtained till now from this program and the scope for Indo-Belgian collaboration.

CT15 Observations of galaxy collisions and prediction of parameters of resulting galaxies

by Rajesh Kumar Dubey (India)

Galaxy collision is an important event in astrophysics and opens doors for many unanswered questions. The collision between NGC 1232 with a dwarf galaxy or NGC 5256 is another example of merging of two galaxies. APR 256 is another example of merging of the two spiral galaxies. These collisions takes place for millions of years and the statistics changes with time. However, observations show that these events may result in very high temperatures of the order of a few MK, covers and spread over very large areas of the order of few kpc in diameter, and moderate to high luminosity. Depending upon certain factors the collision can be observed under X-RAY band or gamma ray bands. By studying these collisions, the prediction can be made about the shape, size, temperature, expansion, luminous afterglow, etc. of the resulting galaxy. For example, two spiral galaxies can merge to form an elliptical galaxy. The behaviour of present such events can help in predicting the future events.

CT16 Application of convolutional neural nets for stellar spectral analysis

by Kaushal Sharma (India), Sheelu Abraham, Ajit Kembhavi, Aniruddha Kembhavi & Thirupathi Sivarani

We propose an automated approach for the classification of stellar spectra using Deep Neural Networks. Due to the ever-expanding volume of observed spectroscopic data from surveys such as SDSS and LAMOST, it has become important to apply artificial intelligence (AI) techniques for analysing stellar spectra to solve spectral classification and regression problems like the determination of stellar atmospheric parameters T_{eff}, log$g$ and [Fe/H]. Traditional machine learning methods with "shallow" architecture (usually up to 2 hidden layers) have been trained for these purposes in the past. However, deep learning methods with a larger number of hidden layers allow the use of finer details in the spectrum which results in improved accuracy and better generalisation. Studying finer spectral signatures also enables us to find rare objects and outliers. Moreover, such models trained on empirical libraries provide wider coverage of the parameters space as compared to synthetic libraries. We examine various machine and deep learning algorithms like Artificial Neural Networks (ANN), Convolutional Neural Networks (CNN), and Autoencoders to classify stellar spectra using the Jacoby Atlas, and ELODIE and MILES spectral libraries as training samples. We test the performance of the trained networks on the Indo-U.S. Library of Coudé Feed Stellar Spectra (CFLIB). We show that using autoencoders, we are able to achieve a precision of 1.5 spectral sub-classes in the classification scheme as compared to the precision of up to 2 sub-classes achieved in the past studies. The trained model can further be used to classify stellar spectra from large databases (e.g SDSS) with better precision and could also be implemented in data-analysis pipelines for various survey programs. With the latest GAIA release, we also plan to take advantage of distances from this mission to compile a better training sample.

CT17 Evolution of magnetic activities on active solar-type stars: starspot modulation, surface differential rotation, and flares

by Subhajeet Karmakar (India), Jeewan C. Pandey, Igor Savanov & Ashish Raj

Solar-type stars with a similar internal structure to that of the Sun (spectral type from late-F to early-M) are supposed to operate a similar type of dynamo mechanism. However, the observations of these stars have introduced a range of stellar rotation periods, gravities, masses, and ages, which put into the debate on the existing magnetic dynamo theory. In order to provide useful constraints for the dynamo theory, we are currently working on a project to investigate the magnetic activities of the stars with the same internal structure. We have chosen the F-type star KIC6791060, the K-type star LO Pegasi, and M-type planet-hosting stars EPIC211901114 and K2-33. We intend to compare the results with those of the Sun. Using several ground-based (mostly from BINA telescopes) and space-based observatories, we intend to study the photospheric, upper chromospheric and coronal activity indicators. Using ~24 years long multi-band photometric data, we derive the rotational period of LO Peg to be 0.4231 ± 0.0001 d. Using the seasonal variations on the rotational period, the surface differential rotation (SDR) pattern is investigated and shows a solar-like pattern of SDR with a period of ∼2.7 yr. A total of 20 optical flares are detected with a flare frequency of ∼1 flare per two days and a flare energy of $\sim 10^{31-34}$ erg. The surface coverage of cool spots is found to be in the range of ∼9–26%. A flip-flop cycle of ~1 yr appears to be present. Using 4 years long multi-band observations of KIC6791060 and three months observations of EPIC211901114 and K2-33 along with the observations with ground-based observatories, we have recreated the surface inhomogeneity map. We also analysed for habitability on those orbiting planets.

CT18 Three years of AstroSat: India's first mission dedicated to astronomy
by Girish Veerappa (India)

AstroSat, India’s first dedicated astronomy mission has successfully completed its third year in orbit. The AstroSat observatory carries five astronomy payloads covering from ultraviolet to soft/medium energies to hard X-rays. The data from AstroSat has led to several new scientific results like X-ray polarisation using the Cadmium Zinc Telluride Imager (CZTI) and solving of a twenty years puzzle of a cool red star in NGC 188 which is simultaneously very bright in ultraviolet too with the help of the UltraViolet Imaging Telescopes (UVIT). In addition we have detected beat period in X-rays in a magnetic cataclysmic variable V2400 Oph which makes it a discless intermediate polar. This makes it an unique cataclysmic variable as intermediate polars with their low magnetic fields do not disrupt the accretion disc. I will be summarising this detection and will discuss other exciting results from AstroSat in general.

CT19 **The ultraviolet imaging telescope on-board AstroSat: recent results**
by Chelliah Subramonian Stalin (India) & Santosh Joshi

The UltraViolet Imaging Telescope (UVIT) is one of the scientific payloads on board India's first multi-wavelength astronomical satellite AstroSat launched by the Indian Space Research Organisation on 28 September 2015. Along with UVIT and other X-ray instruments, AstroSat has the unique capability of simultaneously imaging a celestial source from the ultraviolet to the hard X-ray band. UVIT is working as per the design specifications and has started to produce interesting results. This talk will focus on details of UVIT, its unique capabilities, planning an observation with UVIT, recent interesting results from UVIT and possible synergies between UVIT and other Belgian telescopes.

CT20 **Spectroscopic view on the pulsating A-type stars HD 73045 and HD 118660**
by Eugene Semenko (Russia), Santosh Joshi & Ilya Yakunin

This talk reviews the results of a spectroscopic study of two pulsating A-stars. HD 118660 was known as a photometric variable star whose physical properties had been studied with the use of spectroscopy from the Russian 6-m Большой Телескоп Альт-азимутальный (BTA). Here, we present the direct spectroscopic confirmation of the pulsational nature of the star and outline the requirements for the further study. HD 73045 is a spectroscopic binary SB1-type star with a pulsating component. This star had been extensively observed with the Main Stellar Spectrograph of the BTA in March 2015. That monitoring revealed the changes of radial velocity with a period close to four hours. In this study we have re-analysed the data from the Special Astrophysical Observatory (SAO) and compare them with the results of spectroscopic monitoring carried out with the HERMES spectrograph from the Roque de los Muchachos Observatory (RMO) in La Palma, Spain.

CT21 Stellar and galactic studies with the 2-m Himalayan Chandra Telescope
by Aruna Goswami (India)

The Himalayan Chandra Telescope (HCT), Indian Astronomical Observatory (IAO), Hanle, India, has entered its 15th year of operation. Over the years, various observational programs have been carried out leading to a large number of publications. A brief overview of stellar and galactic studies carried out using HCT and its back end instruments such as the Himalaya Faint Object Spectrograph (HFOSC) and Hanle Echelle Spectrograph (HESP) will be presented. Some important science results will be highlighted with the aim to expand potential collaboration in the area of stellar and galactic studies using these observing facilities.

CT22 Spectroscopic studies of carbon-enhanced metal-poor stars
by Meenakshi Purandardas (India) & Aruna Goswami

The halo system of the Milky Way comprises the vast majority of the presently observed metal-poor ([Fe/H]< -1.0) and very metal-poor ([Fe/H] < -2.0) stars. Among these metal-poor stars, a sizable fraction (~30%) show carbon enhancement ([C/Fe] > 1.0). These stars are called Carbon-Enhanced Metal-Poor (CEMP) stars. Studies of these objects are of special interest, since they bear the fossil records of nucleosynthesis of the first generation of stars and thus provide insight into the nucleosynthesis and chemical evolution of the early universe. In the recent past, although these stars have drawn considerable attention as far as their spectroscopic studies are concerned, several questions still remain poorly understood such as the origin and the production mechanism(s) of carbon and neutron-capture elements exhibited by these objects. A comprehensive study of the abundance patterns of various heavy elements in these objects can give important clues to these questions. We have undertaken to perform chemical composition studies of a selected sample of CEMP stars using the 2-m HCT/HESP and ESO-MPI/FEROS. The abundance distribution patterns and the elemental abundance ratios are critically examined to understand their origin and evolution. We will present some results obtained from our recent spectroscopic studies. Such studies can be highly enhanced through BINA collaborations involving many institutes.

CT23 Probing the Galactic s-process nucleosynthesis using metal-deficient Barium stars
by Shejeelammal Jemaala (India) & Aruna Goswami

The origin and evolution of neutron-capture elements in our Galaxy is poorly understood. Detailed chemical composition analysis of stars with the atmosphere enriched by these elements can throw light on the Galactic chemical evolution history. Metal-deficient Ba stars form useful candidates for this kind of studies. They are mostly in their main-sequence and giant phase of stellar evolution with enhanced abundance of neutron-capture elements in their surface. Nucleosynthesis theories do not support the occurrence of s-process nucleosynthesis during the stellar evolutionary phases to which these stars belong. Low and intermediate mass stars in their Asymptotic Giant Branch (AGB) phase are known to produce the s-process elements. Most of the barium stars are known to be binary systems and they are believed to have received via binary mass transfer mechanisms the products of the companion stars produced during their AGB phase of evolution. Hence, the chemical composition of this class of objects can be used to trace back the AGB nucleosynthesis at their corresponding metallicities. The [hs/ls] ratio (hs/ls refer to the heavy/light s-process elements, respectively) could give clues to the accurate origin of the s-process nucleosynthesis, the reactions operating at different metallicities. The C/O ratio and 12C/13C ratio can provide insight into the evolutionary status of the star and different nucleosynthesis and mixing processes happening in the stellar interiors, while the [Rb/Sr] ratio provides the mass of AGB star. We will present the results of detailed spectroscopic study of a selected sample of Ba stars performed along this line based on the high-resolution optical spectroscopic observations using 2-m HCT/HESP, 8.2-m VLT/UVES and ESO-MPI/FEROS. Possibilities of taking forward such studies in the framework of BINA collaboration will be discussed.

CT24 Probing high-mass star-formation in the outflow source G12.42+0.50
by Anandmayee Tej (India)

The formation of high-mass stars remains an enigmatic process. Through a multi-wavelength study of G12.42+0.50, designated as an outflow source, we probe the various associated components that shed crucial light on the processes involved in the early phases of massive star formation. We present the first low-frequency radio observations of this source and attempt to reveal the nature of this source and the radiation mechanism responsible for the radio emission. Near-infrared spectroscopy is carried out to identify the spectral carriers responsible for the enhanced 4.5 micron emission seen. Further, gas kinematics from molecular line data is investigated to build an overall star formation scenario associated with G12.42+0.50.

CT25 **High-mass star formation toward the southern infrared bubble S10**

by Swagat Ranjan Das (India), Anandmayee Tej, Sarita Vig, Swarna K. Ghosh & Ishwara Chandra Chenakkod

An investigation in radio and infrared wavelengths of two high-mass star-forming regions toward the southern Galactic bubble S10 is presented in this work. The two regions under study are associated with the broken bubble S10 and Extended Green Object, G345.99-0.02, respectively. Radio continuum emission mapped at 610 and 1280 MHz using the Giant Metrewave Radio Telescope, India, is detected toward both of the regions. These regions are estimated to be ionized by early-B- to late-O-type stars. Spitzer GLIMPSE mid-infrared data is used to identify young stellar objects (YSOs) associated with these regions. A Class-I/II-type source, with an estimated mass of 6.2 M_{sun}, lies ~7″ from the radio peak. Pixel-wise, modified blackbody fits to the thermal dust emission using Herschel far-infrared data is performed to construct dust temperature and column density maps. Eight clumps are detected in the two regions using the 250 μm image. The masses and linear diameter of these range between ~300–1600 M_{sun} and 0.2–1.1 pc, respectively, which qualifies them as high-mass star-forming clumps. Modelling of the spectral energy distribution of these clumps indicates the presence of high luminosity, high accretion rate, massive YSOs possibly in the accelerating accretion phase. Furthermore, based on the radio and mid-infrared morphology, the occurrence of a possible bow wave toward the likely ionising star is explored.

CT26 **Optical and X-ray observations of three candidate polars: RX J0859.1+0537, RX J0749.1-0549, and RX J0649.8-0737**

by Arti Joshi (India) & Jeewan C. Pandey

We present analyses of optical (photometric and spectroscopic) data obtained from 1-m class telescopes at ARIES (Nainital) and the 2.01-m Himalayan Chandra Telescope (HCT) at Indian Astronomical Observatory (IAO), Hanle, India, for three candidate polars namely RX J0859.1+0537, RX J0749.1-0549, and RX J0649-0737. An analysis of X-ray data obtained from the ROSAT satellite is also presented. Optical photometric and X-ray observations of these three candidates reveal eclipse features that are deep, total, and variable in shape and are classified for the first time as eclipsing polars. The optical and X-ray modulations of RX J0859.1+0537, RX J0749.1-0549, and RX J0649.8-0737 are found to occur at the derived orbital periods of 2.390 +/-0.003, 3.67 +/- 0.001, and 4.340 +/- 0.001 hr, respectively. Among these systems, RX J0859.1+0537 is found to be the 12th eclipsing polar which lies in the period gap, while RX J0749.1-0549 and RX J0649.8-0737 are found to be the 6th and 7th long period eclipsing polars. The eclipse width at half depth was observed to be more than ∼0.2 for each system which suggests that these are highly inclined binary systems. The optical spectra of these systems are typical of polars with strong high ionization emission lines and inverted Balmer decrement which further confirms the magnetic nature of these systems.

CT27 Ground-based photometric survey to search for the pulsational variability in Ap and Am Stars

by Santosh Joshi (India), Daniel Nhalpo, Nand Kumar Chakradhari & Bruno Letarte

A survey project called the “Nainital-Cape Survey” was started in the late 1990s with the aim to search and study pulsation in Ap & Am stars using the observing facilities from Nainital and Cape Town. This ongoing survey programme has monitored so far more than 350 stars and has discovered pulsation variability in one roAp and seven δ Scuti stars. Recently, we obtained time-series PMT observations of five new Ap stars from the 0.5-m telescope at the South African Astronomical Observatory. Analysis of our data shows that none of the these sample exhibit photometric variability, hence classified as null results. The follow-up time-series CCD photometric observations of two δ Scuti stars, namely, HD13038 and HD13079 were carried out from 1.04-m and 1.3-m telescope of the Aryabhatta Research Institute of Observational Sciences (ARIES), Nainital. The differential photometry of the star HD13038 gives a strong evidence of a new periodicity of 84.98 min. Similarly, in HD13079, we found the pulsation period of 73.8 min and 72.9 min on two different nights. Those are almost consistent to the previously reported values. In this talk, I will give a brief summary of the present status of the Nainital-Cape survey project along with the current activities.

CT28 The spectroscopic survey of southern oEA stars

by David Mkrtichian (Thailand) & Chris Engelbrecht

I will give a review on pulsation properties of the group of mass-accreting components of Algols (oEA stars). I will discuss the importance of detection of high-degree nonradial pulsations (NRP). The precise monitoring of frequencies of high-degree NRPs allows tracking the micro-variations (acceleration and braking) of the surface layers of oEA stars under high mass-transfer events. I will report about first results of the ongoing high-resolution spectroscopic survey of oEA stars started in 2017 using the SALT telescope and aimed to detect the high-degree NRP in Southern oEA stars.

CT29 Prospects for radio observations of Particle-Accelerating Colliding-Wind Binaries with the Giant Metrewave Radio Telescope

by Michaël De Becker (Belgium), Ishwara Chandra Chenakkod & Paula Benaglia

Synchrotron radiation identified in the radio domain for several tens of binary systems made of massive stars provides compelling evidence that a particle acceleration process is at work in these objects, hence their Particle-Accelerating Colliding-Wind Binaries (PACWB) status. Measurements of the synchrotron radio emission allow to investigate the non-thermal physics and to derive some of their properties. In this context, it is worth investigating the expectations from longer wavelengths such as those measured by the Giant Metrewave Radio Telescope (GMRT) in India, in complementarity with the most abundant measurements at centimetric wavelengths obtained with other radio observatories such as the Very Large Array (VLA) or the Australia Telescope Compact Array (ATCA). This talk will outline such expectations and address the issue of the underlying physics in its appropriate context.

CT30 Understanding physical properties of M-dwarfs: near-infrared (HK band) spectroscopic studies

by Dhrimadri Khata (India), Soumen Mondal, Ramkrishna Das & Supriyo Ghosh

A sample of young M-dwarfs from young moving groups and old population from the galactic field is observed using the near-infrared TIRSPEC instrument (R=1200) on the 2-m Himalayan Chandra Telescope (HCT) at Hanle. Using interferometrically measured effective temperatures, radii, luminosities of a sample of calibrators with spectral type ranging from M0 V to M6 V, we have developed modified empirical calibration relations based on HK-band TIRSPEC spectra. The standard deviations in the residuals of our best fits for T_{eff} and radii are 100 K and 0.03 R_{sun}, respectively. The metallicities [Fe/H] and [M/H] of M-dwarfs are estimated from Na I, Ca I equivalent widths and H2O - K2 index. The characterization of M-dwarfs is important to future exoplanet missions targeting for potential habitable exoplanet host stars.

CT31 **DustKING - the story continues: dust attenuation in NGC628**
by Marjorie Decleir (Belgium), Ilse De Looze, Maarten Baes & Médéric Boquien

Dust attenuation is a crucial but highly uncertain parameter that hampers the determination of intrinsic galaxy properties, such as stellar masses, star formation rates and star formation histories. The shape of the dust attenuation law is not expected to be uniform between galaxies, nor within a galaxy. Our DustKING project was introduced at the first BINA workshop in 2016 and studies the variations of dust attenuation curves in nearby galaxies. To this aim, we used the CIGALE code to fit the observed spectral energy distribution. Particularly important for our goal are ultraviolet (UV) data from the SWIFT space telescope, whose filters cover the curious bump feature in the attenuation curve at 2175 Å. As a follow-up of the previous talk, I will present the final results for the spiral galaxy NGC628 (Decleir et al., to be submitted soon). We found that the average attenuation law of this galaxy is characterised by a MW-like bump and a very steep slope. Also, there are some interesting correlations between dust attenuation properties and other galaxy properties. Finally, we showed that UV data are inevitable for our study. Therefore, we would like to use the UVIT from the Indian AstroSat mission in the future. My talk will focus on the possibilities of using this instrument and propose a possible collaboration within the BINA framework.

CT32 **Multi-wavelength variability and quasi-periodic oscillations in blazars**
by Alok Chandra Gupta (India)

Blazar is a sub-class of radio loud active galactic nuclei (AGN). Blazars show large amplitude flux and polarization variability in the complete electromagnetic spectrum and emission being pre-dominantly nonthermal. Occasionally quasi-periodic oscillations (QPOs) are also reported in blazars time series data. In the talk, I will discuss about our recent results obtained using multi-wavelength observational facilities around the globe.

POSTER PRESENTATIONS

P01 **On the requirement for a high resolution spectrograph to investigate the multiplicity of massive stars with the 3.6-m Devasthal Optical Telescope**

by Michaël De Becker (Belgium)

The investigation of the multiplicity of massive stars constitutes a key aspect of their understanding. On the one hand, the evolution of short period systems is tremendously influenced by the companion (through mass exchange, common envelope evolution,...). On the other hand, the wind-wind interaction region in multiple massive systems is the seat of a high level physics, including strong thermal X-ray emission, particle acceleration and non-thermal emission processes. The description and understanding of these processes require the accurate determination of orbital parameters, notably through spectroscopic studies. In this context, I will overview and anticipate some relevant applications of a high resolution spectrograph mounted on the 3.6-m Devasthal Optical Telescope, emphasising its potential complementarity with other Indian facilities such as the Giant Metrewave Radio Telescope and Astrosat.

P02 **Characterization of pre-main sequence population in H II region Sh2-242**

by Alik Panja (India), Soumen Mondal, Somnath Dutta, Santosh Joshi, Sneh Lata & Ramkrishna Das

Dense molecular clouds in presence of massive stars of spectral type O or early B, serve as rich astronomical laboratories for birthplaces of young stars. Sh2-242 (S242) is a highly embedded star-forming region, excited by a B0 V star and located at a distance of 2.1 kpc in the Taurus constellation. Preliminary analysis of a deep near-infrared (NIR) photometric survey reveals that the region evolves with modest values of young stellar object (YSO) population. The region suffers highly spatially variable extinction A_v = 1.3 to 5.5 mag, estimated from K-band extinction map. S242 shows a quite larger structure as predicted by our analysis of radial density profile. The masses of the probable candidate YSOs varies in the range 0.1 to 3.0 M_{sun}, estimated from NIR colour-magnitude diagram. Optical spectroscopic observations for few bright members were conducted, and preliminary results will be presented here. A total of 38 H_α emission line objects were detected from slitless spectroscopic observations and photometry from the INT Photometric H_α Survey of the Northern Galactic Plane (IPHAS). A majority of the H_α emitters are considered to be Classical T Tauri stars. Thus an overall picture on the characterization of YSO's and molecular environment of S242 will be drawn using multi-wavelength perspective.

P03 **Spectral calibration of cool stars: a new medium-resolution HK-band HCT TIRSPEC spectral library**

by Supriyo Ghosh (India), Soumen Mandal, Ramkrishna Das & Dhrimadri Khata

We present here medium-resolution spectra (R~1200) of 107 K-M type giant stars covering the wavelength ranges 1.50-1.80 and 1.95-2.40 micrometer. A total of 72 giants were observed using the TIFR Near-Infrared Spectrometer and Imager (TIRSPEC) on the 2.0-m Himalayan Chandra Telescope (HCT) located at Hanle (India) and 35 giants were taken from the archival Spex spectral library. We focus on some important spectral features (e.g., Si I, NaI, CaI, ^{12}CO overtone bands), and study the behaviour of their equivalent widths with fundamental parameters. We have calibrated the empirical relationship between the measured equivalent widths of ^{12}CO overtone bands and effective temperatures, and also the H_2O-K2 spectral index with effective temperature and spectral type. We found that the ^{12}CO first overtone band at 2.29 micrometer and the second overtone band at 1.62 micrometer are a better temperature indicator above 3400 K. The H_2O-K2 index is tightly correlated with the effective temperature below 3600 K and spectral type later than M4. Hence, it could be a powerful tool for cool sub-types later than M4.

P04 **A search for fast photometric variability of very low mass stars in IC 348**

by Samrat Ghosh (India), Soumen Mondal, Santosh Joshi, Sneh Lata & Ramkrishna Das

We present here our preliminary results from ground-based optical I-band photometric monitoring observations of few young very-low-mass stars (VLMs) in IC348 using the 2-m Himalayan Chandra Telescope (HCT) and the 1.3-m DFOT telescope. IC 348 is a star-forming region in Perseus Molecular Cloud having an age of 2-3 Myr. Our preliminary analysis shows prominent variability features in few sources on few selected regions of IC 348. The I-band light curves analysis of these VLMs show the variability periods of few hours, which are attributed to the fast rotational period in this kind of young VLMs.

P05 **Photometric study of three W UMa type variable stars**
by Alaxender Panchal (India) & Yogesh Joshi

At the Aryabhatta Research Institute of Observational Sciences (ARIES), Nainital, India, we have started a photometric monitoring program to study eclipsing binary candidates to understand their nature and determine their accurate parameters. In recent times, we have carried out photometric analysis of three W Ursae Majoris type variable stars which are also low mass contact binary stars. The photometric variability of W UMa stars ranges from a few tenths to slightly over a magnitude and periods are typically short which vary between 4 hrs to around 24 hrs. The stars are assumed to be in a similar evolutionary state, located near or just above the main sequence. In the first phase of our program, we selected J163321.3+543928, J152450.7+245943 and J163720.4+172047 from the Catalina Surveys periodic variable stars Catalog for our analysis using the 1.3-m telescope. The initial period of these systems is reported to be less than 6 hrs, so, we could easily cover their full orbit on a single night. For the first two sources, we give light curves in the B, V, and I bands while in case of third system we provided light curves in the V, R, and I band. We used the PHOEBE and Wilson-Devinney code for the analysis of light curves. The photometric analysis of these 3 objects has been carried out first time.

P06 **Linear polarization towards anti-galactic direction: a case of the open star cluster Alessi1**
by Sadhana Singh (India), Jeewan C. Pandey, Biman J. Medhi & Arti Joshi

In this poster, we present the linear polarimetric observations for 80 stars in the open cluster Alessi 1 in B, V, R, and I photometric bands using the Aryabhatta Research Institute of Observational Sciences (ARIES) IMaging POLarimeter (AIMPOL) mounted at 1.04-m Sampuranand Telescope, Nainital. Preliminary results show that the average value of the polarization for the cluster Alessi 1 is 0.8% and position angle is 55 degree. The size distribution of the grains within Alessi 1 is similar to those in the general interstellar medium. Our results indicate that the polarization towards Alessi1 is dominated by foreground dust grains. Some of the observed stars have also shown the indication of intrinsic polarization in these measurements. Our study also approaches towards the cluster membership based on polarization and the average size of dust grains.

P07 **Polarization study of massive binaries with the 1.04-m ARIES telescope**
by Bharti Arora (India), Jeewan C. Pandey, Arti Joshi & Michaël De Becker

Massive stars (O type and Wolf-Rayet stars) are hot and luminous objects which are characterized by their huge stellar winds that lead to high mass loss rates (10^{-6} to 10^{-4} M_{sun} per year). These stellar winds are dense and strongly ionized abundant in free electrons and ions. This fact opens the door to a promising way of systematically probing the wind structure of these stars, namely via the polarization of starlight. In particular, it is the free electrons that can lead to linear polarization of light through single Thomson scattering in an ionized optically thin plasma envelope co-rotating with the star. In the case of binary systems with sufficient circumstellar scattering material, phase-dependent modulation in the linear polarization are seen which are caused by the relative orbiting motion of the companion. A model for such variations in binary systems has been developed by several authors assuming the optically thin and co-rotating envelopes around the stars. This model yields the inclination of the orbit (hence the stellar masses, once the radial velocity orbits are known), other parameters characterising the distribution of the scattering matter in the system, and the rate of mass loss. To this aim, we are making optical linear polarization measurements of massive binaries (WR+O and O+O) lying in the northern hemisphere and having the orbital period of few days with the ARIES Imaging Polarimeter mounted on the 1.04-m Sampurnanand Telescope at ARIES, Nainital. We intend to present the preliminary results which we have obtained from the polarization data of massive binaries collected over past 2 years.

P08 **Photometric study of the open clusters NGC 381 and King 21**
by Jayanand Maurya (India) & Yogesh Joshi

The study of open star clusters is important to understand star formation history and stellar-evolution theories because all member stars of a cluster were born from the same molecular cloud and have approximately the same distance, age, and chemical composition. The values of different physical parameters of an open star cluster can be estimated by comparing the colour-magnitude diagram (CMD) and two-colour diagram (TCD) of the cluster with the theoretical evolutionary models. Moreover, the study of the distribution of stellar masses at the time of cluster formation is very important in the analysis of the evolution of galaxies, and the initial mass function plays an important role in understanding the early dynamical evolution of star clusters. To study some of these clusters in the Galaxy, we have carried out UBVRI photometry of stars present in open clusters NGC 381 and King 21. The spatial structure of the clusters were studied and their radii were estimated by drawing radial density profiles (RDP) and fitting King models. The membership probabilities of stars in the region of the clusters were derived through a photometric and kinematic study of the clusters. To estimate the physical cluster parameters like distance, age, and reddening of the clusters, we used the stellar isochrones fitting method in the observed (B - V)/V and (V - I)/V CMDs, and TCDs. We derived the luminosity functions and the mass functions for both the clusters. The detailed photometric study of the cluster shall be presented in the poster.