3rd BINA WORKSHOP

Scientific Potential of the Indo Belgian Cooperation

Graphic Era Hill University

Bhimtal, India

22-24th March 2023

Department of Science & Technology, Government of India

Azadi Ka Amrit Mahotsav

belspo

SCIENTIFIC PROGRAM

21 March 2023

Inauguration of the ILMT

13:30-15:30	Inauguration of the ILMT at Devasthal by *Honorable Minister of State* (Independent Charge) for Science and Technology and Earth Sciences (Venue : Devasthal Campus, ARIES)

Public Lecture on commemorating ARIES Foundation Day

Chair : *Ram Sagar*

16:00-17:00	*Jean Surdej* (University of Liège, Belgium) The 4-m International Liquid Mirror Telescope : A short History (Venue : Devasthal Campus, ARIES)
20:00	Welcome Reception @ *Country Inn Nature Resort, Bhimtal****

22 March 2023

Session 0 : Opening Ceremony of the 3rd BINA Workshop

	09:30-09:35	Opening Remarks by *Director ARIES*
	09:35-09:40	Address by Prof. Kamal Ghansala, President, Graphic Era Hill University
	09:40-09:45	Address by Dr. *S. K. Varshney*, Adviser & Head, International Cooperation, DST, Govt of India
	09:45-09:50	Introductory words by *Mr. Didier Vanderhasselt* (Belgian ambassador)
	09:50-10:00	Video message by *Mr. Arnaud Vajda* (President of the Direction Committee of the Belgian Federal Science Policy Office)
	10:00-10:10	*Peter De Cat*, ROB Belgium (Belgian PI of BINA, Co-Chair SOC) The Belgo-Indian Network for Astronomy and Astrophysics: from Birth to Adulthood
	10:10-10:20	*Dipankar Banerjee*, ARIES, India Indian and Belgian Solar Space Missions
	10:20-10:30	*Santosh Joshi*, ARIES, India (Indian PI of BINA, Co-Chair SOC) A glimpse of the Scientific Program and Vote of Thanks

10:30-11:30	Group Photograph, HIGH TEA BREAK & Interaction with Media

Session 1 : DOT : Observing strategy and upcoming backend Instruments

Chair : *Katrien Kolenberg*

11:30-12:00	*Nissim Kanekar* (NCRA, India) How do I get observing time on the DOT ?
12:00-12:20	*Jayshreekar Pant* (ARIES, India) DOT HRS : A high-resolution spectrograph for Devasthal Optical Telescope - Status and Update
12:20-12:40	*Joe Philip Ninan* (TIFR, India) A new instrument for conducting world's largest spectroscopic survey of YSOs from DOT
12:40-13:00	*Amitesh Omar* (IIT-Kanpur, India) Prospects for polarization observations capabilities using ADFOSC on 3.6-m DOT
13:00-14:30	LUNCH BREAK

Schedule for Main Session

Session 2 : New Observing Facilities and back-end Instruments

Chair : Soumen Mondal

	14:30-14:50	*Brajesh Kumar* (ARIES, India) Observing preparations and commissioning of the 4-m ILMT
	14:50-15:20	*Abhijit Chakraborty* (PRL, India) PRL 2.5-m telescope : first light instruments and projected science cases
	15:20-15:40	*Jyotirmay Paul* (ULiège, Belgium) Enhancing the capability of future medium-size telescopes : First light of the SALTO demonstrator
	15:40-16:00	*Karan Singh Dsilva* (ULB, Belgium) High-resolution spectrograph at a 1-m class telescope: what can we gain ?
	16:00-16:30	TEA BREAK

Session 3 : Solar System Bodies and Exoplanetary Science

Chair : *Shashikiran Ganesh*

	16:30-16:50	*Aravind K.* (PRL, India) Optical spectroscopy of comets
	16:50-17:10	*Mathieu Vander Donckt* (ULiège, Belgium) Photometric and spectroscopic study of periodic carbon-chain depleted comets from Belgian and Indian observatories
	17:10-17:30	*Anandmayee Tej* (IIST, India) Stellar Occultation with DOT : Probing Planetary Atmospheres
	17:30-17:50	*Suman Saha* (IIA, India) Detection and characterization of habitable exo-moons in the JWST era
	17:50-18:00	TEA BREAK

Evening Talk

Chair : *Brijesh Kumar*

	18:00-19:00	*Ram Sagar* Indo-Belgian cooperation in Astrophysics : From inception to future prospects
	20:00	DINNER (own arrangement)

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Session 4 : Multiple Stellar Systems

Chair : *Laurent Mahy*

	09:30-10:00	*Thibault Merle* (ROB/ULB, Belgium) Dancing with the stars : a review on stellar multiplicity
	10:00-10:20	*Alaxender Panchal* (ARIES, India) Characterization of K2 eclipsing binary candidates
	10:20-10:40	*Gurpreet Singh* (ARIES, India) An X-ray Study of Coronally Connected Active Eclipsing Binary, XY Uma
	10:40-11:00	*Namita Uppal* (PRL, India) Optical polarization study of Galactic Open clusters
	11:10-11:30	TEA BREAK

Session 5 : Spectroscopy of Galactic Sources

Chair : *Drisya Karinkuzhi*

	11:30-12:00	*Aruna Goswami* (IIA, India) On the potential of Carbon-enhanced metal-poor stars for Galactic Archaeology
	12:00-12:20	*Deepak* (ARIES, India) 3.9-m AAT's contribution in addressing the mystery of Li-rich giants' origin and valuable lessons for 3.6-m DOT
	12:20-12:40	*Pallavi Saraf (IIA, India)* Connecting Chemistry and kinematics of r-process enhanced stars to trace their origin
	12:40-13:00	*Gajendra Pandey (IIA, India)* Measuring helium abundances of cool stars
	13:00 - 14:30	LUNCH BREAK

Session 6 : Massive stars

Chair : *Abhay Pratap Yadav*

	14:30-15:00	*Gregg Wade* (Royal Military College of Canada, Canada) Magnetism of Massive Stars, on and after the main sequence

15:00-15:20	*Bharti Arora* (ULiège, Belgium) Multi-wavelength view of massive binaries
15:20-15:40	*Anindya Saha* (IIST, India) Are isolated single Wolf-Rayet stars capable of accelerating particles to relativistic speed ?
15:40-16:00	*Gourav Banerjee* (CHRIST (Deemed to be) University, India) Spectroscopic studies of Galactic classical Be stars using Indian optical telescope facilities
16:00-16:30	TEA BREAK

Session 7 : Multi-wavelength studies of star formation regions

Chair : *Tapas Baug*

16:30-17:00	*Devendra K. Ojha* (TIFR, India) Understanding the outbursts in young low mass stars
17:00-17:20	*Arpan Ghosh* (ARIES, India) Spectro-Photometric Monitoring of Eruptive Young Stellar Objects
17:20-17:40	*Jyotirmoy Dey* (IIST, India) A study of ultracompact HII regions with extended emission - their importance, origin, and evolution

	17:40-18:00	*Lokesh Kumar Dewangan* (PRL, India) Multi-wavelength Study of the Star Formation in the Sh 2-305 HII Region
	18:00-18:15	TEA BREAK

Social Events

	18:15-19:30	Cultural Program by Sanskar Sanskritik Evam Paryavaran Sanrakshan Samiti, Almora Venue : Graphic Era Hill University Campus Bhimtal
	20:00-22:00	CONFERENCE DINNER Venue : Graphic Era Hill University Campus Bhimtal

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Session 8 : Compact objects

Chair : *Jeewan C. Pandey*

	09:30-09:50	*Suman Bhattacharyya* (CHRIST, Deemed to be University, India) Unraveling the recent X-Ray flare from MAXI J0709–159 using Indian optical telescope facilities
	09:50-10:10	*Nikita Rawat* (ARIES, India) Confirmation of Two Magnetic Cataclysmic Variables as Polars - 1RXS J174320.1-042953 and RX J1039.7-0507
	10:10-10:30	*Sachindra Naik* (PRL, India) Optical and X-ray studies of Be/X-ray binary 1A 0535+262 during its 2020 giant X-ray outburst
	10:30-10:45	TEA BREAK

Session 9 : Transients

Chair : *Kuntal Misra*

	10:45-11:05	*Dimple Panchal* (ARIES, India) Multi-wavelength analysis of short GRB 201221D and its comparison with other high & low redshift short GRBs

	11:05-11:25	*Rahul Gupta* (ARIES, India) Recent observations of peculiar Gamma-ray bursts using 3.6-m Devasthal Optical Telescope (DOT)
	11:25-11:40	TEA BREAK

Session 10 : Extragalactic astrophysics

Chair : *C. S. Stalin*

	11:40-12:00	*Krishan Chand* (ARIES, India) Intra-night variability of UV emission from powerful blazars
	12:00-12:20	*Priyanka Jalan* (Polish Academy of Science, Poland) Discovery of lensed quasars using multiply imaged quasar candidates
	12:20-12:40	*Vivek Kumar Jha* (ARIES, India) New accretion disk size measurements for reverberation mapped AGN
	12:40-14:00	LUNCH BREAK

Session 11 : Summary of the 3rd BINA Workshop

Chair : *Talat Akhunov*

	14:00-14:20	*Eugene Semenko* (NARIT, Thailand) Stellar Sessions
	14:20-14:40	*Manfred A. Cuntz* (UTA, USA) Solar Sessions
	14:40-15:00	TEA BREAK

Session 12 : Open Discussion

Moderators : *Michaël De Becker & Nilakshi Veerabathina*

	15:00-15:25	Planning of strengthening the ongoing Indo-Belgian collaboration in Science, Instrumentation and Public Outreach & Education in Astronomy
	15:25-16:00	Concluding Remarks by Director, ARIES

End of Workshop

Schedule for Solar Session

22 March 2023

Solar Session 1 : MHD waves and small-scale transients

Chair : *Bhuwan Joshi*

	14:30-14:55	*David Berghmans* (ROB, Belgium) Science opportunities by the Extreme Ultraviolet Imager (EUI) onboard Solar Orbiter
	14:55-15:20	*Girjesh Gupta* (USO, PRL) Tracing the source region of waves in coronal fan loops anchored in the sunspot umbra
	15:20-15:45	*Ramesh Chandra* (Kumaun University, India) Characteristics of solar EUV wave events
	15:45-16:30	TEA BREAK

Solar Session 1 continued...

Chair : *Bhuwan Joshi*

	16:30-16:55	*Tom Van Doorsselaere* (KU Leuven, Belgium) Observations of short-period oscillations in Solar Orbiter/EUI
	16:55-17:20	*Arpit Kumar Shrivastav* (ARIES, India) Study of the Impact of Coronal Rain on Kink Oscillations of Coronal Loops
	17:20-17:45	*Ambika Saxena* (ARIES, India) Exploring spectral line asymmetries due to the propagating MHD waves in the solar atmosphere
	17:45-18:15	TEA BREAK
	18:00 onwards	Rejoin the main session program

23 March 2023

Solar Session 1 continued...

Chair : *Bhuwan Joshi*

	09:30-09:55	*Rajab Ismayilli* (KU Leuven, Belgium) Nonlinear self-deformation of unidirectional surface Alfvén waves and properties of Uniturbulence
	09:55-10:20	*Upasna Baweja* (ARIES, India) Coronal Magnetic field estimation using Bayesian inference
	10:20-10:45	*Tanmoy Samanta* (IIA, India) Generation of solar spicules and subsequent atmospheric heating
	10:45-11:10	*Sahel Dey* (IIA, India) Insights into the genesis and dynamics of the solar spicule forest : aided by laboratory experiments
	11:10-11:30	TEA BREAK

Solar Session 2 : Physics of Flares and CMEs

Chair : *David Berghmans*

	11:30-11:55	*Bhuwan Joshi* (USO, PRL) Onset and evolution of solar flares : application of 2D and 3D models of magnetic reconnection
	11:55-12:20	*Madhurjya Changmai* (KU Leuven, Belgium) Exploring magnetic reconnection due to Rayleigh-Taylor Instability induced turbulence in Solar Prominences
	12:20-12:45	*Anwesha Maharana* (KU Leuven, Belgium) Towards improving CME forecasting with MHD modelling and observations
	12:45 - 14:30	LUNCH BREAK

Solar Session 2 continued...

Chair : *David Berghmans*

	14:30-14:55	*Nitin Vashishtha* (ARIES, India) Numerical simulation and forward modelling of a breakout CME
	14:55-15:20	*Jyoti Sheoran* (ARIES, India) Evolution of the Thermodynamic Properties of a Coronal Mass Ejection in the Inner Corona

	15:20-15:45	*Ritesh Patel* (Southwest Research Institute, USA) Advance image processing algorithm for CMEs studies with Aditya-L1/VELC
	15:45-16:30	TEA BREAK

Solar Session 2 continued...

Chair : *David Berghmans*

	16:30-16:55	*Tinatin Baratashvili* (KU Leuven, Belgium) Icarus: a new highly optimized heliospheric model for forecasting purposes
	16:55-17:20	*Susanta Kumar Bisoi* (NIT-Rourkela, India) Origin of Extremely Non-radial Solar wind
	17:20 onwards	Rejoin the main session program

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Solar Session 3 : Long Term studies

Chair : *Tom Van Doorsselaere*

	09:30-09:55	*Manfred Cuntz* (University of Texas, USA) Evolution of Solar-Type Activity : An Observational and Theoretical Perspective
	09:55-10:20	*Dibya Kirti Mishra* (ARIES, India) Variation in the Chromospheric Differential Rotation over the Century
	10:20-10:45	*Srinjana Routh* (ARIES, India) Study of Variation in the Rotational Profile of the Sun Beyond Photosphere
	10:45-11:30	TEA BREAK
	11:30 onwards	Rejoin the main session program

End of Solar Session

List of Posters

Session 1 : Observing strategy and upcoming backend Instruments

S1-P1	Brijesh Kumar (ARIES, India)	Science highlights with DOT
S1-P2	Tarun Bangia (ARIES, India)	Health analysis of compressor for 3.6-m Devasthal Optical Telescope
S1-P3	Vibhore Negi (ARIES, India)	The 4-m International Liquid Mirror Telescope Data Reduction Pipeline : Analysis and First Results

Session 2 : New Observing Facilities and back-end Instruments

S2-P1	B. C. Bhatt (IIA, India)	Site testing for optical telescopes in India – past and present
S2-P2	Bhavya Ailawadhi (ARIES, India)	An automated photometric pipeline for the ILMT data
S2-P3	Kumar Pranshu (ARIES, India)	Automated Transient detection and classification in the context of ILMT
S2-P4	Naveen Dukiya (ARIES, India)	Astrometric and photometric standard candidates for the upcoming 4-m ILMT survey
S2-P5	Peter De Cat (ROB, Belgium)	The prospects of pulsating stars studies with the International Liquid Mirror Telescope
S2-P6	Prachi Prajapati (PRL, India)	Near-infrared Imager, Spectrometer, and Polarimeter (NISP)
S2-P7	Purvi Udhwani (ARIES, India)	Assembly and testing of a Ground Layer Adaptive Optics (GLAO) system on ARIES telescopes
S2-P8	Vibhore Negi (ARIES, India)	Astrometric calibration of the 4m ILMT data

S2-P9	Kuntal Misra (ARIES, India)	Accessibility of the ILMT survey data #(not mentioned on website)
S2-P10	Brajesh Kumar (ARIES, India)	Supernovae detection rate with the ILMT and their followup strategy with ARIES facilities
S2-P11	Monalisa Dubey (ARIES, India)	A year-long representation of the ILMT observations in different coordinate systems
S2-P12	Jean Surdej (Uliege, Belgium)	The 4-m International Liquid Mirror Telescope project
S2-P13	Paul Hickson (UBC, Canada)	Serendipitous Detection of Orbital Debris by the International Liquid Mirror Telescope: First Results
S2-P14	Ethen Sun (UBC, Canada)	Progress on a photometric data pipeline for extracting quasar light curves from ILMT images
S2-P15	Jiuyang Fu (UBC, Canada)	Surface brightness properties of LSB galaxies with the ILMT
S2-P16	Baldeep Grewal (UBC, Canada)	Extracting High-Quality Light Curves for Cepheid Variables with the ILMT
S2-P17	Talat Akhunov (NUUU, Uzbekistan)	Gravitational Lensing Observations Of Quasars With The 4-m ILMT
S2-P18	Anna Pospieszalska (Uliege, Belgium)	Detection and characterisation of Asteroids with the 4-m ILMT

Session 3 : Solar System Bodies and Exoplanetary Science

Session 4 : Multiple Stellar Systems

S4-P1	Alok Durgapal (KU-Nainital, India)	Search of variable stars in open clusters
S4-P2	Anju Panthi (BITS-Pilani, India)	Study of BMP stars using UVIT/AstroSat
S4-P3	Athul Dileep (ARIES, India)	Exploring the Nainital-Cape Survey Stars with TESS
S4-P4	A. S. Hojaev (UBAI, Uzbekistan)	Study for variable stars in King 18
S4-P5	Jeewan C. Pandey (ARIES, India)	X-ray study of a disc-overflow system TX Col
S4-P6	Katrien Kolenberg (KU Leuven, Belgium)	Study of RR Lyrae stars
S4-P7	Kaushar Vaidya (BITS-Pilani, India)	Blue Straggler Stars of NGC 7789 and NGC 2506 using AstroSat/UVIT
S4-P8	Komal Chand (BITS-Pilani, India)	Characterisations of hot populations of Berkeley 39 open cluster using UVOT/Swift
S4-P9	Khushboo Kunwar Rao (BITS-Pilani, India)	Blue straggler stars : setting up a dynamical clock for open clusters
S4-P10	Maurya Jayanand (PRL, India)	Probing stellar evolution properties through variable stars in open cluster NGC 381
S4-P11	Mrinmoy Sarkar (ARIES, India)	Time-Resolved TESS Photometry of HD 118660
S4-P12	Priya Hasan (MANUU, India)	Binary fraction in Star Clusters
S4-P13	Ramakant Singh Yadav (ARIES, India)	UVIT/Astrosat studies of blue straggler star in NGC 362- detection of extremely low mass white dwarf
S4-P14	Sadhana Singh (PRL, India)	Polarimetric Approach towards Membership Probability

S4-P15	Sneh Lata (ARIES, India)	Detection of variable stars in the Galactic Globular Cluster M15
S4-P16	Srinivas M. Rao (ARIES, India)	Change in accretion flow in the Intermediate Polar, V709 Cas
S4-P17	Subhajeet Karmakar (MIRA, USA)	Astrosat investigation of X-ray flares on two active K-M systems: CC Eri and AB Dor
S4-P18	Subhajeet Karmakar (MIRA, USA)	Spectroscopic Investigation of stellar atmosphere from MIRA/OOS
S4-P19	Yogesh Chandra Joshi (ARIES, India)	Investigation of orbital-period changes of the short-period eclipsing binaries
S4-P20	Diya Ram (SNBNCBS, India)	Magnetic Activity of M-dwarfs
S4-P21	Rajib Kumbhakar (SNBNCBS, India)	Photometric Variability of Young Brown Dwarfs and very Low Mass Stars in the Taurus Star Forming Region)

Session 5 : Spectroscopy of Galactic Sources

S5-P1	Farha Gaffur (University of Calicut, India)	The isotopic ratios of Ba and Eu in s-process enhanced stars
S5-P2	Laurent Mahy (ROB, Belgium)	Identifying quiescent compact objects in massive Galactic single-lined spectroscopic binaries
S5-P3	Meenakshi P. (IIA, India)	LAMOST J045019.27 + 394758.7, with peculiar abundances of N, Na, V, Zn, is possibly a Sculptor dwarf galaxy escapee
S5-P4	Mohammad Riyas (University of Calicut, India)	Is i-process dependent on metallicity?
S5-P5	Partha Pratim Goswami (IIA, India)	Formation scenarios of Ba stars: new evidence from the masses of the companion AGBs

Session 6 : Massive Stars

S6-P1	Abhay Pratap Yadav (NIT-Raurkela, India)	Study of instabilities and outbursts in luminous blue variables
S6-P2	Michaël De Becker (Uliège, Belgium)	Investigating the role of pre-supernova massive stars in the acceleration of galactic cosmic rays
S6-P3	Michaël De Becker (Uliège, Belgium)	Synchrotron radio emission as a proxy to identify long period massive binaries
S6-P4	Sugyan Parida (NIT-Raurkela, India)	Study of B[e] type supergiant MWC 137

Session 7 : Multi-wavelength studies of star formation regions

S7-P1	Aayushi Vema (ARIES, India)	Study of Young Star-Forming Region near AFGL 5157
S7-P2	Harmeen Kaur (KU-Nainital, India)	Spatial structure and star formation scenario in young star cluster Bochum
S7-P3	Neelam Panwar (ARIES, India)	Formation and Evolution of young low-mass stars in star forming Regions
S7-P4	Saurabh Sharma (ARIES, India)	Multi-wavelength Star formation studies
S7-P5	Théo Furst (ROB, Belgium)	Characterisation of the massive star formation history in young open clusters
S7-P6	Tapas Baug (SNBNCBS, India)	Protostellar outflows and their orientation with host filaments in massive protoclusters
S7-P8	Sudip Pramanik (SNBNCBS, India)	Census of Young Stars in Galactic Star-forming Region Sh2-88

Session 8 : Compact Objects

Session 9 : Transients

S9-P1	Amar Aryan (ARIES, India)	Supernovae from a pop III star of 25 Solar mass
S9-P2	Amit Kumar Ror (ARIES, India)	Prompt emission and early optical afterglow of VHE detected GRB 201015A and GRB 201216C : onset of the external forward shock.
S9-P3	Ankur Ghosh (ARIES, India)	On the multi-wavelength nature of GRB 200524A : from prompt emission to afterglow.
S9-P4	Kuntal Misra (ARIES, India)	Gamma Ray Bursts and their afterglows at TeV energies

Session 10 : Extragalactic Astrophysics

S10-P1	Akhunov Talat (NUUU, Uzbekistan)	Light curves and time delay of the gravitationally lensed systems : SDSS J2124+1632 and SDSS J0806+2006
S10-P2	C. S. Stalin (IIA, India)	Star formation characteristics of galaxies hosting AGN
S10-P3	Mainpal Rajan (DU, India)	Spectro-timing analysis of an NLS1 galaxy NGC 4748.
S10-P4	Margarita Safanova (IIA, India)	Deep photometry of suspected gravitational lensing events
S10-P5	Shivangi Pandey (ARIES, India)	Measuring the black hole mass of the low-luminous AGN : NGC 4395
S10-P6	Sunil Chandra (SAAO, South Africa)	One-HaLe model for the SED of blazars and a curious case of CGRaBS J0211+1051

S10-P7	Vijayakumar H Doddamani (Bangalore University, India)	Nature of UV variability in NGC 4151 using IUE's intensive monitoring spectroscopic data
S10-P8	Vinit Dhiman (ARIES, India)	Multi-band Optical Variability of the TeV Blazar PG 1553+113
S10-P9	Haritma Gaur (ARIES, India)	X-ray spectral breaks in high redshift blazars : probes of intervening medium

S-P	Aakash Narayan (IS-BHU, India)	Study of Magnetic Dipole Moment of Pulsar

EVENING TALK

The 4-m International Liquid Mirror Telescope : A Short History

Jean Surdej
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Since Newton's time, scientists knew that the surface of a spinning liquid takes the shape of a paraboloid, the perfect surface of reference to focus into a single point the light rays coming from a celestial source. However, it was not until 1850 that an Italian astronomer - Ernesto Capocci - suggested to use a rotating recipient filled with mercury as the primary mirror of an astronomical telescope. But at that time, the concept was not taken seriously, mainly because a mercury mirror cannot be tilted to track moving objects. Indeed, because of the Earth's rotation, astronomical objects would produce long streaks instead of stellar images on the photographic emulsions used in astronomy until the end of the XXth century. The advent of charge coupled devices (CCDs) in the 1970s changed the situation. CCDs enable a technique, called time-delayed integration (TDI), to compensate for the Earth's rotation. This is done by electronically stepping the electronic charges on the surface of the CCD at the same speed as the stellar images drift in the focal plane of the telescope. TDI has revived scientific interest in liquid mirrors (LMs), which are considerably less expensive to build and operate than glass mirrors. Starting in the early 1980s, scientists mostly in Canada have been engaged in significant development work in the laboratory and observatories. Researchers first demonstrated the feasibility of large liquid optics and developed the basic technology behind it. Optical shop tests of liquid mirrors with diameters as large as 2.5 m had shown diffraction-limited optical quality. Several telescopes were then built and operated, starting with a 2.7-m diameter LMT at the University of British Columbia (UBC), then a 3-m diameter LM, the NASA Orbital Debris Observatory (NODO), used to

observe space debris and the 6 m diameter Large Zenith Telescope (LZT) built at UBC. Liquid mirrors have also been used by atmospheric scientists for LIDAR applications. For instance, the LZT has been used to study with an unprecedented spatial resolution the structure and dynamics of the Earth's mesosphere and lower thermosphere. Benefiting from all these developments, the 4m International Liquid Mirror Telescope (ILMT) was ready for construction. The ILMT project is a scientific collaboration in observational astrophysics between the Liège Institute of Astrophysics and Geophysics (Liège University), several Canadian universities (British Columbia, Laval, Montréal, Toronto, Victoria and York) and the Aryabhatta Research Institute of Observational Science (ARIES, Nainital, India). Several colleagues from the Royal Observatory of Belgium, the Poznań Observatory (Poland), the Ulugh Beg Astronomical Institute of the Uzbek Academy of Sciences and the National University of Uzbekistan, and the Indian Space Research Organization (ISRO) have also joined the ILMT project. After several years of design work in Belgium and construction in India, commissioning began in April 2022, and the telescope achieved first light on April 29th. A brief history of the ILMT project will be presented and also some first scientific results.

Session 1

Observing strategy and upcoming backend Instruments

How do I get observing time on the DOT ?

Nissim Kanekar
National Centre for Radio Astrophysics (NCRA),
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In this talk, I will describe the DTAC proposal evaluation process, various statistics of the proposals received by DTAC, issues that we have seen in the DOT proposals, and basic things that could be implemented to improve the chances of getting DOT observing time.

DOT HRS : A High-Resolution Spectrograph for Devasthal Optical Telescope - Status and Update

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DOT HRS is a fiber-fed high-resolution spectrograph for 3.6m Devasthal Optical Telescope at Aryabhatta Research Institute of Observation Sciences (ARIES). The spectrograph is being built in collaboration with Australian Astronomical Optics (AAO) and is currently in the design phase. The design of the spectrograph is based on the white pupil configuration with a prism cross disperser to record the specified wavelength range from 380-850 nm on one large-size detector in a single exposure. DOT HRS offers two modes of observation namely high resolution and high efficiency to cater a variety of science requirements. The spectrograph aims at high precision radial velocity measurement with the possibility of recording simultaneous spectra of object and calibration or object and sky. The spectrograph will be housed in a vacuum tank inside a thermally controlled enclosure to achieve the required instrument stability. In this contribution, we will present the details of the instrument and project status.

A new instrument for conducting world's largest spectroscopic survey of YSOs from DOT

Joe Philip Ninan
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Accretion and outflows in young protoplanetary disc systems remain one of the biggest open problems in planet and star formation. Spectroscopic analysis are currently the only way to study these spatially unresolvable inner part of the disc. Unfortunately, spectroscopy of these systems using traditional spectrographs are too expensive. ARIES and TIFR is building a new kind of multi-object optical to near infrared spectrograph as a second generation instrument on DOT. This spectrograph can simultaneously obtain spectra of up to 8 stars located anywhere in the 10x10 armin^2 FoV of DOT in the wavelength range of 380 nm to 2500 nm at a resolution of R~2500. In this talk, I shall present about this new instrument and its design status.

Prospects for polarization observations capabilities using ADFOSC on 3.6-m DOT

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Efforts to enable full polarization mode observations in the ADFOSC on the 3.6-m DOT will be presented. Two prototypes to assess instrument polarization have been installed in the ADFOSC - one setup uses a single Wollaston prism and different polarization states of incoming light from the sky are measured via rotation of the entire ADFOSC instrument on the telescope while the second setup uses two Wollaston prisms with orientations such that 4 well-separated images are formed at a time. The second setup is useful for spectropolarimetry using different grisms and slits while the first setup is used for imaging polarimetry in different filters. The instrument calibration results will be presented in this talk. Designs for the science-mode spectro-polarimetry setup under development in ADFOSC will also be presented.

Session 2

New Observing Facilities and back-end Instruments

Observing preparations and commissioning of the 4-m ILMT

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The 4m International Liquid Mirror Telescope (ILMT) is a zenith-pointing optical observing facility at ARIES Devasthal Observatory (Uttarakhand, India). The ILMT will perform a multi-band optical (SDSS g', r', and i') imaging of a narrow strip (~22') of sky utilizing the time-delay integration technique. Single-scan images have an effective integration time of 102 sec which can be further improved by co-adding the nightly images. Various preparatory activities were carried out, followed by the first light observations in April-May 2022. Multi-band observations have been obtained with the ILMT before the Monsoon closing (9th June 2022). Presently, the data pipeline testing is in progress. Some technical issues were recently resolved with the AMOS team. The commissioning phase observations are planned from mid-Oct 2022. In this work, we present a discussion of the major preparatory activities before the observations, along with some preliminary results based on the data obtained during the commissioning phase.

PRL 2.5-m telescope : first light instruments and projected science cases

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PRL has recently established a 2.5m telescope at its observatory site at Gurushikhar, Mt Abu. The telescope is the most modern state of art in technology and comes with a primary mirror active optics system and a tip/tilt system for first order seeing correction a tip/tilt system. The telescope is designed and built by M/s AMOS, Belgium based on the telescope parameters defined by PRL. I will be discussing the telescope performance and issues we have faced with the operation and it's performance. The telescope has so far performed mostly as per it's designed specifications. I will be also discussing the first light instruments and it's performance namely PARAS 2 and FOC. PARAS 2 is the high resolution fiber fed spectrograph under stabilized conditions working at resolution of R=110000 , and showing intrinsic stability of 30 to 40cm/s for exoplanets studies. FOC is the faint object camera with SDSS filters.

Enhancing the capability of future medium-size telescopes : First light of the SALTO demonstrator

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The adaptive optics technology is crucial to achieve the full potential of ground-based telescopes. Over the last three decades, the world has witnessed the successful advent and operation of AO systems on large ground-based telescopes. The complexity and cost of AO systems have largely gone down in the last decade thanks to advances in deformable mirror, wavefront sensor, and real-time computing technologies. Here, we present a robust Rayleigh scattered laser-guided single conjugated adaptive optics system called SALTO, which was designed, built, and tested in the Belgian countryside on a 1-meter class telescope. This project aims to demonstrate the possibility of rejuvenating the scientific goals of medium-class telescopes (1-3 m) with AO technology, as well as to enable optical telecommunication from relatively poor observing sites. This talk discusses the overall study of the design of the AO system, from the optics to the control system. It also includes a description of the integration and calibration of SALTO. It concludes with the presentation of successful on-sky results at 1.55µm under 2-3'' seeing.

High-resolution spectrograph at a 1-m class telescope - what can we gain ?

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High-resolution spectroscopy provides a unique perspective on many scientific problems in stellar astronomy. Science data acquired with the HERMES spectrograph mounted on the 1-m Mercator telescope has contributed to research on stellar variability, multiplicity, atmospheric analysis and even towards the search for black holes. With a well-developed pipeline that streamlines the data reduction along with the access to consistent monitoring of targets throughout the year, data from such a facility is well-suited to handle large surveys as well as long-term monitoring of individual targets. Furthermore, this data also complement that obtained from other larger facilities where telescope time is much more expensive. In my talk, I will highlight some of the science questions that have been investigated with HERMES in the past few years and discuss the benefits of a high-resolution spectrograph on a meter-class telescope.

Session 3

Solar System Bodies and Exoplanetary Science

Optical spectroscopy of comets

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Comets are the primordial remnants of the Solar system containing pristine materials in the proto-Solar nebula. They are called 'dirty snowballs', built up of dust and ice. These objects are inactive and non-detectable during a more significant part of their orbit as the ambient temperature is not high enough to sublimate the volatiles. As the comet moves closer to the Sun, its volatile materials sublimate, pushing out the dust in it. The light observed from a comet is composed of two components, the fluorescence emission from the gas and the Sunlight reflected by the dust particles present in it. Spectroscopic observations aid the study of both fluorescent and continuum emissions. The spatial variation of dust and gas emissions can help understand their characteristics within the coma. Using low-resolution long slit spectroscopy, the spatial variation in the column density of different molecular emissions can be analysed to compute their production rates and to model the scale lengths of their parent species using the Haser model. The availability of the spatial information can also be exploited to extract the Af(rho) parameter as a function of distance from the photocentre. The resulting characteristic Af(rho) profile can provide information regarding the dust emissions within the coma. High-resolution spectroscopy is also an efficient analysis technique to probe the different vibrational bands present in each molecular emission band. They can also help in separating the cometary and telluric oxygen line to understand better the major source of Oxygen present in the cometary spectrum, Water ice or Carbon dioxide ice. While both low-resolution and high-resolution spectroscopy have their disadvantages, they can be employed effectively to understand in-depth the comet's chemical composition.

Photometric and spectroscopic study of periodic carbon-chain depleted comets from Belgian and Indian observatories

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Comets are remnants from the formation of the Solar System, and are believed to have kept a pristine composition since their formation 4.4 billion years ago. Studying comets is then of great interest to understand the dynamical and chemical evolution of the Solar System from the protoplanetary disk stage until now. Optical observations of comets give insight into the composition of their atmospheres, especially of the secondary species (volatiles processed by the solar radiation field). From such observations, A'Hearn et al. (1995) found two main groups of comets based on their chemical composition: typical and carbon-depleted; the latter group showing a clear depletion of the C2 and C3 species with respect to OH and CN. We present here new observations of several potential carbon-depleted Jupiter-family comets 4P, 57P, 260P and 398P (Jehin et al. 2020) from a photometric narrow-band survey with the Belgian 0.6m TRAPPIST-South (La Silla, Chile) and 0.6m TRAPPIST-North (Oukaimeden, Moroco) telescopes (Jehin et al., 2011) that are compared with Long-slit spectroscopic observations that were carried out with the 2m Himalayan Chandra Telescope (HTC) over different epochs. This work results from a collaboration in the framework of the BINA program.

Stellar Occultation with DOT - Probing Planetary Atmospheres

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Stellar occultations offer a very powerful and unique tool for detecting and studying the tenuous atmospheres around remote celestial bodies. The talk will mainly focus on the recent results obtained with the 3.6-m DOT and 1.3-m DFOT which enabled probing and constraining Pluto's atmosphere.

Detection and characterization of habitable exo-moons in the JWST era

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Rocky exomoons in the habitable zones of the exoplanetary systems hold special significance as they can host life. Although the detection of exomoons has yet remained elusive, mainly due to their smaller expected size, the next generation space missions such as JWST can provide unique opportunity for their detection and characterization. In this talk, I will present a comprehensive analytical formalism in order to model the lightcurves of transiting exoplanets hosting exomoons. In order to achieve an analytical formalism, we have considered circular orbit for the exomoon around the host planet, which is indeed the case for tidally locked moons. The formalism takes care of the co-alignement or non-coalignment of the orbits of the planet and the moon using a two anglular parameter approach, and can be used to model and characterize all the possible orbital alignments for a star-planet-moon system. Using this formulation, we have studied the detectability of rocky exomoons using the next generation telescopes, such as JWST. I will also present our study on the detectability of the atmospheric features for such exomoons to study their habitability, using transmission spectroscopic observations from JWST.

EVENING TALK

Indo-Belgian cooperation in Astrophysics - from inception to future prospects

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Scientists and Engineers from India and Belgium started formal interaction and academic collaboration about 2 decades ago. Using resources available in both countries, this collaboration has strengthened both observational facilities and research publications in the area of astrophysics and astronomy. This talk will present the accomplishment and future potential of this collaboration in the present era of multi-wavelength astronomy.

Session 4

Multiple Stellar Systems

Dancing with the stars : a review on stellar multiplicity

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Stars like company. They are mostly formed in clusters and their lives are often altered by the presence of one or more companions. Interaction processes between components may lead to complex outcomes like Algols, blue stragglers, chemically altered stars, type Ia supernovae, as well as progenitors of gravitational wave sources, to cite a few. Observational astronomy has entered the era of big data, and thanks to large surveys like spatial missions Kepler, TESS, Gaia, and ground-based spectroscopic surveys like RAVE, Gaia-ESO, APOGEE, LAMOST, GALAH (to name a few) the field is going through a true revolution, as illustrated by the recent detection of stellar black holes and neutron stars as companions of massive but also low-mass stars. In this review, I will focus on interesting recent discoveries on binaries and higher order systems and present statistical properties of multiples that can help to constrain the formation mechanisms of multiple stars and the numerous evolutionary pathways of their evolution.

Characterization of K2 eclipsing binary candidates

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Eclipsing binaries (EBs) are key sources to determine accurate stellar parameters and distances. A statistically large sample of well characterized EBs can be used for testing stellar evolution models and theories. The Kepler mission of NASA discovered thousands of EBs along with exoplanets. The Kepler EB database consists of precise photometric data for nearly 3000 confirmed EBs. Apart from these confirmed EBs, there are thousands of candidate EBs listed in Kepler archive. Under the project Optical characterization and Radial velocity monitoring with Belgian and Indian Telescopes (ORBIT), we confirm and characterize the K2 EB candidates using ground based photometric monitoring and high-resolution spectroscopic observations. In this talk, I will discuss results from our follow-up observations of some EB systems.

An X-ray Study of Coronally Connected Active Eclipsing Binary, XY Uma

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We present a detailed analysis of the coronally connected system, XY UMa. XY UMa is a short period (~0.48 day) eclipsing binary with a G2 type dwarf orbiting a K5 dwarf. The system serves as excellent grounds for the effect of a late-type star on the sun-like star. Based on the coronal imaging using an X-ray light curve inversion technique, we found that both the components in the system are active, with primary being 4 times more X-ray bright than secondary. Coronal images show active regions are concentrated on the poles of each component, with a bright X-ray active region at the coronal connection. The simultaneous UV light curves show positively correlated emission with X-ray emission, and nearly half of the observed UV emission originates from the photospheres of components. The quiescent X-ray spectra of this system can be well explained by a two-temperature plasma model with average values of lower and higher temperatures of 0.29 and 1.01 keV, respectively. The phase-resolved X-ray spectral analysis shows emission measures and luminosity are orbitally modulated, whereas the temperatures and coronal abundances do not vary with the orbital phase. A total of three X-ray flares have been detected with loop lengths ranging from 3-22 $\times 10^{9}$ cm. All these flares seem to be originating from the same active region. Our results show a physical coronal connection is possible in short-period binary systems, which increases the activity of both the stars in the system. Due to coronal connection, each component's coronae equilibrated to a single system.

Optical polarization study of Galactic Open Clusters

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Dust is a ubiquitous component in our Galaxy. It accounts for only 1% mass of the ISM, but still is an essential part of the Galaxy. It affects our view of the Galaxy by obscuring the starlight at shorter wavelengths and re-emitting in longer wavelengths. Studying the dust distribution in the Galaxy at longer wavelengths may cause discrepancies due to distance ambiguity caused by unknown Galactic potential. However, another aspect of dust, i.e., the polarization of the background starlight, when combined with distance information, will help to give direct observational evidence of the number of dust clouds encountered in the line of sight. Besides this, the polarization measurements help to explore the dust properties and plane of sky magnetic fields on small as well as large scales. We used two instruments: an EMCCD-based polarimeter (EMPOL) and an ARIES Imaging POLarimeter (AIMPOL) at two Indian observational facilities, i.e., the 1.2 m telescope of Mount Abu Observatory and the 1.04 m Sampurnanand telescope, ARIES respectively to carry out the observations. With proper observation strategy and careful data reduction techniques, these instruments were used to target several Galactic open clusters, distributed at increasing distances, in three sets of directions to scrutinize the dust distribution and orientation of the local plane of sky magnetic fields towards those directions.

Session 5

Spectroscopy of Galactic Sources

On the potential of Carbon-enhanced metal-poor stars for Galactic Archaeology

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The fractions and the properties of the Carbon-enhanced metal-poor (CEMP) subclasses provide a unique opportunity to probe the formation and evolution of the Galactic halo and its building blocks. Insights into the properties of the First Stars, and binary interactions at very low metallicity can also be derived. We have explored the chemical nature of the different components of the Galaxy based on the distribution of the chemical elements including carbon with respect to iron. A primary objective is to assess the potential of CEMP stars for Galactic Archaeology. The study is based on high resolution spectroscopic analyses of a large sample of CEMP subclasses that include metal-poor, very metal-poor, and extremely metal-poor stars. The high resolution spectra of the objects were obtained using the Hanle Echelle spectrograph attached to the Himalayan Chandra Telescope (HCT), IAO, Hanle. High resolution archival spectroscopic data from other observing facilities, and data obtained from High-Efficiency and High-Resolution Mercator Echelle Spectrograph (HERMES), attached to the 1.2 m Mercator telescope at the Roque de los Muchachos Observatory in La Palma, operated by the Institute of Astronomy of the KU Leuven, Belgium are also being used for a few CEMP stars. Some highlights of the results including abundance anomalies and their implications will be presented.

3.9-m AAT's contribution in addressing the mystery of Li-rich giants' origin and valuable lessons for 3.6-m DOT

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In this talk, I will present the success story of the 3.9-m Anglo Australian Telescope (AAT) in helping to address the four-decade-old mystery of the origin of the lithium-rich red-giant star. First discovered in 1982, Li-rich red giant stars are known to have an unexpectedly higher amount of lithium than the one predicted by the standard stellar evolutionary models. More surprisingly, only about one per cent of giants are known to be Li-rich. We will discuss how observations from the 3.9-m AAT, especially the ones carried out for the GALAH survey, helped in the discovery of hundreds of new Li-rich red giant stars and also helped in discovering their exact stellar evolutionary phases. Further, we would like to discuss the possibilities with the 3.6-m Devasthal Optical Telescope (DOT), which can help address more long-standing astrophysical problems like this.

Connecting Chemistry and kinematics of r-process enhanced stars to trace their origin

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Understanding the formation of heavier elements is one of the key topics in stellar astronomy. The rapid neutron capture process (r-process) is the prime nucleosynthesis mechanism for producing heavy elements. There have been proposed several sites of the r-process, but none of them is well constrained. Studying heavier elements in the metal-poor stars is the pristine tool to investigate the site of r-process nucleosynthesis. Here, we report a detailed abundance analysis of four r-process-enhanced metal-poor stars selected from the SDSS/MARVEL survey and re-observed with a 10-m class telescope Gran Telescopio CANARIAS (GTC). The high signal-to-noise (S/N) ratio at R~25000 spectral resolution of GTC allows us to detect 21 neutron-capture elements. We could also detect Th in two of the program stars that we used to constrain their ages. We used our program stars together with already identified r-process-rich stars in literature to constrain the r-process production sites. We have shown the actinide-to-lanthanide evolution and investigated the excess actinide seen in some r-process-rich stars. We have also tested the origin of r-process-rich stars using their kinematics. The connection of r-I and r-II subclasses of r-process-rich stars with the Galaxy's bulge, disk, and halo is also presented.

Measuring helium abundances of cool stars

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The hydrogen and helium are the most abundant elements in the universe and also the main constituents of stars. Almost all the stars are made up of hydrogen (H) and helium (He) in a specific ratio, that is helium in any star is one tenth of hydrogen, this is a standard ratio (He/H=0.1). There are stars in the Galactic field and also in the Galactic globular clusters that are not having the standard He/H ratio, but slightly higher value such as: He/H= 0.1, 0.2, 0.3 and 0.4. This enhancement in He/H ratio means that the hydrogen is mildly deficient and helium is slightly enhanced. The origin of this deficiency/enhancement and its significance will be discussed in my talk.

Session 6

Massive Stars

Magnetism of Massive Stars, on and after the main sequence

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Strong magnetic fields are known to be present at the surfaces of some intermediate-mass and high-mass main sequence stars with radiative envelopes. These “fossil fields” are anchored deep within their interiors, and are observed to transform as their host stars evolve. This includes field dilution as the stars expand into the blue supergiant phase, excitation of dynamos as they cool and develop deep convective envelopes as yellow and red supergiants, and the revealing of intense fields as deep surface layers are exposed due to mass loss during the final phases of evolution Understanding these stellar “magnetic biographies” may guide our understanding of the magnetic properties of their degenerate remnants, magnetic white dwarfs, neutron stars, and magnetars.

Multi-wavelength view of massive binaries

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The high luminosity of massive, early-type stars drive strong stellar winds through the line scattering of the star's continuum radiation. Winds are able to modify the ionizing radiation of hot stars dramatically. Their momenta contribute substantially to the dynamics and energetics of the ambient interstellar medium in galaxies. Within our own galaxy there are many examples of early type stars, both single objects and multiple systems lying in young star clusters. Detailed multi-wavelength study of radiation emission from massive O-type and Wolf-Rayet binaries is essential to explore the hydrodynamics of the shocks formed in the stellar outflows and wind structure. Further, deep analysis of some of the interesting phenomena like particle acceleration and dust formation associated with hot stars' winds provides a global view of stellar outflows. In this context, a few massive binaries have been explored using photometric, polarimetric, and spectroscopic measurements in different wavebands. This presentation aims to highlight important insights gained from this study performed with several ground and space-based facilities

Are isolated single Wolf-Rayet stars capable of accelerating particles to relativistic speed ?

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Massive stars (OB type and Wolf-Rayet (WR) stars) are characterised by their supersonic stellar winds that lead to high mass loss rates and large wind kinetic power. Investigating the physical processes in the expanding atmospheres and wind interaction/collision regions of these massive stars in their late evolutionary phase is essential to understand several astrophysical problems. Supersonic winds of these stars can generate strong shocks in the ambient interstellar medium, which can accelerate charged particles up to relativistic speed. These particles in the regions of shock emit radio continuum emission, thus providing a tool to study the aspects of particle acceleration in systems involving massive OB and WR stars. Detection of non-thermal emission (synchrotron radiation) for these systems in the radio domain provides compelling evidence of particle acceleration. For the last few decades, synchrotron emission has been primarily detected in binary systems of WR stars. In contrast, the role of single isolated WR stars in accelerating particles is unclear. In this talk, I will give a brief overview of our study of particle acceleration in a small sample of isolated single WR stars using Giant Metrewave Radio Telescope (GMRT) observations.

Spectroscopic studies of Galactic classical Be stars using Indian optical telescope facilities

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A classical Be (Be hereafter) star is a special type of massive B-type main sequence star surrounded by a geometrically thin, equatorial, gaseous, decretion disc orbiting the star in Keplerian rotation. Spectra of Be stars show emission lines of different elements. Studying these lines provide an excellent opportunity to understand the geometry and kinematics of the circumstellar disc and properties of the central star itself. However, the disc formation mechanism in Be stars - the 'Be phenomenon' - is still poorly understood. Hence, spectroscopic study of Be stars has gained momentum in India within the past many years to better understand the 'Be phenomenon' using different national optical facilities. Mathew et al. (2011) performed a slitless spectroscopic survey to study the spectral features of 150 Be stars in open clusters. Following this, we produced an atlas of all major emission lines found in field Be stars (Banerjee et al. 2021) using the 2.1-m HCT facility at Ladakh. This study revealed several important aspects of Be star discs, such as their discs are generally optically thick in nature, Hα emission equivalent width values for these stars are mostly lower than 40 Å, importance of considering the extinction parameter (AV) for studying Be star properties, etc. Recently, another of our study (Banerjee et al. 2022) focused in understanding the disc transient nature of Be stars through continuous monitoring of their Hα line profile variations for 5 consecutive years (2015 -- 2019) using the 1-m telescope facility at Vainu Bappu Observatory, Kavalur. Presently, one more collaborative work with ARIES faculties is ongoing on variability of emission lines seen in Be stars. Being a part of the few active international research groups in Be star research, we hope that further studies of Be stars through collaborative efforts will help in providing a better understanding about their properties and also the ‘Be phenomenon'.

Session 7
Multi-wavelength studies of star formation regions

Understanding the outbursts in young low mass stars

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The low mass young stellar objects (LM-YSOs) that are still accreting from their disc, are observationally found to undergo short duration outbursts which are separated by long quiescent phases. These rare outburst phenomenon observed in LM-YSOs are called FU Ors and EX Ors. These eruptions of the LM-YSOs are caused by strongly enhanced accretion from the surrounding disc. FU Ors display outbursts of ~ 4 mag or more and last several decades, whereas EX Ors show smaller outbursts (Δm ~ 2 - 3 mag) that last from a few months to a few years and may occur repeatedly. These short timescales, when compared to the 104 −105 formation timescales of the young stars, make these events extremely rare, and so far, a dozen sources have been detected. Spectroscopically, FU Ors have broad line widths, believed to be due to large rotational velocities. Their spectral type varies from early type F or G in the optical to later type M in the NIR. The most realistic models of their spectra are produced by using a strong accretion disc with lower temperatures at larger radii. The episodic nature of accretion seen in these LM-YSOs can shed light on several open problems in star formation and accretion disc theories. In this talk, I will present recent results from our long-term monitoring observations of a few rare type of eruptive young low mass variables using Indian facilities.

Spectro-Photometric Monitoring of Eruptive Young Stellar Objects

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Spectro-photometric monitoring of eruptive Young Stellar Objects (YSOs) in the last few years have contributed significantly towards understanding of the episodic accretion phenomenon.These objects are highly embedded and therefore obscured in the visible wavelengths. Continuous multi-band photometric monitoring helps in the study of color-color evolution by disentangling the effects of variability due to change in extinction or accretion change. In conjunction with the optical photometry, it helps in the construction of multi-epoch Spectral Energy Distribution (SED) thus helping in studying the transient energy changes occurring in such systems. Spectroscopic monitoring also presents a wealth of information about the evolution of these sources. Evolution of the spectroscopic features associated with the accretion process and the lines associated with a molecular outflow or disc wind during the active and the quiescent phases help in constraining the various existing models that describe these outbursts. These sources also display 12CO overtone features either in emission or absorption that are generally associated with the boundary layer accretion process.

A study of ultracompact H II regions with extended emission - their importance, origin, and evolution

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The ultracompact (UC) H II regions (ionized medium with size<0.1 pc and n_e>10^4 cm^-3) surrounding the high-mass stars (M > 8 M_sun) retain signatures associated with their formation processes. These processes are otherwise difficult to observe due to their highly obscured environment. In the case of UC H II regions, the ionizing (Ly-continuum) photon rate estimated from the ionized gas appears to be much lower (80-90% in some cases) than the rate calculated from the total infrared luminosity of dust present within them. One of the solutions to this problem is the presence of extended radio emission (generally undetected by most compact arrays) associated with the ultracompact core. In this presentation, I will talk about the results from our study of eight UC H II regions with extended emission and discuss the role of their extended emission in solving this problem. For this study, radio data (1.25-1.45 GHz) from our observation using the upgraded Giant Metrewave Radio Telescope were analyzed with other ancillary data such as 4-8 GHz radio data from the GLOSTAR survey, and infrared data from the UKIDSS, 2MASS, MIPSGAL, and Hi-GAL surveys. We fitted a SED function to the infrared emission (8-1000 micron) to calculate the ionizing photon rate from the total infrared luminosity. Our ongoing research shows that this rate is within a reasonable agreement (20-30%) of the ionizing photon rate calculated from the radio emission if we include the extended emission. We also located the candidate ionizing stars and found that, in a few cases, multiple stars are ionizing the neutral gas in a UC H II region. Our research also positively addresses the 'age problem' of UC H II regions by excluding the existence of excessive dust to keep them stalled for a longer time.

Multiwavelength Study of the Star Formation in the Sh 2-305 HII Region

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Massive OB-stars (> 8 Msun) have a profound impact on their immediate environment through the radiative and mechanical energy they inject from their formation phase until their death. Hence, these stars have the ability to trigger the birth of young stellar objects (YSOs) and young massive stars. However, understanding the feedback processes of massive OB-stars are still far from complete. In this relation, a carefull analysis of multi-scale and multi-wavelength data of a promising Galactic HII region Sh 2-305, hosting massive O8.5V and O9.5V stars, has been performed. The ionized, neutral, molecular, and dust environments as well as the young stellar population around the HII region or its photon-dominant regions (PDRs) have been studied. Infrared images reveal an extended sphere-like shell (extension ~7.5 pc) enclosing the Sh 2-305 HII region (size ~5.5 pc; age ~1.7 Myr). The extended structure observed in the Herschel temperature map indicates that the molecular environment of Sh 2-305 is heated by the massive O-type stars. Regularly spaced molecular condensations and dust clumps are investigated toward the edges of the infrared shell, where the polycyclic aromatic hydrocarbon (PAH) and H2 emission is also observed. The molecular line data show a signature of an expanding shell of molecular gas in S305. Giant Metrewave Radio Telescope 610 and 1280 MHz continuum maps reveal overdensities of the ionized emission distributed around two O-type stars, which are surrounded by the horseshoe envelope (extension ~2.3 pc). The edges of the infrared shell are found to be located in the front of the horseshoe envelope. The association of the younger generation of stars with the PDRs is also investigated. All these outcomes provide the observational evidence of the feedback of O-type stars in S305. Moreover, nonthermal radio emission is detected in S305 with an average spectral index of -0.45. I will discuss these observed findings and also their implication in my talk.

Session 8

Compact Objects

Unraveling the recent X-Ray flare from MAXI J0709–159 using Indian optical telescope facilities

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Rocky exomoons in the habitable zones of the exoplanetary systems hold special significance as they can host life. Although the detection of exomoons has yet remained elusive, mainly due to their smaller expected size, the next generation space missions such as JWST can provide unique opportunity for their detection and characterization. In this talk, I will present a comprehensive analytical formalism in order to model the lightcurves of transiting exoplanets hosting exomoons. In order to achieve an analytical formalism, we have considered circular orbit for the exomoon around the host planet, which is indeed the case for tidally locked moons. The formalism takes care of the co-alignement or non-coalignment of the orbits of the planet and the moon using a two anglular parameter approach, and can be used to model and characterize all the possible orbital alignments for a star-planet-moon system. Using this formulation, we have studied the detectability of rocky exomoons using the next generation telescopes, such as JWST. I will also present our study on the detectability of the atmospheric features for such exomoons to study their habitability, using transmission spectroscopic observations from JWST.

Confirmation of Two Magnetic Cataclysmic Variables as Polars - 1RXS J174320.1-042953 and RX J1039.7-0507

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We present optical photometric and spectroscopic observations of two magnetic cataclysmic variables, namely 1RXS J174320.1-042953 and RX J1039.7-0507. An attempt is made to characterize these two systems using present observations with the aid of the archival X-ray data from XMM-Newton for 1RXS J174320.1-042953. We confirm and refine the orbital periods of both sources. 1RXS J174320.1-042953 was observed in two distinctive high and low states where a phase shift was seen, which could be due to the changes in the shape, size, and (or) location of the accretion region. The X-ray modulations of J1743 at the orbital period only persist in the soft (0.3-2.0 keV) energy band, which could be attributed to the photoelectric absorption in the accretion flow. We did not find any signature of spin and beat periods in the system J1039. The presence of strong Balmer and He II 4686 Å emission lines in the optical spectra indicates the magnetic nature of both sources. However, the X-ray spectra of J1743 exhibit a multi-temperature post-shock region. The hard X-rays are absorbed through a thick absorber with an equivalent hydrogen column of ~7.5 × 10^23 cm ^(−2) , which partially covers ~56 % of the emission. No soft X-ray excess was found to be present; however, a soft X-ray emission with a blackbody temperature of ~97 eV exhibits the spectra. The low and high states, presence of only one period and its harmonics in the power spectra, and strong emission lines in the optical spectra confirm that the sources 1RXS J174320.1-042953 and RX J1039.7-0507 belong to the polar subclass of magnetic cataclysmic variables.

Optical and X-ray studies of Be/X-ray binary 1A 0535+262 during its 2020 giant X-ray outburst

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We report results obtained from the optical and X-ray studies of the Be/X-ray binary 1A~0535+262/HD~245770 during the 2020 October giant X-ray outburst, using the 1.2 m telescope at Mount Abu Infrared observatory and AstroSat, respectively. The peak flux of the outburst was recorded to be ~11 Crab in the 15-50 keV range, the highest ever observed from the pulsar. We performed optical observations in the 6000-7200 A band before, during, and after the outburst to investigate the evolution of the circumstellar disc of the Be star between 2020 February and 2022 February. Our optical spectra exhibit prominent emission lines at 6563 A (HI), 6678 A (HeI), and 7065 A (HeI). We found a significantly variable H_alpha line in the spectra. The single-peaked line profile appeared asymmetric with broad red- & blue-wings in the data before and during the outburst. The post-outburst observations, however, resulted in a double-peaked profile with asymmetry in the blue-wing. Our observations before the outburst confirmed a larger Be disc that decreased in size as the outburst progressed. Furthermore, the observed variabilities in the H_alpha line profile and parameters suggest the presence of a highly misaligned, precessing, and warped Be disc. AstroSat observation of the pulsar detected pulsations at ~103.55 s in the light curve up to 110 keV. We found strongly energy-dependent pulse profiles with increasing contribution of the pulsing component in hard X-rays. The broadband spectral fitting in the 3-90 keV range confirmed the presence of the known cyclotron resonance scattering feature at ~45 keV.

Session 9

Transients

Multi-wavelength analysis of short GRB 201221D and its comparison with other high & low redshift short GRBs

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We present a detailed analysis of short GRB 201221D lying at redshift z = 1.045. We analyse the high-energy data of the burst and compare it with the sample of short gamma-ray bursts (SGRBs). The prompt emission characteristics are typical of those seen in the case of other SGRBs except for the peak energy (Ep), which lies at the softer end (generally observed in the case of long bursts). We estimate the host galaxy properties by utilising the Python-based software Prospector to fit the spectral energy distribution of the host. The burst lies at a high redshift relative to the SGRB sample with a median redshift of z = 0.47. We compare the burst characteristics with other SGRBs with known redshifts along with GRB 200826A (SGRB originated from a collapsar). A careful examination of the characteristics of SGRBs at different redshifts reveals that some of the SGRBs lying at high redshifts have properties similar to long GRBs indicating they might have originated from collapsars. Further study of these GRBs can help to explore the broad picture of progenitor systems of SGRBs.

Recent observations of peculiar Gamma-ray bursts using 3.6-m Devasthal Optical Telescope (DOT)

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India has a long history of more than two decades of observations of optical counterparts of gamma-ray bursts (GRBs) using Indian meter-class telescopes like the 1.04m Sampurnanand Telescope (ST), 1.3m Devasthal Fast Optical Telescope (DFOT), 2m Himalayan Chandra Telescope (HCT), and 2.34m Vainu Bappu Telescope (VBT) utilizing the longitudinal advantage of the place. In recent times, astronomers started exploring these exciting and explosive astronomical sources using recently commissioned (since 2016) India's largest optical telescope, i.e., 3.6m Devasthal Optical Telescope (DOT) at Devasthal observatory of Aryabhatta Research Institute of Observational Sciences (ARIES), Nainital. In a short period of the proposed target of opportunity (ToO) observations (since cycle 2020-C2), DOT discovered many interesting results such as the detection of long GRB (GRB 211211A) from binary merger, the detection of host galaxies of peculiar GRBs, discoveries of dark and orphan afterglows, the detection of most delayed optical flare (GRB 210204A) observed from any GRB so far, observations of optical counterparts of very high energy detected burst, etc. In this work, we briefly summarizes the recent discoveries and observations of GRBs using 3.6m DOT.

Session 10

Extragalactic astrophysics

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Intra-night variability of UV emission from powerful blazars

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We report the first study to characterize intranight variability of the blazar class from the perspective of (rest-frame) UV emission. For this, we carried out intranight optical monitoring of 14 flat-spectrum radio quasars (FSRQs) located at high redshifts ($1.5 < z < 3.7$), in 42 sessions of median duration ~ 5.4 hr using the 1-m class optical telescopes and the 3.6-m Devasthal Optical Telescope at ARIES. These sources were grouped into two samples distinguished by published fractional optical polarization: (i) nine low-polarization sources with popt<3% and (ii) five high-polarization sources. Unexpectedly, a high duty cycle (DC ~ 30%) is found for intranight variability (with amplitude ψ>3%) of the low-polarization sources. This DC is a few times higher than that reported for low-polarization FSRQs located at moderate redshifts (z ~ 0.7) and hence typically monitored in the rest-frame blue-optical. Further, we found no evidence for an increased intranight variability of UV emission with polarization, in contrast to the strong correlation found for intranight variability of optical emission. We briefly discuss this in the context of an existing scenario which posits that the non-thermal UV emission of blazars arises from a relativistic particle population different from that radiating up to near-infrared/optical frequencies.

Discovery of lensed quasars using multiply imaged quasar candidates

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The Gaia GraL group's aim is to discover gravitationally lensed quasars. However, to remove contamination from nearby sources, an optimized extraction technique is necessary. Here, we will discuss the spectral extraction technique for bright/faint nearby dispersion axes (sources). Using a masking technique, we detect the high S/N peaks in the CCD image. This technique computes the cumulative signal using a weighted sum, yielding a reliable approximation of the total counts. The width of the mask is decided through an iterative process. We have efficiently extracted the spectra to confirm/refute 57 quasar lens candidates using this technique. Out of 57 candidates, 10 of them are found to be lensed quasars.

New accretion disk size measurements for reverberation mapped AGN

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In the innermost regions of Active Galactic Nuclei (AGN), the matter is understood to be flowing onto the Supermassive black hole (SMBH), which forms an accretion disk. This disk is responsible for the optical/UV continuum emission observed in the spectra of AGN. Reverberation Mapping of the accretion disk using multiple bands can yield the structure of the disk. The simple lamppost model implies a disk that irradiates in the X-ray wavelengths, and the photons are reprocessed in the form of UV and optical wavelength emissions. As the emission is expected to be of the black body type peaking at different wavelengths, depending on the temperature of the disk, continuous, simultaneous monitoring in multiple wavelength ranges to cover hotter inner regions and cooler outer regions is expected to yield the structure and temperature profile of the accretion disk itself. Using the 3 optical band light curves from the ZTF survey, we have measured the accretion sizes for 19 AGN with SMBH masses obtained through previous reverberation mapping campaigns. We found that the disk sizes are on average 3.8 times larger than the expectations of the SS disk for most sources, which agrees with the recently obtained results. Further, the disk sizes obtained are weakly correlated with the SMBH mass and the AGN luminosity. To understand the accretion disk further using multi-band observations, and test various accretion disk models we are monitoring a sample of bright but intrinsically low luminosity AGN using a combination of telescopes. For 5 AGN in our sample, the observations are completed. We will present the new results obtained from these observations, and discuss the possibility of other models for the AGN accretion disks in order to resolve the size discrepancy.

Solar Session 1

MHD waves and small-scale transients

Science opportunities by the Extreme Ultraviolet Imager (EUI) onboard Solar Orbiter

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The Extreme Ultraviolet Imager (EUI), onboard Solar Orbiter consists of three telescopes: the two High Resolution Imagers in EUV (HRIEUV) and in Lyman-α (HRILya), and the Full Sun Imager (FSI). Solar Orbiter/EUI started its Nominal Mission Phase on 2021 November 27. EUI images from the largest scales in the extended corona off limb, down to the smallest features at the base of the corona and chromosphere. EUI is therefore a key instrument for the connection science that is at the heart of the Solar Orbiter mission science goals. The highest resolution on the Sun is achieved when Solar Orbiter passes through the perihelion part of its orbit. On 2022 March 26, Solar Orbiter reached for the first time a distance to the Sun close to 0.3 au resulting in a pixel foot print of 100km on the Sun. No other coronal EUV imager has been this close to the Sun. In this paper we will review the scientific highlights of EUI so far and we will discuss opportunities for joint observations with other observatories in space and on the ground.

Tracing the source region of waves in coronal fan loops anchored in the sunspot umbra

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Sunspots host various oscillations and wave phenomena like umbral flashes, umbral oscillation, running penumbral waves, and coronal waves. All the fan loops rooted in the sunspot umbra constantly show a 3-min period propagating slow magnetoacoustic waves in the corona. However, their origin in the lower atmosphere is still unclear. In this work, we studied oscillations in the fan loop system rooted in the sunspot umbra observed by Interface Region Imaging Spectrograph (IRIS) and Solar Dynamics Observatory (SDO). We traced the locations of several fan loops at different atmospheric heights from the corona to the photosphere. We found presence of 3-min oscillations in all the loops at all the atmospheric heights. We traced the origin of these waves by utilising their amplitude modulation characteristics with time while propagating in the solar atmosphere. We found several modulation periods, such as 11 min, 19 min, and 30-35 min, in both amplitude and frequency modulations of these 3-min oscillations at all heights. Based on our findings, we interpret that 3-min slow magnetoacoustic waves propagating in the coronal fan loops are driven by 3-min oscillations observed at the photospheric footpoints of these fan loops in the umbral region. We also explored any connection between 3-min and 5-min oscillations observed at photospheric footpoints of these loops and found them to be weakly coupled. Results provide clear evidence of magnetic coupling of the solar atmosphere through the propagation of 3-min waves along the fan loops at different atmospheric heights.

Characteristics of solar EUV wave events

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Extreme-ultraviolet (EUV) waves are one of the large scale phenomena on the Sun. They are defined as large propagating fronts on whole solar surface with a speed ranging from a few 100 kms−1 to multiple of 1000 kms−1 . They can be associated with solar filament eruptions, flares, or coronal mass ejections (CMEs). EUV waves shoes different features like: wave and non-wave components, stationary fronts, reflection, refraction, and mode conversion. Apart from these, they can hit the nearby loop and filaments during their propagation and trigger them to oscillate. These oscillating loops and prominences can help for the coronal seismology. Another interesting feature of EUV waves is wave trains, which are interpreted to be driven by downward and lateral compression of CMEs and/of the unwinding motion of the filament helical structures can also produce EUV wave trains. Their driving mechanism needs to be studied in detail and comprehensively.

Observations of short-period oscillations in Solar Orbiter/EUI

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High-frequency wave phenomena present a great deal of interest as one of the possible candidates to contribute to the energy input required to heat the corona as a part of the AC heating theory. However, the resolution of imaging instruments up until the Solar Orbiter have made it impossible to resolve the necessary time and spatial scales. Here we report on high-frequency transverse motions in a small loop located in a quiet Sun region of the corona.The oscillations were observed with the HRIEUV telescope (17.4 nm) of the EUI instrument onboard the Solar Orbiter. We detect two transverse oscillations in short loops with lengths of 4.5 Mm and 11 Mm. The shorter loop displays an oscillation with a 14 s period and the longer a 30 s period. Despite the high resolution, no definitive identification as propagating or standing waves is possible. The velocity amplitudes are found to be equal to 72 km/s and 125 km/s, respectively, for the shorter and longer loop. Based on that, we also estimated the values of the energy flux contained in the loops - the energy flux of the 14 s oscillation is 1.9 kW · m^−2 and of the 30 s oscillation it is 6.5 kW · m^−2 . While these oscillations have been observed in the Quiet Sun, their energy fluxes are of the same order as the energy input required to heat the active solar corona. Numerical simulations were performed in order to reproduce the observed oscillations. The correspondence of the numerical results to the observations provide support to the energy content estimates for the observations. Such high energy densities have not yet been observed in decayless coronal waves, and this is promising for coronal heating models based on wave damping.

Study of the Impact of Coronal Rain on Kink Oscillations of Coronal Loops

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Coronal rain occurs in thermally unstable coronal loops and comprises cool plasma condensations falling towards the solar surface guided by the magnetic field. Sometimes the coronal rain clumps are seen to be subjected to transverse oscillations, yet, it is uncertain how coronal rain formation may affect an already oscillating loop. In this study, we present the analysis of an event of coronal rain that occurred on 25 April 2014 and was simultaneously observed by the Slit-Jaw Imager (SJI) onboard Interface Region Imaging Spectrograph (IRIS) and Atmospheric Imaging Assembly (AIA) onboard Solar Dynamic Observatory (SDO). We find signatures of oscillations before and after coronal rain at similar positions to those during coronal rain. Before and after coronal rain, oscillation amplitudes range from 45 to 195 km, while during coronal rain, they range from 105 to 415 km. The period of oscillations is in the range of 1.7 to 3.6 minutes before and after coronal rain and 1.7 to 4.6 minutes during coronal rain. The individual cases show a greater amplitude and period during coronal rain. The average period is increased by ~1.3 times during coronal rain, in agreement with the expected density increase from coronal rain. We find that the average amplitude is ~2 times larger during coronal rain.

Exploring spectral line asymmetries due to the propagating MHD waves in the solar atmosphere

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MHD waves are considered to be one of the candidates for coronal heating and solar wind acceleration, so, understanding their spectroscopic properties and propagation through different layers of the solar atmosphere is important. Over a decade-long study of asymmetries in spectral lines observed from solar coronal and transition regions point towards mass and energy transport from lower layers of the solar atmosphere to the corona. Two possible drivers for these asymmetries are slow magnetoacoustic waves and jets or upflows. However, due to insufficient multi-wavelength observations and low spatial and spectral resolution of the current instruments, spectral line asymmetries due to fast transverse MagnetoHydro Dynamic (MHD) waves have not been observed yet. But their study is possible by MHD simulations. In this study, we used the forward-modelled data for the Fe XIII emission line obtained from 3D MHD simulations using MPI-AMRVAC for propagating fast transverse waves. The 'Modified Blue-Red (BR) Asymmetry' technique was applied to this data to obtain BR asymmetry profiles. Our analysis for the simulation of a coronal hole region driven by propagating fast transverse MHD waves showed the presence of spectral line asymmetries caused by these waves in an inhomogeneous plasma. These asymmetries are expected to be observed by future ground and space-based facilities such as Visible Emission Line Coronagraph (VELC) onboard Aditya-L1 and DKIST. We also plan to study the spectral line asymmetries for the data integrated for different lines of sight and other associated properties.

Nonlinear self-deformation of unidirectional surface Alfvén waves and properties of Uniturbulence

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One of the main goals of this research project is to make new three-dimensional numerical simulations of propagating transverse waves to learn more about the physics of turbulence caused by the non-linearly self-cascading model of unidirectional surface Alfvén waves (Ismayilli et al., Frontiers, 2022). In addition to the numerical simulations, we also established an analytical model for the evolution of uniturbulence in surface Alfvén waves. Currently, we are comparing the simulation results for Yaglom's law (predicted energy dissipation) with the results from our analytical model. Additionally, we aim to predict the turbulent flow's inertial range. Plasmas in the solar corona and solar wind are known to be structured across the magnetic field, suggesting that uniturbulence may play a role in these regions. The uniturbulence might provide an extra channel for the turbulent cascade and enhance dissipation, particularly in regions with open magnetic fields. Due to the coherence of the interaction, uniturbulence may also be important in closed magnetic environments like coronal loops. In the future, we would like to clarify our results with the relevant observational data

Coronal Magnetic field estimation using Bayesian inference

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The physical parameters of the solar corona, for instance, the magnetic field, cannot be measured directly. The solar corona holds many oscillating structures, such as coronal loops, which support a variety of waves. These waves allow us to infer physical parameters using Coronal Seismology. We used Doppler velocity and density data from Coronal Multichannel Polarimeter (CoMP) on 2016 October 14 to obtain the global coronal magnetic field using simple inversion. The information obtained from these waves is incomplete and uncertain. For such inversion methods, it is better to use a probabilistic approach. We obtain the 3d map of the global coronal magnetic field using Bayesian inference. This gives us the probability of each magnetic field value at each CoMP field of view location. We also obtain the radial profile of the magnetic field. In future, we will extend our analysis using Upgraded Coronal Multichannel Polarimeter.

Generation of solar spicules and subsequent atmospheric heating

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Rapidly evolving fine-scale jets known as spicules are the most prominent and dynamical phenomena observed in the solar chromosphere. At any given instant, around a few million of these spicules shoot plasma material out from the Sun's surface. It is highly likely that these spicules play a crucial role in key solar physics mysteries, such as chromospheric and coronal heating and mass supply to the solar wind. Despite intensive delving in the past decades, still, there is no clear consensus on how these small-jets of magnetized plasma originate from the solar surface, nor we understand how exactly they transfer energy into and possibly heat the solar atmosphere. The exact source of these small-scale jets are hard to observe due to the resolution limitations of earlier telescopes. Therefore, they remain poorly understood. Using an unprecedented multi-wavelength and high-sensitive magnetic field observations from the 1.6-m Goode Solar Telescope at the Big Bear Solar Observatory, we strive to reach conclusions on the possible scenario among the many proposed hypotheses of spicule's origin. We found that the dynamical interaction of magnetic fields in the partially ionized the lower solar atmosphere is the precursor of these high-speed jets which subsequently energizes the upper solar atmosphere.

Insights into the genesis and dynamics of the solar spicule forest : aided by laboratory experiments

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It is estimated that about three million spicule jets are present at any given time over the entire solar disk. Due to their ubiquitous nature, they have become a crucial candidate for conduiting mass and momentum flux to the solar wind and non-thermal energy to the solar corona.

First, we find an intriguing mathematical and phenomenological parallel between the spicular forest excited in a solar-like atmosphere and the numerous jets of polymeric fluid in a container when both are subjected to harmonic vibration (Faraday excitation) at the bottom. Comparing the two disparate systems, we arrive at sufficient conditions required to obtain a forest of such jets. Next, upon the addition of a sub-surface convective layer into an LTE radiative magnetohydrodynamics (rMHD) framework, we further obtain a spicule forest that matches very well with the observed quantitative features on the Sun.

Apart from their formation mechanism, the dynamical complexity of spicules (e.g., swaying, spinning clusters) has been reported with the advent of high-resolution observation facilities including Hinode. When our model is extended to 3D, we find that the bulk spinning motion is due to the interaction of spicules and swirls in the solar atmosphere.

Solar Session 2

Physics of Flares and CMEs

Onset and evolution of solar flares: application of 2D and 3D models of magnetic reconnection

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The contemporary multi-wavelength observations have immensely improved our understanding of the various physical processes occurring in different atmospheric layers of the Sun during a solar flare. The formation of parallel ribbons and associated overlying large post-flare arcades are important signatures which form the basis for the standard 2D model of solar flares. The standard flare model recognizes the flare's impulsive and intense brightening as a consequence of the large-scale magnetic reconnection in a vertical current sheet in the solar corona. Notably, the recent observations have shown departure from this scenario with the observations of a new subclass of flares called circular ribbon flares for which one of the ribbons presents an almost fully closed quasi-circular or quasi-ellipsoidal shape. In the simplest case, the photospheric magnetic field distribution associated with circular-ribbon flares consist of a parasitic polarity embedded in an opposite sign polarity of a larger dipolar active region. In this talk, I will present a few complex cases of circular ribbon flares where the primary event also exhibits the presence of parallel ribbons, remote ribbons, and jet activity. The typical morphological features and other complexities of such events are discussed in view of the topological structure of a 3D null point. These observations also enable us to explore analogies between the circumstances that govern the onset of jets, confined flares or CMEs.

Exploring magnetic reconnection due to Rayleigh-Taylor instability-induced turbulence in Solar Prominences

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The internal dynamics of solar prominences have been observed to be highly complex for many decades, many of which also indicate the possibility of turbulence. Prominences represent large-scale, dense condensations suspended against gravity at great heights within the solar atmosphere. Therefore, it is no surprise that the fundamental process of the Rayleigh-Taylor (RT) instability has been suggested as the potential mechanism for driving the dynamics and turbulence remarked upon within observations. Observations have also revealed presence of bi-directional jets due to current sheets in the prominence body, thus highlighting the shift of topology of the magnetic fields induced due to the gravity driven flows. We begin with the 2.5D fully-resistive magnetohydrodynamic (MHD) high-resolution simulations with the open-source MPI-AMRVAC code and follow the far nonlinear evolution of an RT instability that starts at the prominence-corona interface. We use statistical analysis to investigate the evolution of turbulent regimes, which corresponds to the observational counterpart. Furthermore, the strength of the mean magnetic field directed into the 2D plane, and its alignment with the plane itself, creates a system with varying turbulent behaviour. The intermittent heating and energy dissipation events are caused by magnetic reconnection, which we investigate in detail by the 2.5D fully-resistive MHD model. Based on the evolution of plasma beta (β) along the prominence's height, the stratified numerical model generates different dynamics of turbulent magnetic reconnection. As a result, we observe that the turbulent dynamics and prominence reconnection events are unique from those occurring elsewhere in the solar corona.

Towards improving CME forecasting with MHD modelling and observations

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Coronal mass ejections (CMEs) from the Sun are one of the major drivers of space weather as they can cause geomagnetic storms impacting space and ground-based technologies, and in turn life on Earth. With EUropean Heliosphere FORecasting Information Asset (EUHFORIA), we can perform MHD modelling of the solar wind and the evolution of the CMEs in the heliosphere. Observations of the initiation and early propagation of the CMEs are used to obtain the geometrical and magnetic field parameters for CMEs initialization in EUHFORIA. 3D geometrical reconstruction methodology is applied using observations from multiple vantage points to constrain geometrical parameters. Magnetic field parameters are obtained from proxies like flare ribbons, coronal dimmings, and post eruptive arcades. Although we can constrain the CME orientation based on the polarity inversion line, the CME undergoes considerable rotation and deflection in the low corona itself where we do not have observations. In cases when we do not have source region observations in low corona, CME 3D reconstruction techniques can provide a tilt/geometrical inclination but not the axial field direction. Moreover, with STEREO-B coming close to Earth, we are losing the setup of multiple vantage points for 3D reconstruction. In the absence of observations/higher errors on the parameters constrained for simulations, we rather need to perform ensemble modelling to consider multiple alternatives for forecasting. This would be possible only if we had a model with global geometry (CME legs) consuming less computational time for real-time forecasting. Flux rope CME models such as the spheromak model (spherical geometry) and the FRi3D model (global geometry) are already functional in EUHFORIA. We will discuss the drawbacks of the existing models and motivate the development of the novel torus CME model to improve the computational time while having a global geometry.

Numerical simulation and forward modelling of a breakout CME

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Coronal Mass Ejections(CMEs) being one of the main drivers for space weather, it becomes essential to understand their initiation and evolution in the solar corona. It is also crucial to perform numerical simulations to probe the dynamics of CMEs in the inner corona for a better understand the CME initiation and evolution in this region. We have performed the numerical simulation of CMEs in the Magnetohydrodynamics framework using MPI-AMRVAC in 2.5D. For the initiation, we have adopted the breakout model in which we have three magnetic arcades with alternative polarities embedded in a dipole magnetic field. In this multipolar topology, when we impose the shear stress at the solar base of one of the arcades, this sheared arcade reconnects with the neighbouring arcade and gives rise to the CME. We analyse the effect of poloidal magnetic field strength on the eruption of the CMEs. We found that increase in the strength of the poloidal magnetic filed strength constrain the CME eruption. We perform the forward modelling on this simulated data in Fe XIV and Fe XI emission lines visible in Visible Emission Line Coronagraph on-board Aditya-L1 and estimate how line intensity, Doppler velocities, and line widths vary. The VELC will also be looking at the inner corona, so the comparison between the observation and the simulated data will help us to understand the kinematics of the CMEs.

Evolution of the Thermodynamic Properties of a Coronal Mass Ejection in the Inner Corona

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The thermodynamic evolution of Coronal Mass Ejections (CMEs) in the inner corona (≤ 1.5 R sun) is not yet completely understood. In this work, we perform, to the best of our knowledge, the first-ever study of the evolution of thermodynamic properties of a CME core observed in the inner corona on July 20, 2017, combining the MLSO/K-Cor white-light and the MLSO/CoMP Fe XIII 10747 Å line spectroscopic data. We also estimate the emission measure weighted temperature (T_EM) of the CME core by applying the Differential Emission Measure (DEM) inversion technique on the SDO/AIA six EUV channels data and compare it with the effective temperature (T_eff) obtained using Fe XIII line width measurements. We find that the T_eff and T_EM of the CME core show similar variation and remain almost constant as the CME propagates from ~1.05 to 1.35 R_sun. The temperature of the CME core is of the order of million-degree kelvin, indicating that it is not associated with a prominence. Further, we estimate the electron density of this CME core using K-Cor polarized brightness (pB) data and found it decreasing approximately one order of magnitude as the core evolves. An interesting finding is that the temperature of the CME core remains almost constant despite expected adiabatic cooling due to the expansion of the CME core, which suggests that the CME core plasma must be heated as it propagates. We conclude that the expansion of this CME core behaves more like an iso-thermal than an adiabatic process.

Advance image processing algorithm for CMEs studies with Aditya-L1/VELC

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One of the objectives of the Visible Emission Line Coronagraph (VELC) of Aditya-L1 is to understand the initial evolution of space weather drivers, coronal mass ejections (CMEs). The white-light images so obtained will require a separation of the static F-corona and the dynamic K-corona and reducing the radial intensity gradient to understand the processes occuring at different heights. To process the bulk of coronagraph data, we have developed a Simple Radial Gradient Filter (SiRGraF). This algorithm requires subtraction of a long term minimum intensity background followed by normalisation using a azimuthally symmetric uniform intensity background revealing the dynamic structures such as CMEs throughout the field of view of the instrument. SiRGraF has been successfully implemented on existing white-light coronagraph images of SOHO/LASCO, STEREO and KCor. In this talk I will present the details of the algorithm and its comparison with existing ones along with the advantages and limitations of each. I will also highlight how this algorithm will be useful for CMEs studies with Aditya-L1/VELC after its launch.

Icarus : a new highly optimized heliospheric model for forecasting purposes

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Coronal Mass Ejections (CMEs) are the main drivers of interplanetary shocks and space weather disturbances. One of the key parameters that determine the geo-effectiveness of the CME is its internal magnetic configuration. Strong CMEs directed towards Earth can have a severe impact on our planet and their prediction can mitigate possible damages. Thus efficient space weather prediction tools are necessary, in order to produce timely forecasts for the CME arrival at Earth and their strength upon arrival. The novel heliospheric model Icarus (Verbeke et al. 2022), which is implemented within the framework of MPI-AMRVAC (Xia et al. 2018) introduces new capabilities to model the heliospheric solar wind and real CME events. Ideal MHD equations are solved in the co-rotating reference frame with the Sun. This guarantees stationary solution after obtaining the relaxed solar wind in the domain. Different CME models are injected in the domain on top of the stationary solar wind. To optimize the simulations advanced techniques, such as adaptive mesh refinement and gradual radial grid stretching are implemented. By imposing these techniques, we avoid cell deformation in the domain and only the necessary/desired areas are refined to higher spatial resolutions (and coarsened again when the high resolution is no longer necessary, e.g. behind a travelling shock wave). The refinement and coarsening conditions are controlled by the user. Currently, we have implemented various refinement criteria based on the models. We refine the CME interior, the shocks associated with the CMEs, the shocks at the CIRs etc. The biggest advantage of the AMR in MPI-AMRVAC is that you can design the refinement in the simulations according to the purpose of the run. These techniques result in optimized computer memory usage and a significant speed-up, which is crucial for forecasting purposes. In order to demonstrate the capabilities of the code we model a particular CME event. We use radially stretched grid in the Icarus simulations. The solution mesh refinement is applied to the CMEs in order to model its arrival time and interior magnetic field better. To analyse the results, the plasma variables are compared to the original EUHFORIA simulations and the observed data. As a result, the new heliospheric model provides accurate results and gives various options to apply to the domain in simulations, while the simulations are much more efficient and save significant amounts of computational resources and time.

Origin of Extremely Non-radial Solar wind

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In the Sun's atmosphere, which is well-known as solar corona, when the plasma beta (ratio of thermal to magnetic pressure) is low, coronal mass flows upward along open magnetic field lines to form the solar wind. Generally, the solar wind outflow is primarily radial in nature beyond 10 solar radii. However, non-radial solar wind flows have been observed on several occasions, which are usually geo-effective and also have consequences on space weather. Some of those non-radial solar wind events are found to be associated with coronal mass ejections (CMEs), which are usually flux rope eruptions along with a large coronal mass outflows, and the others are usually found to be associated with coronal interaction regions (CIRs), which are stream interaction regions formed when the faster solar wind stream overtakes preceding slower solar wind stream. However, on few occasions, extremely non-radial solar wind flows were observed during which no CMEs/CIRs were seen. The exact origin of such non-radial flows has not yet been fully addressed. Here, we present a detailed investigation of 12 such extremely non-radial solar wind events where the azimuthal solar wind flow angle is exceeding > 6 degree for a period of one day or more and when there are no CMEs/CIRs signatures observed at 1 AU. In all of the events, the solar wind outflow at 1 AU is typically characterised by low solar wind velocity and low solar wind density. Amongst them, for many events the near-Earth solar wind density was < 5 per cc for periods > 1 day, similar to the well-known "solar wind disappearance events" wherein an unusual drop of the near-Earth solar wind density < 1 per cc for prolonged periods (>1 day) was typically noticed. Based on the significant increase seen in the charge state ratio of O7+/O6+ at 1 AU for all of the events, we have traced them back to the Sun and found that their source regions are originated in around active region and coronal hole (AR-CH) pairs mostly located at the central meridian. Further, examining the dynamical evolutions in their source regions using Extreme ultra-violet Imaging Telescope (EIT) and Michelson Doppler Imager (MDI) data, a clear reduction in CH area accompanied by the formation of new coronal loops and the emergence of new magnetic flux regions are

observed. We believe that the evolutions taking place in AR-CH boundaries eventually disturb the stable CH configurations, resulting in reduction of CH area and finally its disappearance, leaving only the AR. The solar wind outflows coming from the CH form a stream interaction region that acts as a slowly moving wall to the incoming radial solar wind, and thereby, leading to the extremely non-radial solar wind outflows. In the presentation, I will explain, the possible causative mechanism for the origin of these extreme non-radial solar wind flows with no CME/CIR signatures at 1 AU.

Solar Session 3

Long Term studies

Evolution of Solar-Type Activity : An Observational and Theoretical Perspective

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When stars depart from the main-sequence, various changes occur including the loss of angular momentum owing to changes in the stellar interior and the impact of stellar winds. These processes affect the amount and scope of outer atmospheric heating and emission as revealed by observations in the UV and X-ray spectral regimes. From a theoretical perspective, both magnetic and acoustic energy generation are affected as well as obtained by detailed theoretical simulations. In this review, I will present selected observational and theoretical results, including recent work for beta Hydri (G2 IV), a star constituting a prime example and proxy for the future Sun.

Variation in the Chromospheric Differential Rotation over the Century

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Differential rotation is a well-established property of the Sun, with the photosphere being extensively studied using various techniques. However, the dynamics of the chromospheric differential rotation and its relationship with the photosphere are still not fully understood due to contradictory results from different data sources and methods. To address this issue, we utilized a century-long dataset of Kodaikanal Solar Observatory (KoSO) Ca II K images (1907-2007) to investigate the rotation profile of the chromosphere during different solar cycles. By employing image correlation analysis on sets of consecutive day images, we found that the chromosphere rotates 1.52% faster than the photosphere but with less differential rotation compared to the photospheric values. To validate our method and results, we applied the same technique to MDI white light data and other Ca II K data sources (Meudon and PSPT/Rome) and obtained consistent results. Additionally, we explored the solar cycle dependence of differential rotation parameters and investigated the north-south asymmetry of the solar rotation profile.

Study of Variation in the Rotational Profile of the Sun Beyond Photosphere

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Differential Rotation in the Sun has been a subject of fiery interest owing to its connection to the Solar dynamo and Solar cycle models. Although the photospheric and internal differential rotation profile of the Sun is fairly understood, the rotation of the Solar atmosphere above the photosphere is mostly debated due to the contrasting results in various studies. The availability of multi-wavelength data from SDO/AIA, which probes the different heights of the solar atmosphere, provides us with an opportunity to take a step in this direction. Therefore, in this work, we developed a new method based on image processing to measure the rotation profile of the solar atmosphere using the high-resolution SDO/AIA multi-wavelength data for 2010-22. Our preliminary results suggest increased equatorial rotation rate with increasing height (temperature) and rigidity (less differential) in higher layers.

List of Posters

Observing strategy and upcoming back-end Instruments

Science highlights with DOT

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The 3.6m Devasthal Optical Telescope is equipped with high resolution imaging and low-resolution spectroscopy instruments at optical and NIR wavebands. The imaging instruments SPIM and TIRCAM2 are permanently mounted on the side ports whereas the spectroscopic instruments TANSPEC and ADFOSC are mounted on the main axial port as per the science demands. The telescope can provide sub-arcsec observations of celestial sources and the photometric observations of celestial sources as faint as 25th magnitude and low-resolution spectroscopy of about 20th magnitude are routinely taken. A wide range of science programs in the field of galactic and extragalactic astronomy are being taken up. This talk will summarise a few key science highlights using the data primarily from the telescope.

Health analysis of compressor for 3.6-m Devasthal Optical Telescope

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Monitoring the health of various equipment supporting telescope operations such as compressors, hydraulic power packs and chillers etc. is decisive for the proper functioning of telescopes and reducing downtime. A shift from preventive to predictive maintenance of equipment is planned for the equipment at the Devasthal observatory. Monitoring the condition of equipment requires deploying suitable sensors in various sub-systems and data collection for different parameters to analyze significant changes that indicate the initiation of a fault in its component. The pneumatic system of 3.6m Devasthal Optical Telescope is powered by a compressor that gives clean air to its vital components such as pneumatic actuators of the primary mirror, altitude and azimuth brakes etc. The compressor of the telescope has been taken as the model equipment for its health analysis. The temperature sensors DS18B20 and Raspberry Pi based platform are used to collect the data for the compressor components. Sample data is being analyzed and the experiences gained in the health analysis of the compressor will be beneficial for implementing additional sensors on various equipment supporting telescope operations. Real-time data collection and analysis are being planned to be used in scheduling and optimizing the maintenance requirements of the compressor for the telescope.

The 4-m International Liquid Mirror Telescope Data Reduction Pipeline : Analysis and First Results

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The 4m International Liquid Mirror Telescope has recently achieved its first light at the ARIES Devasthal Observatory, Nainital, India. It is coupled with a 4k x 4k CCD camera and has a field of view of ~22.5 x 22.5 arc-min covering a total sky area of ~120 sq. degrees. ILMT will be unique as it will observe the same sky area towards the zenith direction every night and will perform a deep survey of that long and narrow strip by looking at all astronomical sources crossing its field of view. ILMT uses liquid mirror technology, where the primary mirror is a rotating container filled with a highly reflecting liquid. The surface of the spinning liquid takes the shape of a paraboloid, and the reflecting surface focuses the light of the celestial objects in the focal plane. Since ILMT is not steerable, it cannot track the sources like conventional telescopes and hence uses a special mode of observation to do the integration of the incoming photons, known as the Time Delay Integration (TDI) mode. Since standard data reduction techniques are not the most efficient for the TDI mode observations, we have developed a data reduction pipeline for the analysis of the data to be observed with the ILMT. This pipeline includes pre-processing like dark subtraction, flat field correction, and sky subtraction, followed by precise astrometry and photometry of the detected sources. We have tested this pipeline on data obtained with other TDI mode facilities as well as with the ILMT during the first commissioning phase. The results we have obtained are very encouraging. We present the methodology involved in our data reduction pipeline and the first results on the astrometry and photometry based upon preliminary data obtained with the ILMT.

New Observing Facilities and back-end Instruments

Site testing for optical telescopes in India – past and present

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Site testing for optical telescopes in India – past and present B. C. Bhatt (Indian Institute of Astrophysics, Bangalore) and Dorje Angchuk (Indian Astronomical Observatory, IIA Campus, LEH-Ladakh) Since it's an invention in 17th century, Telescopes are used as a powerful tool for exploring the deep space. For any ground-based astronomical observatory, the site of the telescope is an extremely important parameter in view of the efficiency, quality, and quantity of observations one can obtain. More and more critical problems in modern astronomy demand data obtainable only at excellent sites. Indian efforts are being carried out since a long and today, a few of telescopes are established in excellent Indian sites. We present these site testing campaigns and discuss the efforts required to preserve these sites for a long period.

An automated photometric pipeline for the ILMT data

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The International Liquid Mirror Telescope (ILMT) is a 4-meter survey telescope constantly observing towards the zenith in the SDSS g', r', and i' bands. This survey telescope is designed to detect various astrophysical transients (for example, SNe, GRBs) and very faint objects like quasars and galaxies. A single scan of a 22' strip of sky contains a large amount of photometric information. To process this type of data, it becomes critical to have some tools or pipelines that handle it in an efficient and accurate way with minimal human biases. We offer a fully automated pipeline generated in Python to perform aperture and PSF photometry over the ILMT data acquired through CCD in Time Delayed Integration (TDI) mode. The calibration of the

instrumental magnitudes is done with respect to the SDSS/PanStarrs catalog. The light curve from these calibrated magnitudes will characterize the objects as variable stars or rapidly decaying transients.

Automated Transient detection and classification in the context of ILMT

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We present a detailed prompt emission and early optical afterglow analysis of the two very high energy (VHE) detected bursts GRB 201015A and GRB 201216C, and their comparison with a subset of similar bursts. Time-resolved spectral analysis of multi-structured GRB 201216C using the Bayesian binning algorithm revealed that during the entire duration of the burst, the low energy spectral index (α) remained below the limit of the synchrotron line of death. However, statistically some of the bins supported the additional thermal component. Additionally, the evolution of spectral parameters showed that both peak energy Ep and α tracked the flux. These results were further strengthened using the values of the physical parameters obtained by synchrotron modeling of the data. Our earliest optical observations of both bursts using FRAM-ORM and BOOTES robotic telescopes displayed a smooth bump in their early optical light curves, consistent with the onset of the afterglow due to synchrotron emission from an external forward shock. Using the observed optical peak, we constrained the initial bulk Lorentz factors of GRB 201015A and GRB 201216C to Γ_0 = 204 and Γ_0 = 310, respectively. The present early optical observations are the earliest known observations constraining outflow parameters and our analysis indicate that VHE-detected bursts could have a diverse range of observed luminosity within the detectable redshift range of present VHE facilities.

Astrometric and photometric standard candidates for the upcoming 4-m ILMT survey

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The International Liquid Mirror Telescope (ILMT) is a 4-meter class survey telescope that has recently achieved first light and is expected to swing into full operations by 1st January 2023. It scans the sky in a fixed \ang{;22;} wide strip centered at the declination of \ang{+29;21;41} and works in \emph{Time Delay Integration (TDI)} mode. We present a full catalog of sources in the ILMT strip that can serve as astrometric calibrators. The characteristics of the sources for astrometric calibration are extracted from \textit{Gaia} EDR3 as it provides a very precise measurement of astrometric properties such as RA (α), Dec (δ), parallax ({π}), and proper motions ($\mu_{\alpha^{*}}$ \& μ_{δ}). We have crossmatched the \textit{Gaia} EDR3 with SDSS DR17 and PanSTARRS-1 (PS1) and supplemented the catalog with apparent magnitudes of these sources in g, r, and i filters. We also present a catalog of spectroscopically confirmed white dwarfs with SDSS magnitudes that may serve as photometric calibrators. The catalogs generated are stored in a SQLite database for query-based access. We also report the offsets in equatorial positions compared to \textit{Gaia} for an astrometrically calibrated TDI frame observed with the ILMT.

The prospects of pulsating stars studies with the International Liquid Mirror Telescope

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The Hertzsprung-Russell diagram is covered with pulsating stars of many different kinds and flavours. Asteroseismology uses the pulsations of these stars to gain information about their interior, which is needed to improve our understanding of stellar evolution. During the last decade, asteroseismic studies have received an enormous boost thanks

to space missions like MOST, CoRoT, Kepler/K2, and TESS. These missions have collected nearly uninterrupted photometric time-series with a precision down to a few micromag and a total time base of up to 4 years. TESS is the only one of these missions that is still collecting data and that is covering the largest part of the sky and hence will have targets in common with the ILMT strip. For which types of pulsating stars are the ILMT observations expected to give an added value to the already existing space-based observations? In this presentation, we try to give an answer to this question.

Near-infrared Imager, Spectrometer, and Polarimeter (NISP)

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Near-Infrared Imager, Spectrometer, and Polarimeter (NISP) is an upcoming multifaceted backend instrument to be used at the main port of 2.5 m telescope of Mount Abu Observatory, operated by Physical Research Laboratory (PRL). NISP will have the ability to function in imaging, spectroscopic as well as polarimetric modes in a selectable manner. Near-infrared broadband filters (Y, J, H, Ks, and K) used in the instrument will cover the wavelength of about 0.8 to 2.5 microns. The optics has been designed in-house to provide an FOV of 10' x 10' in the imaging mode using an H2RG detector from Teledyne. The spectroscopic design with R ~ 2000 has been achieved using grisms. Further, NISP will also facilitate imaging-polarimetry in two shots (0 and 90 degrees, 45 and 135 degrees) with the help of two wollastons used in its optical design. NISP electronics has also been designed and developed in-house at PRL. The presented poster provides an overview of diverse scientific goals of NISP and various sub-systems of the instrument.

Assembly and testing of a Ground Layer Adaptive Optics (GLAO) system on ARIES telescopes

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Many AO systems have been designed and tested over the years to improve the data and performance of ground based telescopes by correcting for various atmospheric aberrations. A significant portion of the aberration or seeing is caused by the ground layer of the atmosphere which is what we are aiming to correct for when testing the AO unit at various sites. The required unit was assembled using SBIG components like the filter wheel, CCD and a tip-tilt corrector in the lab and tested on ARIES telescopes later. The system uses natural guide stars from the same iso-planatic patch as the source and makes low frequency corrections for slowly varying ground layer turbulence. This analysis will provide fraction of time seeing is stable and how much it wanders during a typical night of observations, which is so far undetermined . Finally, the images can be processed and sharper than presently obtained images can be obtained.

Astrometric calibration of the 4m ILMT data

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The 4m International Liquid Mirror Telescope (ILMT) has recently achieved its first light at the ARIES Devasthal Observatory, Nainital, India. It is coupled with a 4k x 4k CCD camera and has a field of view of ~22 x 22 arc-min covering a total sky area of ~120 sq. degrees. ILMT will be unique as it will observe the same sky area towards the zenith direction every night and will perform a deep survey of that long and narrow strip by looking at all astronomical sources crossing its field of view. Since the science goals of any survey telescope rely heavily on the astrometry of the detected objects, we have developed a data reduction pipeline for the astrometric calibration of the data that will flow from the ILMT. Testing this pipeline on the data obtained from the ILMT in the commissioning phase, we have achieved a sub-arcsec accuracy in the astrometry of the

detected objects, and the pipeline is ready to be implemented in real-time ILMT data. We will present the methodology involved in this data reduction pipeline and the first results on the astrometry based upon preliminary data obtained with the ILMT.

Accessibility of the ILMT survey data

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The 4m International Liquid Mirror Telescope (ILMT) continuously scans the 22’ wide strip of the zenithal sky and records the images in three broadband filters (g’, r’ and i’) using a 4Kx4K CCD camera. In about 10-12 hours of observations during a single night, ~15 GB of data volume is generated. The raw images resulting from the observations in Oct-Nov 2022 have been pre-processed and astrometrically calibrated. In order to exploit the scientific capabilities of the ILMT survey data by the larger scientific community, we are disseminating the raw data (along with dark and flat fields) and the astrometrically corrected data. These data sets can be downloaded by the users to conduct the scientific projects of their interest. In future, the data will be processed in near real-time and will be available via the ARIES data archive portal.

Supernovae detection rate with the ILMT and their followup strategy with ARIES facilities

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The 4m International Liquid Mirror Telescope (ILMT) is presently under commissioning phase at Devasthal Observatory (Nainital, India). This facility continuously scans the same strip (22' wide) of the sky (in g, r and i bands) with a fixed pointing towards the zenith direction. Consequently, it provides a unique opportunity for supernovae (SNe)

detection and study. We estimated the SNe detection rate with the ILMT by considering the progenitor mass range for Type Ia SNe and core-collapse supernovae (CCSNe) as 3-8 MSun and 8-50 MSun, respectively. Here, the CCSNe mass range is for different types of events (Ibc, IIL, IIP, and IIn). Our calculation indicates that it is possible to detect hundreds of supernovae each year by implementing an optimal image subtraction technique. The photometric classification of SNe is also possible with the ILMT data. The observatory hosts two additional optical facilities (1.3m DFOT and 3.6m DOT) along with the ILMT and therefore, immediate monitoring of ILMT-detected transients/SNe is planned under the target of opportunity mode. The spectroscopy with DOT facility will be useful for the classification of SNe.

A year-long representation of the ILMT observations in different coordinate systems

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The 4-meter International Liquid Mirror Telescope (ILMT) is the first optical survey telescope in India that performs zenithal observations of a 22’ wide strip of the sky. In order to determine which portion of the sky will be observed by the ILMT during the entire year, we show the ILMT Field of View (FoV) in three different coordinate systems - galactic, ecliptic, and equatorial. We adopt a constant declination of +29°22’26” and varying RA ranges corresponding to the Local Sidereal Time (LST). The observations from June to September are hampered due to the monsoon season. The handiness of such representations will allow us to determine if any newly discovered transient is present in the ILMT FoV or not. This will enable prompt follow-up observations with other facilities.

The 4-m International Liquid Mirror Telescope project

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The International Liquid Mirror Telescope (ILMT) project is a scientific collaboration in observational astrophysics between the Liège Institute of Astrophysics and Geophysics (Liège University, Belgium), the Aryabatta Research Institute of Observational Science (ARIES, Nainital, India) and several Canadian universities (British Columbia, Laval, Montréal, Toronto, Victoria and York). Meanwhile, several other institutes have joined the project: the Royal Observatory of Belgium, the National University of Uzbekistan and the Ulugh Beg Astronomical Institute (Uzbekistan) and the Poznan Observatory (Poland).

The Liège company AMOS (Advanced Mechanical and Optical Systems) has fabricated the telescope structure that has been erected on the ARIES site in Devasthal (Uttarakhand, India). It is the first liquid mirror telescope being dedicated to astronomical observations.

First light has been obtained on 29 April 2022 and commissioning is going on at the present time. In this poster, we describe and illustrate the different components of the ILMT and their functions.

Taking advantage of the best seeing conditions and atmospheric absorption towards the zenith, the ILMT performs a deep survey and high S/N photometric and astrometric observations in the SDSS g', r' or i' spectral bands of a narrow strip of sky (22' in declination) passing over the zenith. In combination with a highly efficient 4kx4k CCD camera and a dedicated optical corrector, the images are being secured at the prime focus of the telescope using the Time Delayed Integration (TDI) technique. The singly scanned CCD frames correspond to an integration time of 102 sec, corresponding to the time an object's image remains within the active area of the detector. The ILMT presently reaches 21 mag (g-band) in a single scan but this limiting magnitude can be further improved by co-adding the nightly images.

The uniqueness of good cadence (one day) and deeper imaging with the ILMT make it possible to detect and characterize artificial satellites and space debris (see Hickson et al.'s ILMT poster, hereafter ILMTP), solar system (see Pospieszalska et al.'s ILMTP), galactic (see Grewal et al.'s ILMTP) and extra-galactic objects (see Akhunov et al. + Sun et al. + B. Kumar et al.'s ILMTPs).

The fast f/D ~2.4 ratio of this telescope is particularly well adapted to the detection and characterization of low surface brightness objects (see Fu et al.'s ILMTP). Several examples of very extended and faint galactic nebulae observed with the ILMT are presented.

An image subtraction technique is also being applied to the nightly recorded observations in order to detect transients, objects exhibiting variations in flux or position (see P. Kumar et al.'s ILMTP). Science data acquired during the fall of 2022 are being made freely available to the scientific community (see Misra et al.'s ILMTP).

Serendipitous Detection of Orbital Debris by the International Liquid Mirror Telescope: First Results

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Orbital debris presents a growing risk to space operations, and is becoming a significant source of contamination of astronomical images. Much of the debris population is uncatalogued, making the impact more difficult to assess. We present initial results from the first ten nights of commissioning observations with the International Liquid Mirror Telescope, in which images were examined for streaks produced by orbiting objects including satellites, rocket bodies and other forms of debris. We detected 83 streaks and performed a correlation analysis to attempt to match these with objects in the public database. 48% of these objects were uncorrelated, indicating substantial incompleteness in the database, even for some relatively-bright objects. We were able to detect correlated objects to an estimated magnitude of 14.5 and possibly about two magnitudes greater for the faintest uncorrelated object.

Progress on a photometric data pipeline for extracting quasar light curves from ILMT images

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Recent research suggests a correlation between the variability and intrinsic brightness of quasars. This could lead to the use of quasars on the cosmic distance ladder, but this work is currently limited by lack of quasar light curve data. The new 4-metre International Liquid Mirror Telescope (ILMT)'s nightly imaging could produce high quality light curves for thousands of faint quasars in its field. A Python photometric data pipeline is under development to directly extract light curves from astrometrically calibrated ILMT images using aperture photometry.

Surface brightness properties of LSB galaxies with the ILMT

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LSB galaxies make up a significant amount of the luminosity density of the local universe. They have to be considered when building complete and homogeneous catalogs of galaxies. Their low surface brightness suggests a different formation and evolution process compared to more typical high-surface-brightness galaxies. LSB galaxies may hold important clues about the nature of dark matter, which is believed to be responsible for the observed rotation curves of galaxies, including LSB galaxies. Installed on the mountain of northern India, the ILMT provides surveys in g', r' and i' bands, which makes it possible to study the difference between red and blue LSB galaxies based on the g−r colour criteria. Additionally, by investigating the surface brightness properties of LSB galaxies, the distribution and properties of dark matter in the universe can be learned in further research.

Extracting High-Quality Light Curves for Cepheid Variables with the ILMT

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The Hubble Tension is a discrepancy between the measurements of the Hubble constant, which describes the expansion rate of the Universe, derived from cosmological observations. This is an important tension because the value from the current model of cosmology Lambda Cold Dark Matter has a 5-sigma discrepancy compared to the latest type Ia supernovae measurements. One way to address the Hubble tension is by using Cepheid variable stars, which pulsate with a period that is related to their intrinsic luminosity. Cepheids are used as "standard candles" to measure distances to nearby galaxies, and their period-luminosity relation can be used to calibrate other distance indicators. Nestled in the mountains of Northern India, and employing a 4-meter rotating liquid-mercury primary mirror, the 4m international liquid mirror telescope is well-suited to study the photometric variability of Cepheids over a multi-year time span.

GRAVITATIONAL LENSING OBSERVATIONS OF QUASARS WITH THE 4-m ILMT

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Gravitational lensing may enrich our view of the distant Universe and affect our physical understanding of various classes of extragalactic objects. The great interest in gravitational lensing comes from the fact that this phenomenon can be used as an astrophysical and cosmological tool to solve a number of scientific problems. Quasars and gravitationally lensed quasars (GLQs) are of particular interest since they sufficiently probe the deep Universe and can be bright enough to be detected and investigated. But to do this successfully we need to know how many multiply imaged quasars we will be

able to detect, how to analyze the observational data, their sensitivity, what problems and challenges await us. In this poster, we try to briefly highlight these points: why GLQs are interesting to us, what objects should we observe, how many of them, etc? According to our last estimations, the number of quasars which may be detected with the ILMT is ~ 6700. So, at least 15 of them should consist of multiply imaged quasars.

Detection and characterisation of Asteroids with the 4-m ILMT

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A very unique strength of the Devasthal Observatory will be to combine the detection capability of optical transients by the 4m International Liquid Mirror Telescope (ILMT) with their follow up studies using the 1.3m Devasthal Fast Optical Telescope (DFOT) and/or the 3.6m Devasthal Optical Telescope (DOT), installed right next to the ILMT.

In this context, we have inspected 20 fields having an angular extent of 22' in declination by 9x22' in right ascension observed during October/November 2022 during 9 consecutive nights. All these fields were observed with the Sloan i'-band filter during the nights of 28, 29 and 30 October. Defining a transient as being a source appearing clearly on only one of the three i'-band frames and an asteroid candidate as consisting of three transients detected at the three different epochs, having similar angular separations while being properly oriented as a function of time, a total of more than 160 asteroid candidates have been visually identified. Furthermore, we report in these same fields 611 additional i'-band detections of transients which could be other known or new asteroids, highly variable stars, supernova candidates, etc.

Concentrating on just one of those 20 fields, the field with its R.A. (2022.8) starting at 04h32m, we have visually identified 25 known asteroids reported in the database of the Minor Planet Center. Making use of the image subtraction technique applied to the three g'-, r'- and i'-band CCD frames covering this same field (see ILMT poster by P. Kumar et al.), we could identify 10 additional known asteroids reported in the Minor Planet Center database. Furthermore, 142 additional transients have been identified on the basis of the g'-, r'- and i'-band CCD frames covering this unique field.

The conclusion is that in order to detect and characterize new supernovae, micro-lensing events, highly variable stars and quasars among the ILMT transients, we shall first have to identify all known and new asteroids. Thanks to its large diameter and short focal length (f/D ~2.4), the ILMT turns out to be an excellent hunter for asteroids.

Solar System Bodies and Exoplanetary Science

Multiple Stellar Systems

Search of variable stars in open clusters

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We present a CCD photometric survey for the search of variable stars in four open clusters namely Berkeley 69, King 5, King 7, and Berkeley 20. The time series observations were carried out for 1 and/or 2 nights for each of the clusters in the year 1998, which have led to identify nineteen variable stars in these clusters. Out of these 19 variable stars, five stars show δ Scuti like variability and two stars show W UMa type variability. In other stars, we could not find the periods and hence the type of variability due to the lack of sufficient data. The periods of δ Scuti type stars are found to be in the range of 0.13 to 0.21 days, whereas the two stars in the cluster Berkeley 20, which showed W UMa type variability have orbital periods of 0.396 and 0.418 days, respectively. Using the Gaia data, the basic parameters of the clusters Berkeley 69, King 7 and King 5 are also revised. The age and reddening are estimated to be 0.79±0.09 Gyr and 0.68±0.03 mag for Berkeley 69, 0.79 ± 0.09 Gyr and 1.22±0.03 mag for the cluster King 7 and 1.59±0.19 Gyr and 0.63±0.02 mag for the cluster King 5, respectively. Signature of mass segregation is found in the clusters King 7 and King 5.

Study of BMP stars using UVIT/AstroSat

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Blue metal-poor (hereafter BMP) stars are the main-sequence stars that are brighter and bluer than the normal turn-off stars of globular clusters of similar metallicty and hence analogous to field blue straggler stars (hereafter FBSS). These FBSS are expected to be either field blue straggler stars (hereafter FBSS) formed via post-mass transfer

mechanism or accreted from dwarf satellite galaxies of the Milky Way. The major fraction of BMP stars are discovered to be binaries, typically with long periods and circular orbits, likely to have a compact companion. We study 27 BMP stars observed using UVIT/AstroSat in two FUV filters, F148W and F169M and report the discovery of white dwarf companions in 14 BMP stars for the first time. Out of these 14 stars, 11 are known to be single-lined spectroscopic binaries or binary candidates with periods of 0.9 to 840 days and eccentricity 0 to 0.5, and 3 BMP stars are known to have constant radial velocities. The hot companions with estimated temperatures, Teff ~ 10500 − 40000 K are white dwarfs with masses 0.17 M$\odot$ − 1.1 M$\odot$. We suggest that mass transfer and merger in triple system channels play a significant role in the formation of BMP stars and thus at least 14 BMP stars (~ 52 %) in our sample are confirmed FBSS.

Exploring the Nainital-Cape Survey Stars with TESS

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Nainital-Cape Survey was initiated to study the pulsational variability in chemically peculiar (CP) stars, namely the Ap and Am stars for understanding their internal structure and evolution through asteroseismology. The primary target selection criterion was to choose candidates with Stromgren photometric indices similar to those known CP stars exhibiting pulsational variability. We performed the time-series analysis of these targets, for which short cadence data from TESS was available. A total of 369 targets were studied and classified based on their lightcurves. We present the compilation of the results obtained from this study.

Study for variable stars in King 18

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The preliminary results of searching and study for variable stars using TESS photometry in the inter-media age open star cluster King 18 are presented. We have investigated the light curves and frequency spectra of different type variable stars located in the open cluster's area. The results obtained together with prospects of study of this open cluster are briefly discussed.

X-ray study of a disc-overflow system TX Col

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TX Col is an intermediate polar in which the primary white dwarf accreats via disc as well as stream. It also changes its accretion geometry from one of observations to other. We investigate the X-ray timing and spectral properties of TX Col in order to further prob its variable nature of accretion. We make use of the archival data obtained from Chandra, Swift, and Suzaku at three different epochs of observations from 2000 to 2009. The orbital, spin, and beat periods of TX Col from three different epochs of observations are found to be similar those derived in earlier studies. The X-ray spectrum, which was strongly absorbed by dens material with an average equivalent hydrogen column density of ~10^22.5 cm^-2 is explained by the isobaric cooling flow model with the black body emission and its reflection from the cold matter for each epoch of observations. We found that TX Col changes its accretion geometry from disc dominance to stream dominance.

Study of RR Lyrae stars

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RR Lyrae stars play and important role in astrophysics as standard cases and as witnesses of galactic evolution. Yet, there are some unsolved riddles surrounding these stars. In this poster, we share some of our recent work on RR Lyrae stars and the questions surrounding their pulsations, using both space-based photometry and ground-based data.

Blue Straggler Stars of NGC 7789 and NGC 2506 using AstroSat/UVIT

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Blue straggler stars (BSS) are intriguing objects that seem to defy the standard theory of single-star evolution. They manage to elongate their main-sequence lifetimes by acquiring mass either in a direct stellar collision or through mass transfer in a binary or in mergers. We study the BSS candidates of two intermediate-age open clusters NGC 7789 and NGC 2506 using the NUV and FUV observations from AstroSat/UVIT in combination with other multi-wavelength data. Around 40% of BSS candidates show an excess in the UV wavelengths and are fitted with two-component spectral energy distributions. We detect all of these BSS to contain a low-mass or extremely low-mass white dwarf as a hot companion, whereas all the yellow straggler stars and red clump stars of NGC 2506 with WDs of normal mass or high mass as a companion. Based on our analysis, we infer that around 33-42% of BSS have likely formed via mass transfer by the Case-A/Case-B mechanism in these two clusters.

Characterisations of hot populations of Berkeley 39 open cluster using UVOT/Swift

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Open star clusters consist of normal stellar populations as well as exotic stellar populations such as blue straggler stars (BSS), yellow straggler stars (YSS), subdwarfs (sdBs), cataclysmic variables, etc. Among the exotic stellar populations, BSS are common, easy to be identified and found in diverse environments. The location of BSS on the color-magnitude diagrams (CMDs) implies that BSS gained mass either in a direct stellar collision or via mass transfer in a binary system. Owing to their hotter temperatures, BSS emit a significant amount of radiation at UV wavelengths. Multi-wavelength spectral energy distributions (SEDs) of stars including UV data points have proven to be an excellent tool for discovering unresolved hot companions in exotic stars such as BSS. Berkeley 39 is an old Galactic open cluster located at a distance of 4200 pc. Using the ML-MOC algorithm on Gaia EDR3 data, we identified 861 cluster members. Here, we characterize 16 BSS and 8 main-sequence (MS) stars of Berkeley 39 based on the multiwavelength SEDs constructed using UV data from swift/UVOT, optical data from Gaia DR3, IR data from 2MASS, Spitzer/IRAC, and WISE. We find excess flux in UV data in 3 BSS, implying the presence of hot companions. We present the properties of the BSS and their hotter companions based on the SED fitting.

Blue straggler stars: setting up a dynamical clock for open clusters

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Blue straggler stars (BSS) are late bloomers that are bluer and brighter than the turnoff stars in a cluster's main sequence. Their abnormal appearance is a signature of binary or multiple stellar interactions that took place in a cluster environment and resulted in such massive objects. Therefore, being a massive population compared to their other cluster siblings, the sedimentation level of BSS has been used to probe the dynamical evolution of globular clusters (GCs). In a series of studies, we explored the dynamical evolution of old open clusters (OCs) for the first time, making use of the trait of BSS that they settle quicker in the cluster core than any other cluster population. In Vaidya and Rao et al. (2020), based upon the radial distributions of BSS, we classified 7 OCs into 3 different categories of dynamical evolution, from dynamically young to old OCs. In Rao et al. (2021, 2023 in prep), we investigated the dynamical evolution of 23 OCs based on the area enclosed between the cumulative radial distributions of BSS and a less massive cluster population, called A+. Furthermore, we calculated the dynamical ages of OCs using the theoretical dynamical age parameter, Nrelax, which is calculated based on cluster properties. Finally, by comparing both empirical and theoretical parameters, we date the dynamical stages of OCs, demonstrating that BSS may also be utilized to determine the dynamical ages of Ocs.

Probing stellar evolution properties through variable stars in open cluster NGC 381

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We study variable stars in the field of the open cluster NGC 381 using photometric data observed over 27 nights and identify a total of 57 variable stars. The variable stars are

classified based on their periods, amplitudes, light curve shapes, and locations in the H-R diagram. We found a rich variety of variable stars in the cluster. We identified a total of 10 eclipsing binaries out of which 2 are Algol type (EA) while 8 are W UMa type (EW) binaries. The estimated ages of these EW binaries are greater than 0.6 Gyr which is in agreement with the formation time constraint of > 0.6 Gyr on short-period eclipsing binaries. The estimation of the physical parameters of the three EW type binaries is done using PHOEBE model-fitting software. The pulsating variable stars include one each from δ Scuti and γ Dor variability class. The δ Scuti star is found to be possibly pulsating in first overtone mode using the pulsation constant (Q) method. We also determined pulsation modes of pulsating variables with the help of the FAMIAS package. The physical parameters for the δ Scuti star are calculated using empirical relations. We obtained 15 rotational variables stars comprising four dwarf stars identified on the basis log(g) versus log(T) diagram. These dwarf stars are found to have generally larger periods than the remaining rotational variables. Two RS Canum Venaticorum-type (RS CVn) variables are also identified.

Time-Resolved TESS Photometry of HD 118660

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Asteroseismology investigates internal stellar structure using its natural pulsation frequencies. HD 118660 pulsating with a very regular sequence of the frequency spectrum with a spacing of 6.465 c/d. We performed mode identification using a custom light curve of TESS photometry. We produced an Echelle diagram and from f-ratios we identified radial and dipole ridges, incorporating 4 radial and 3 dipole modes. Theoretical eigenfrequencies are calculated from best-fit stellar models using GYRE. A sinusoidal variation of amplitude is observed at a frequency of 24.38 c/d with a periodicity of 8.703d due to the beating of close frequencies within resolution. No shift in frequency was observed, restricting the star far from the evolutionary change. Theoretical isochrones are calculated from stellar models using MESA, visualized HD 118660 in the H-R diagram, and basic parameters are calculated.

Binary fraction in Star Clusters

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It is well known that stars are born in clusters which eventually dissolve. In this work, using Gaia DR3 data, we study the binary fraction in the complete sample of 376 star clusters within 1 kpc of the Sun and study its evolution in time in relation to their galacto-centric distance, size (core and limiting radii), location in the galaxy (l,b) and mass-functions. Our sample is used to make important conclusions about the life, dissolution and star clusters and the binary fraction in clusters as well as in field stars using the Gaia DR3 data.

UVIT/Astrosat studies of blue straggler star in NGC 362- detection of extremely low mass white dwarf

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We present the detection of extremely low-mass white dwarfs (ELM WD) as a companion of blue straggler stars (BSS) in the Galactic globular cluster NGC 362. The data taken from AstroSat's UltraViolet Imaging Telescope (UVIT), UVOT and 2.2m ESO are used for the present analysis. Based on the Spectral Energy Distribution (SED) of the BSS, an ELM WDs is detected as a binary companion. The effective temperature, radius, and luminosity for the ELM WD and BSS are determined.

Polarimetric Approach towards Membership Probability

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Stokes parameters are beneficial for membership information of a cluster. The linear polarization is a result of the dichroic extinction of starlight from aligned asymmetric dust grains that lie in front of the star. Member stars of the cluster lie at the nearly same distance so Stokes parameters for members should lie close to each other, while if there is a foreground or background star then depending upon the column density different value of stars appears. Therefore, the principle behind the membership from this technique is based on the selective extinction from aligned asymmetric interstellar dust grains. We have used the polarimetric technique to get the membership probability of proper motion member stars of the open star cluster. We have calculated the membership probability of members of the cluster NGC 2345 and NGC 1817 using the polarimetric technique and we found a good correlation between our results and previously estimated probabilities of members. From this study, one can infer that the polarization property can be used for membership probability if other values are not available. However, there are some drawbacks to this technique because stars that have a component of intrinsic polarization may also show the scattered distribution and the cluster with differential reddening may also influence the polarization and hence values of Stokes parameters.

Detection of variable stars in the Galactic globular cluster M15

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We present time series observations of the variable stars in the globular cluster M15 using the 3.6-meter Devasthal Optical Telescope (DOT) and 2-meter class HCT telescope, in India. This cluster is an old and dense globular cluster that contains many evolved stars, particularly dozens to hundreds of RR Lyrae stars, therefore, it is an ideal target to study variability in RR Lyrae stars to understand their evolution. This work identifies

more than 130 known and newly variable stars. The majority of the identified known variables are RR Lyrae variables. The RR Lyrae variables could be RRc and RRab-type, based on their variability characteristics.

Change in accretion flow in the Intermediate Polar, V709 Cas

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We have carried out a detailed time-resolved timing analysis of an intermediate polar V709 Cas, using the long-baseline, short cadence optical photometric data from the Transiting Exoplanet Survey Satellite(TESS). We refine the orbital period as 5.33306 ± 0.00004 hr, a spin period as 312.748 ± 0.002 s and a beat period as 317.927 ± 0.002 s. These periods are similar and more precise than the earlier published results. From the continuous data, we report the system's accretion geometry as disc overflow with disc-fed dominance with some part of it being also stream-fed. We also found a double peaked pulse profile which indicates that V709 Cas is a two pole accretor.

Astrosat investigation of X-ray flares on two active K-M systems : CC Eri and AB Dor

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We present an X-ray and UV investigation of eight X-ray flares detected on two active systems, CC Eri and AB Doc, using the Astrosat satellite. CC Eri is a K7.5+M3.5 binary located at a distance of ~11.5 pc, whereas AB Dor is known to be a K0+M8+M5+M5-6 quadrupole system located at âˆ¼14.9 pc. Both the objects showed variations in X-ray and UV, and multiple flaring activities have been observed. Using the Astrosat SXT, LAXPC, and CZTI observations in the 0.3â^'150 keV energy band, both sources are detected only in 0.3â^'15 keV. The peak X-ray luminosities of the flares in the 0.3â€“15 keV band are found to be â^¼10^{31â€“32} erg s^{â^'1}. The X-ray spectrum of the events has been analyzed with Astrophysical Plasma Emission Code, assuming the bremsstrahlung continuum and adopting the emission lines from the latest Astrophysical Emission Database. Preliminary spectral analysis indicates the presence of three and four-temperature corona for CC Eri and AB Dor, respectively, where the highest temperature is found to vary with flare. The flare temperatures peaked at 51â€“59 MK for CC Eri and 29â€“44 MK for AB Dor. The peak emission measures of the flaring loops are estimated to be ~10^{54} for CC Eri and ~10^{55} cm^{â^'3} for AB Dor. To derive the length and dimensions of the flaring loop, we performed quasi-static loop modeling of the flaring events. Preliminary results show the loop lengths and loop density of the flaring plasma are derived to be ~10^{12} cm and ~10^{11} cm^{-3} for CC Eri, and ~10^{11} cm and ~10^{11} cm^{-3} for AB Dor. Our analysis also estimates the magnetic field required for causing these flares and thus gives further insight into the associated dynamo mechanisms.

Spectroscopic Investigation of stellar atmosphere from MIRA/OOS

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Using the variable-resolution (Resolution ~6,000 -- 60,000) spectroscopic observations from the Oliver Observing Station (OOS) of the Monterey Institute for Research in Astronomy (MIRA), California, USA, we present an investigation of the stellar atmosphere of FGKM-dwarfs. The observations were carried out between 2000 and 2023 using the "Concurrent Observing and Data Acquisition System" (CODAS) mounted on a 36-inch F/10 classical Cassegrain Telescope at the OOS. The CODAS provides capabilities of user-selectable simultaneous photometric, spectroscopic, and high-precision polarimetric observations. Most spectroscopic observations have been carried out in wavelength modes 2970--4890 and 5170--7090 angstroms. We used standard packages available in IRAF, Python, and IDL for initial data reduction, wavelength calibration, and modeling. We used Kurucz atmospheric models to model the atmosphere, whereas the synthetic spectra have been generated using the spectral analysis code TURBOSPECTRUM. We performed spectral fitting and equivalent width analysis to derive the chemical abundances in the stellar atmosphere. The stellar parameters are cross-verified following the standard ionization equilibrium technique using Fe I lines along with the spectral fits to the wings of the broad lines. The radial velocity is determined using a standard cross-correlation technique with template spectra and applying the shift throughout the spectral region. Further, the wavelength coverage and spectral resolution of MIRA facilities enabled us to study Ca II H and K lines, Hg, HÎ´, Ca I, HÎ³, and HÎ² lines, obtain a first estimate of the `alpha' elements and study the activity level of the stars. Other atomic features (including the CN bandhead feature at 3883 angstroms) in the given spectral range have also been analyzed to derive the abundances. This analysis also helps shed light on the evolutionary stage, nucleosynthesis history, and formation epochs of the studied stars.

Investigation of orbital-period changes of the short-period eclipsing binaries

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High quality photometric and spectroscopic data for double lined Eclipsing binaries (Ebs) provide accurate parameters which are crucial for testing the stellar evolution models

and theories. The use of photometric data alone can shed light on a number of astrophysical processes in semi-detached and contact systems like understanding the interaction between binary components. The investigation of period variation can reveal the mass loss/transfer processes, apsidal motion as well as magnetic activity cycles. Most of the short period EBs are considered as a part of multiple systems but it is hard to directly observe the other components due to their faintness. Using the 1.04-m ST, 1.3-m DFOT and other archival data, we studied many contact and detached EBs. In this poster, we will present some of the results obtained from photometric analysis of few EBs based on the ARIES telescopes.

Magnetic Activity of M-dwarfs

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M dwarfs are the most numerous stars in our Galaxy, amounting to about two-thirds (~70%) in number and about 40% in stellar mass. M dwarfs are the lowest-mass hydrogen-burning stars, which are found at the bottom of the main sequence in the H-R diagram. These stars possess masses of 0.08–0.6 $M_\odot$ and have effective temperatures of 2500 - 4000 K. Due to their convective interiors and rotation, they have relatively strong magnetic fields and are capable of producing very strong flares, are triggered by magnetic reconnection with energies up to 104 times or greater than the strongest flare (~1032) observed on the Sun. To understand their magnetic activity, we have undertaken optical/Near-IR spectroscopic studies of a unique sample of M-dwarfs including some having strong flares and magnetic fields. Using Himalayan Faint Object spectrograph (HFOSC) and TIFR Near-IR spectrograph (TIRSPEC) instruments on the 2-m Himalayan Chandra Telescope (HCT) telescope, and TIFR-ARIES Near Infrared Spectrometer (TANSPEC) on the 3.6-m Devasthal Optical Telescope (DOT), we have taken optical and near-IR spectra of a sample of M dwarfs to investigate the chromospheric activity and evolution of the atmosphere of M-dwarfs. Several important atomic and molecular lines in the optical and Near-IR wavelengths (e.g., H alpha, Ca II IR triplet, He 10833, Na, CO, etc) are detected in the observed spectra, and are used to characterize these late-type dwarfs. We utilize Transiting Exoplanet Survey Satellite (TESS) photometric data of M-dwarfs to investigate the relationship between star-spots,

stellar flares and magnetic fields, etc. Our aim is to understand the magnetic activities on those active M dwarfs by using photometric and spectroscopic data. Data analysis is on going and we will present a few preliminary results in this presentation.

Photometric Variability of Young Brown Dwarfs and Very Low Mass Stars in The Taurus Star-Forming Region

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Photometric variability studies of very low-mass stars (VLMs) and Brown Dwarfs (BDs) are important tools to probe the physical nature of their atmospheres. Photometric variability in these dwarfs is due to surface features like magnetic spots (strong magnetic fields) or dust clouds, which cause optical modulation as it rotates. It is possible to measure the period of rotation of an object from its light curve. The time-series photometric observations are a key probe of atmospheric inhomogeneities in VLMs and BDs. BDs are known to be rapid rotators (~ hours to days), so the rotation modulation of their light curves gives information about surface features such as magnetic spots or dust clouds, which provides an opportunity to measure the period of rotation in these dwarfs. However, it is very challenging to detect their variability amplitude, which is the order of a few tens of milli-magnitudes. We have taken optical I-band time-series photometric observations on a few BDs and VLMs in the Taurus star-forming region. From our preliminary analysis of the observed data in the I-band on CFHT Tau 6 and CFHT Tau 8, we found that CFHT Tau 8 shows significant periodic variability. We estimate a rotation period in the hour scale. While CFHT Tau 6 shows no significant variability with a given accuracy with the observed ground-based time-series I-band data. The time series data of a few BDs are also taken from the archive of space-based observations using Transiting Exoplanet Survey Satellite Survey (TESS), and CFHT-BD-Tau 6, CFHT-BD-Tau 8 and MHO 4 all show sinusoidal variability with a period in day scale. Interestingly, we have also observed two flare events in MHO 4 with an energy range in the superflare category.

Spectroscopy of Galactic Sources

The isotopic ratios of Ba and Eu in s-process enhanced stars

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The low-to-intermediate stars (LIMS) dominate the stellar population in galaxies. These stars are also the major contributors to the chemical evolution of the universe due to various nucleosynthetic reactions occurring in them, especially when they are at their later stage of evolution called the Asymptotic Giant Branch (AGB) stage. The galactic chemical evolution (GCE) models generally try to explain the origin and evolution of chemical elements in the galaxy. The key aspects in understanding the GCE are the accurate abundances of chemical elements in stars along with yield predictions from theoretical models. But most of the chemical elements have multiple stable isotopes and different nucleosynthetic reactions may be contributing to their production. The situation will be more complex in the case of heavy elements produced by different neutron capture

processes. The abundances at the isotopic levels are thus more important to constrain the conditions (temperature, density) at which the nucleosynthesis takes place and also to identify the actual isotopic path followed by the different neutron capture processes. This will help us identify the relative contribution of different neutron capture processes to the abundance of individual elements, which is an essential ingredient of the GCE models. Thus the contribution of different astrophysical sites, such as the contribution of AGB stars, to the overall chemical enrichment of our Galaxy can be estimated with greater accuracy. Here we present the initial results from the analysis of a sample of s-process enhanced stars at various metallicities.

Identifying quiescent compact objects in massive Galactic single-lined spectroscopic binaries

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It is now clearly established that massive stars are predominantly found in multiple systems. While their period and eccentricity distributions are now well established across different metallicity regimes, the mass-ratio distribution has been mostly limited to double-lined spectroscopic binaries. The mass-ratio distribution therefore remains subject to significant uncertainties and open questions encompass the shape and extend of the companion mass-function towards its low-mass end and the nature of undetected companions in single-lined spectroscopic binaries, i.e. low-mass main-sequence stars, binary interaction products, compact objects… We have conducted a large and systematic analysis of a sample of more than 80 single-line O-type spectroscopic binaries in the Milky Way and in the Large Magellanic Cloud using a sophisticated multi-technique, and multi-wavelength approach. We report on the developed methodology, the constraints obtained on the nature of SB1 companions, the distribution of O star mass-ratios at LMC metallicity and the occurrence of quiescent OB+black hole binaries.

LAMOST J045019.27 + 394758.7, with peculiar abundances of N, Na, V, Zn, is possibly a Sculptor dwarf galaxy escapee

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Carbon stars are a special class of objects that exhibit strong bands due to carbon molecules such as C2, CH, and CN in their spectra. These group of stars have drawn considerable attention as far as their spectroscopic studies are concerned. Many sky surveys were conducted to explore carbon stars due to their chemical peculiarities. One of the most recent survey is the Large Sky Area Multi-Object Fiber Spectroscopic Telescope (LAMOST) survey, and further low-resolution spectroscopic studies of these LAMOST stars by different authors could identify a substantial number of carbon stars based on the measurement of the line indices of carbon molecular lines. In this poster, we will present some recent results obtained from the high-resolution (R ~ 60 000)

spectroscopic analysis of the star LAMOSTJ045019.27+394758.7 (hereafter J045) from the list of carbon stars of LAMOST DR2. Although previous studies have classified this star as a carbon star with no identifiable sub-type, our analysis shows that J045 does not exhibit the spectral characteristics of carbon stars. From our analysis, we found that this object is a metal-poor ([Fe/H] = −1.05) giant that shows very unusual elemental abundances, particularly for N, Na, V, and Zn. We have derived stellar atmospheric parameters and chemical abundances for this object and we find that the observed abundance patterns in the star are not compatible with abundances characteristic of Galactic metal-poor stars of similar metallicity, but, matches quite closely with those observed in Sculptor Dwarf Galaxy stars. Based on the above observational evidences, we suggest that the object is a possible Sculptor Dwarf Galaxy escapee.

Is i-process dependent on metallicity?

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Observations of certain groups of carbon-enhanced metal-poor (CEMP) stars (the so-called CEMP-rs stars) revealed that their slow-neutron capture process (s-process) enrichments are also accompanied by heavy elements traditionally produced by the rapid neutron-capture process (r-process). These stars have raised the need for a neutron-capture process operating at neutron densities intermediate to that of the s and r-process: the so-called intermediate neutron-capture process (i process). Recently it is identified that the i-process is the result of the ingestion of protons into the convective helium-burning region of low-mass AGB stars. But, many other physical characteristics of the i-process nucleosynthesis such as its dependence on metallicity, mass, mixing processes, etc remain poorly understood. We attempt to characterize the i-process by the analysis of a large sample of stars with rs enrichments that are at various metallicities. Here we present the initial results from this analysis.

Formation scenarios of Ba stars: new evidence from the masses of the companion AGBs

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We have performed detailed high-resolution spectroscopic analysis on seven metal-poor stars and derived their atmospheric parameters. The metallicity range is found to be -2.57 < [Fe/H] < -0.42. The elemental abundances of 17 light elements and 12 heavy elements are estimated. We have classified two objects as strong Ba stars, and one as a mild Ba star, and the remaining four objects as CEMP-s stars. We have estimated the masses of the stars from the Hertzsprung-Russel diagram, and, compiling the data of 205 Ba stars from literature, estimated the mass distribution of Ba stars. We have also estimated the initial masses of the companion AGBs of the program stars as well as the masses of the companion AGBs of 159 Ba and 36 CEMP-s stars from literature, with the help of a parametric-model-based analysis using FRUITY models. While the primary mass distribution of mild Ba stars peaks at 3.7 M_sun, for the strong Ba stars, the peak appears at 2.5 M_sun. We, therefore, propose that the initial masses of the progenitor AGBs dominantly control the formation of mild and strong Ba stars. However, a clear overlap, in the range 1.3 - 4.0 M_sun, noticed between the progenitor masses of both the subclasses of Ba stars, may indicate that other factors, such as metallicities and the orbital periods, may also have significant contributions. The progenitor AGBs' mass distribution of CEMP-s stars is found to peak at 2.03 M_sun.

Massive Stars

Study of instabilities and outbursts in luminous blue variables

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Luminous blue variables (LBVs) also known as S Doradus variables are evolved massive stars close to the Eddington limit, with a distinct spectroscopic and photometric variability having unsteady mass-loss rates. These stars show a considerable change in their surfaces temperature from quiescent to outbursts phase. The cause of irregular variability and unsteady mass-loss rate is not properly understood. Here we present the result of linear stability analysis in two classical LBVs during their quiescent and outbursts phase. We note that several modes are unstable in the models of considered LBVs. Observational facilities of BINA network will be very beneficial to study the spectroscopic and photometric behaviour of the considered LBVs.

Investigating the role of pre-supernova massive stars in the acceleration of galactic cosmic rays

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Galactic cosmic rays (GCR) constitute a significant part of the energy budget of our galaxy, and the study of their accelerators is of high importance in modern astrophysics. Their main sources are likely supernova remnants (SNR), consisting in an sudden outflow of large amounts of material at speeds of several thousands of km/s. These objects are capable to convert a part of their mechanical energy into charged particle acceleration. However, even though the mechanical energy reservoir of SNRs is promising, a conversion rate into particle energy of 10 to 20% is necessary to feed the population of GCR. Such an efficiency is however not guaranteed. Complementary sources deserve thus to be investigated. This communication aims at addressing the question of the contribution to the acceleration of GCRs by pre-supernova massive

stars. In particular, stellar wind collisions in binary systems are known to accelerate particles, thanks to their synchrotron emission in the radio domain. Their stellar winds are energy reservoirs less abundant than SNRs, but they are capable to sustain a high acceleration efficiency for millions of years (to be compared to a few thousand years for SNR). This endeavour consists in leading many radio observations to identify a significant number of particle accelerators among massive stars, and make a decisive leap forward in our understanding of their contribution to the production of GCRs. Our approach includes observations at various frequencies and various angular scales, to optimize the identification efficiency. The exploration of this scientific question is meant to achieve a more global view of the origin of GCR.

Synchrotron radio emission as a proxy to identify long period massive binaries

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Galactic cosmic rays (GCR) constitute a significant part of the energy budget of our galaxy, and the study of their accelerators is of high importance in modern astrophysics. Their main sources are likely supernova remnants (SNR), consisting in an sudden outflow of large amounts of material at speeds of several thousands of km/s. These objects are capable to convert a part of their mechanical energy into charged particle acceleration. However, even though the mechanical energy reservoir of SNRs is promising, a conversion rate into particle energy of 10 to 20% is necessary to feed the population of GCR. Such an efficiency is however not guaranteed. Complementary sources deserve thus to be investigated. This communication aims at addressing the question of the contribution to the acceleration of GCRs by pre-supernova massive stars. In particular, stellar wind collisions in binary systems are known to accelerate particles, thanks to their synchrotron emission in the radio domain. Their stellar winds are energy reservoirs less abundant than SNRs, but they are capable to sustain a high acceleration efficiency for millions of years (to be compared to a few thousand years for SNR). This endeavour consists in leading many radio observations to identify a significant number of particle accelerators among massive stars, and make a decisive leap forward in our understanding of their contribution to the production of GCRs. Our approach includes observations at various frequencies and various angular scales, to

optimize the identification efficiency. The exploration of this scientific question is meant to achieve a more global view of the origin of GCR.

Study of B[e] type supergiant MWC 137

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Luminous blue variables (LBVs) also known as S Doradus variables are evolved massive stars close to the Eddington limit, with a distinct spectroscopic and photometric variability having unsteady mass-loss rates. These stars show a considerable change in their surfaces temperature from quiescent to outbursts phase. The cause of irregular variability and unsteady mass-loss rate is not properly understood. Here we present the result of linear stability analysis in two classical LBVs during their quiescent and outbursts phase. We note that several modes are unstable in the models of considered LBVs. Observational facilities of BINA network will be very beneficial to study the spectroscopic and photometric behaviour of the considered LBVs.

Multi-wavelength studies of star formation regions

Study of Young Star-Forming Region near AFGL 5157

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We have carried out a detailed analysis of the star forming region near 'AFGL 5157' by performing deep optial photometry taken with Imager mounted on Devasthal optical telescope (DOT) along with recently available high quality proper motion data from the Gaia DR3 to understand the star formation scenario in the region. Recent studies have suggested that the expansion of MIR bubbles associated with the H II regions can trigger the 14 to 30% of the formation of the stars in our galaxy. Our primary aim is to determine the impact of massive stars on their nearby surroundings. We have identified Young Stellar Objects (YSOs) based on their excess IR-emission using the two-color diagrams (TCDs). MIR and radio continuum maps are used to trace the distribution of the cold gas/dust as well as ionised gas in the region. Optical TCDs and color magnitude diagrams (CMDs) are used to derive extinction/age/mass function of the stellar sources in this region. All these information will be use to constrain the star-formation processes in the region.

Spatial structure and star formation scenario in young star cluster Bochum 2

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Young open clusters (age ≤ 10 Myr), having just formed from gravitationally bound molecular clouds and still nested in the parent nebulous region is considered to be the fundamental entity of star formation in our galaxy as the higher mass stars tends to move towards core region with time due to dynamical evolution and their study can directly abode a number of fundamental astrophysical problems. Moreover, young clusters offer the smallest physical scale over which meaningful determination of the stellar IMF can be made. Apart from this, cluster's colour magnitude diagram have been used to provide classical tests of steller evolution theory. One of the important question in the field of star formation is the role of stellar feedback on the subsequent star formation process. The evolution of HII regions can trigger a new generation of stars at their peripheries, with environmental conditions that may affect the IMF, disk evolution and star formation efficiency. In this work we study the stellar content and star formation processes in the young open cluster Bochum 2. To study the large scale environment of the cluster we used wide field optical data from 1.3m DFOT alongwith multiwavelength data sets.

Formation and Evolution of young low-mass stars in Star-forming Regions

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Star-forming regions (SFRs) contain stars of variety of masses in different evolutionary stages. Therefore, young clusters and SFRs are ideal sites to study the star formation and evolutionary processes. We have studied a few SFRs/ cluster complexes to study the formation and evolution of young stars. Here, I will present results of our recent work based on the deep optical/ infrared data from 3.6m DOT and other facilities and discuss the formation/ evolution of the young low-mass stars, mass distribution and star formation histories of the studied regions.

Multi-wavelength Star formation studies

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Understanding the formation process of stars and their evolution constitute one of the basic problems in astrophysical research. Star forming regions present an unique laboratory for understanding the, process of star formation, the Initial Mass Function (IMF), the early evolution of stars over a wide mass range, and the nature of interactions between young stars and their surrounding interstellar medium. Various efforts have been already made to study these regions but the satisfactory explanation of star formation process is still far from reality. Availability of good quality multi-wavelength data from various telescopes/instruments provides an excellent opportunity to study in detail the physical process going on in these regions which will be very helpful to constrain various star formation scenarios. In this talk, I will be presenting the results of our study related to star formation in several star forming regions.

Characterisation of the massive star formation history in young open clusters

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The central star of A30 is believed to have undergone a very late thermal pulse that caused ejection of hydrogen deficient material, prominently seen in the light of [O iii] lines, about 850 years back. The inner parts of the nebula are filled with this material where as the outer rim of the nebula is of H-normal composition and of about 12,500 yrs of age. A30 is also an X-ray source showing both a diffuse source covering the inner few arc seconds region covering the hydrogen deficient knots and a point source located on the central star. We imaged A30 with UVIT (Ultraviolet imaging telescope) on board of Indian Astronomical satellite ASRTROSAT, in 3 FUV and 2 NUV filters. Two FUV lters, F154M (and F169M (1608 A) allow the high excitation lines of He ii, C iv etc. The other FUV lter F172M (1717 A) allows mostly the nebular continuum. The NUV lters N219M (2196 A) and N279N2 (2796 A) allow mostly low excitation lines or continuum. In the present work, we contrast the UV images with both X-ray contours as well as ground based [O iii] and H images. The most surprising result of our UV imaging is the presence of FUV halo in two FUV lters, F154M and F169M, extending beyond the known optical and NUV nebular size. We also detected such halos in other PNs eg. NGC 6058, NGC 6302 etc. We discuss the morphology and nature of these halos (which might be a result of H2 molecular fluorescent emission).

Protostellar outflows and their orientation with host filaments in massive protoclusters

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Filamentary structures in Galactic molecular clouds have the ability to feed prestellar cores by swiftly flowing gas along their long-axis. Although filaments are identified with flowing gas that could aid the star formation, a direct implication of it would be identifying a correlation between the protostellar accretion and gas flow along the

filaments. However, it is difficult to have a direct detection of accreting gas at core-scale, and thus, a solution to this problem could be finding correlation of the protostellar outflows associated with the filamentary structures. These outflows are generally launched by the rotating accretion disk of the protostar, and can be used to infer the orientation of the accretion disk. With the assumption that filaments enhance the flow of molecular gas onto protostellar accretion disks, one would ideally expect a preferred position angle of bipolar outflows with respect to the orientation of the long-axis of the filaments. We studied protostellar outflows in massive Galactic protoclusters using several lines of ALMA data observed as a part of the ALMA three-millimeter observations of massive star-forming regions (ATOMS) survey. The plane of sky position angles between outflow axes and dust filaments are distributed in a random fashion. However, a bimodal distribution (i.e., orthogonal and parallel) is observed while the orientation of outflows are compared with the gas filaments in these evolved regions (i.e., HII regions). Earlier a preferred perpendicular orientation of outflows with respect to their host filaments mostly found in young massive star-forming clouds (i.e., infrared dark clouds). In this workshop, I would like to present the details of the study. In addition, possible near-infrared probes of outflows in these sources will also be discussed.

Census of Young Stars in Galactic Star-forming Region Sh2-88

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We present here identification of the young stellar objects (YSOs) associated with one of the active star-forming region Sh2-88 (S88) located in the Vulpecula OB association. We use several archival catalogues, e.g., UKIDSS, 2MASS, Spitzer etc. To characterize the structure of molecular clouds in S88, an extinction map is generated using UKIDSS (H-K) colours of the stars using the nearest neighbourhood method. From the map, we estimated a median visual extinction (Av) of the region, about 4.71 mag. Using the infrared colour excess from Spitzer four IRAC bands and 2MASS Ks photometric data, a total of 6 Class I and 68 Class II YSOs are classified within the region. To understand the distribution of young stars and star-formation in the regions, identified YSOs are

overplotted in the extinction map, which shows that the majority of them are lying in the core high extinction regions.

Compact objects

Transients

Supernovae from a pop III star of 25 Solar mass

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In this work, we present the 1-D stellar evolution of a 25 solar mass zero-age main-sequence (ZAMS) pop III star. We study the physical properties of the star throughout the course of its evolution on HR diagram. The radius, density and temperature of the pop III star with different rotations are also compared with a normal

solar type 25 solar mass ZAMS with Z = 0.02. We also study the implications on the resulting supernovae.

Prompt emission and early optical afterglow of VHE detected GRB 201015A and GRB 201216C : onset of the external forward shock

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We present a detailed prompt emission and early optical afterglow analysis of the two very high energy (VHE) detected bursts GRB 201015A and GRB 201216C, and their comparison with a subset of similar bursts. Time-resolved spectral analysis of multi-structured GRB 201216C using the Bayesian binning algorithm revealed that during the entire duration of the burst, the low energy spectral index (α) remained below the limit of the synchrotron line of death. However, statistically some of the bins supported the additional thermal component. Additionally, the evolution of spectral parameters showed that both peak energy Ep and α tracked the flux. These results were further strengthened using the values of the physical parameters obtained by synchrotron modeling of the data. Our earliest optical observations of both bursts using FRAM-ORM and BOOTES robotic telescopes displayed a smooth bump in their early optical light curves, consistent with the onset of the afterglow due to synchrotron emission from an external forward shock. Using the observed optical peak, we constrained the initial bulk Lorentz factors of GRB 201015A and GRB 201216C to Γ_0 = 204 and Γ_0 = 310, respectively. The present early optical observations are the earliest known observations constraining outflow parameters and our analysis indicate that VHE-detected bursts could have a diverse range of observed luminosity within the detectable redshift range of present VHE facilities.

On the multi wavelength nature of GRB 200524A : from prompt emission to afterglow

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We present a detailed multi-wavelength analysis of GRB 200524A which is one of the brightest GRB detected by \textit{Fermi} Gamma Ray Burst Monitor (GBM). An in-depth study of this GRB in the prompt and afterglow phase reveals several interesting features. No significant spectral lag in the prompt phase was found mainly due to the presence of multiple overlapping pulse structure. The time resolved spectra is best fit with the band function. The peak energy in the prompt phase tracks the flux pattern. The multi-wavelength afterglow evolution is best described by a forward-reverse shock model. A bright reverse shock emission component is seen in the optical bands at very early times. At a redshift of z $\sim$ 1.256, GRB 200524A is one of the energetic burst (E_{iso} = 3×10^{53} erg) which occurred in a medium with a very low ambient density ($3.5\times10^{-3} cm^{-3}$) which is typically unusual for a long GRB.

Gamma Ray Bursts and their afterglows at TeV energies

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In recent times, emissions at TeV energies have been detected from Gamma Ray Bursts (GRBs) and their afterglows. The TeV emissions have been detected using the HESS and the MAGIC telescopes. In this work, I will review the properties of the TeV-bright long GRBs both in the prompt and afterglow emission phases. I will focus on the multi-wavelength modeling of the afterglow of GRB 190114C with an emphasis on its low-frequency evolution and the nature of the shock microphysical parameters.

Extragalactic Astrophysics

Light curves and time delay of the gravitationally lensed systems : SDSS J2124+1632 and SDSS J0806+2006

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We present results of photometric processing of new CCD images of two double gravitationally lensed quasars SDSS J2124+1632 and J0806+2006 observed at Maidanak observatory (Uzbekistan) in 2017-2022. The light curves of the lensed images in SDSS J2124+1632 show brightness of the components during 2018-2022 has an active variability caused, among other things, by microlensing. The probable value of the time delay ΔtAB = 105.3±18.8 days was calculated.This value is consistent with the previously found time delays for binary gravitationally lensed quasars with a similar configuration. The light curves of another lensed quasar with double images – SDSS J0806+2006 show that the brightness of the source-quasar in this period has a noticeable, and possibly periodic, variability. The probable value of the delay time ΔtAB = –17.0±2.5 days was calculated. This value is consistent with previously predicted theoretical values for this system. The photometry methods we developed can also be applied to images of dense fields that will be obtained on the 4-m ILMT telescope.

Star formation characteristics of galaxies hosting AGN

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In the recent times, observationally there has been increasing indication of close relationship between active galactic nuclei (AGN) and the galaxies that host them. A

larger number of studies have addressed the issue of star formation in galaxies hosting AGN and most of those studies use optical observations. Also, to firmly understand the connection if any between AGN and star formation, one needs to probe the star formation characteristics of AGN host galaxies at different spatial scales using different probes. I will be presenting recent observational efforts taken in this area to characterise the star formation in galaxies hosting AGN using data acquired in the ultra-violet band, using the ultra-violet imaging telescope onboard AstroSat, India's first multi-wavelength astronomical observatory. I will also highlight the importance of using multi-wavelength data for such studies.

Spectro-timing analysis of an NLS1 galaxy NGC 4748

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We present a detailed timing and spectral study of an extremely variable narrow-line Seyfert 1 galaxy NGC 4748 using observations in the year 2017 and 2014 performed with AstroSat and XMM-Newton, respectively. Both observations show extremely variable soft and hard X-ray emission that are correlated with each other. In the 2014 data set, the source retains its general behaviour of “softer when brighter” while the 2017 observation exhibits a “harder when brighter” nature. Such changing behaviour is rare in AGNs and is usually observed in the black hole binary systems. The “harder when brighter” is confirmed with the anti-correlation between the photon index and the 0.3-10 keV power-law flux. This suggests a possible change in the accretion mode from standard to the advection-dominated flow. Additionally, both the observations show soft X-ray excess below 2 keV over the power-law continuum. This excess was fitted with a single or multiple blackbody component(s). The origin of soft excess during the 2017 observation is likely due to the cool Comptonization as the photon index changes with time. On the other hand, the broad iron line and delayed UV emission during the 2014 observation strongly suggest that X-ray illumination onto the accretion disk and reflection and reprocessing play a significant role in this AGN. In future, our ARIES facilities and multiwavelength AstroSat mission jointly may help us to explore such phenomena with more deeper information.

Deep photometry of suspected gravitational lensing events

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Cosmic strings (CS) are one-dimensional extended objects predicted by modern cosmology, which, however, have not yet been detected with a high degree of confidence. The presence of cosmic strings changes the global geometry of the Universe and could serve as a unique proof of higher-dimensional theories. The principal question here is: do cosmic strings exist in our Universe? Two main methods of observational search for CS are: CMB anisotropy induced by a fast-moving CS, and gravitational lensing (GL) which arises when a CS is located between the observer and the background object(s). The last method consists both in search for single objects – pairs of lensed images, as well as for chains and statistically excessive number of characteristic GL events. Several conditions are used to identify CS GL events; main ones are the presence of two images of the lensed background source with respect to the lens (a CS), separated by some characteristic angular distance and same intensity ratio of each image component in all filters. In addition, CS lensing of extended objects produces sharp edges in the isophotes of the image, a phenomenon which cannot be found in standard GL. In average seeing conditions, these sharp edges are rounded off, hence, high-resolution data are needed. To test this property, the angular resolution of the observations is crucial since the angular size of the lensing signatures is related to the angular size of string strip. It was proposed that there can be few dozen long strings crossing horizon volume and, therefore, any survey aimed at detecting them through the photometric signature induced by the GL needs to be multiband, very deep and of high photometric accuracy.

Measuring the black hole mass of the low-luminous AGN : NGC 4395

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To understand the mass distribution and co-evolution of supermassive black holes and their host galaxy, it is crucial to measure the black hole mass of AGN accurately. Dynamical measurements are challenging for far-away galaxies due to the requirement of high spatial resolution. Spectroscopic reverberation mapping allows us to overcome this difficulty using the light epochs from the broad-line region (BLR). Previous reverberation mapping observations provided a relationship between the size of the BLR and luminosity, which is usually used for the black hole mass of all AGNs from the single-epoch spectrum. However, it is not clear if the size-luminosity relation is valid for low-luminosity AGNs (L5100< 1042 erg/s). We performed reverberation mapping of an extremely low luminosity Seyfert 1 galaxy NGC 4395 containing the least-luminous broad-lined active galactic nucleus (AGN) known to date using all three telescope facilities hosted by ARIES including 1m ST, 1.3m DFOT and 3.6m DOT for photometric and spectroscopic simultaneous observations. The preliminary results: We observed Hbeta broad line region size is estimated to be 72 light minutes and they are revolving with 304 km/s speed around the central engine with black hole mass measured to be 2.4x10^(5)Msun and the corresponding optical continuum luminosity is ~10^38 erg/s.

One-HaLe model for the SED of blazars and a curious case of CGRaBS J0211+1051

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The blazars are a subclass of Active Galactic Nuclei (AGN) seen almost along the relativistic jet, emanated from very close to the host accreting super massive black hole. Because of these having jets at close angles to our line of sight, blazars make a unique sample for studying the extreme particle energisation, nature of magnetic field and many other physical properties of the jet close to the central engine. The blazars are well known to show flux and spectral variations on a diverse time scale.

Nature of UV variability in NGC 4151 using IUE's intensive monitoring spectroscopic data

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The intensive observations active galaxies are useful in understanding the complex relation between continuum and emission line variability of Seyfert galaxies and quasars. NGC 4151 was considered as an interesting opportunity to study the nature of rapid UV continuum and emission line variability by making short-interval observations. IUE satellite has monitored NGC 4151 more intensively when the source was at its historical high flux state with shortest interval of 70 minutes between two successive and obtained a total of 397 spectra from its campaign during December 1-15, 1993. In this meeting, we present our results on emission line and continuum variability amplitudes characterized by Rmax and Fvar parameters. From our analysis, we have found the highest variability of nearly 8.3 % at 1325 Å continuum with smallest amplitude of ~ 4 % at 2725 Å. The Rmax values have been found to be 1.372, 1.319, 1.302 and 1.182 at 1325, 1475, 1655 and 2725 Å continua respectively. The continuum and emission line variability characteristics obtained in the present analysis are in excellent agreement with the results obtained by Edelson et al (1996) and Crenshaw et al (1996). The large amplitude rapid variability characteristics obtained in our study have been attributed to the continuum reprocessing of X-rays absorbed by the material in the accretion disk as proposed by Shakura and Sunyaev (1973). The continuum and emission light curves have shown four distinct high state events of flux maxima during the short duration observations over 15 days. These results have provided constraints on the amplitude of UV variability and the BLR-size in low luminosity Seyfert galaxies. Our results would be useful for constraining the continuum emission models. The decreasing Fvar amplitudes of UV continuum with respect to increasing wavelength is a significant result of the present studies.

Multi-band Optical Variability of the TeV Blazar PG 1553+113

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We report the flux and spectral variability of PG 1553+113 on intra-night (IDV) to short-term timescales using BVRI data collected over 27 nights from 15 March to 14 June 2019 employing two optical telescopes 1.04m ST and 1.3m DFOT ARIES, Nainital, India. We monitored the blazar quasi-simultaneously for 11 nights in the V and R bands and 5 nights in the V, R, I bands and examined the light curves (LCs) for intra-day flux and colour variations using two powerful tests: the power-enhanced F-test and the nested ANOVA test. The source was found to be significantly (> 99%) variable in 2 nights out of 13 in R-band, 1 out of 11 in V-band, and 1 out of 5 nights in I-band. No temporal variations in the colours were observed on IDV timescale. During the course of these observations the total variation in R-band was 0.51 mag observed. We also investigated the spectral energy distribution (SED) using B, V, R, and I band data. We found optical spectral indices in the range of 0.891±0.039 to 1.102±0.063 by fitting a power law ($F_\nu \propto \nu^{-\alpha}$) to these SEDs of PG 1553+113. We found that the source follows a bluer-when-brighter trend on IDV timescales. We discuss possible physical causes of the observed spectral variability.

X-ray spectral breaks in high redshift blazars : probes of intervening medium

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An X-ray spectral flattening has been reported in FSRQs that is attributable either to absorption from gas along the line of sight or to intrinsic jet-based radiative processes. We study a sample of 16 high-redshift FSRQs (z of 1.1–4.7) observed with the XMM-Newton and Swift satellites spanning 29 epochs. The model selection is unable to distinguish between them in 10 of the 16 FSRQs. Intrinsic jet-based radiative processes are indicated in 4 FSRQs. Two of the FSRQs indicate mixed results, supportive of either scenario, illustrating the difficulty of identifying X-ray absorption signatures. A clear detection can be employed to disentangle the relative contributions from the intergalactic medium and the intracluster medium, the method of which is outlined and applied to the latter two sources.

Study of magnetic dipole moment of the pulsars

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Pulsar are the ideal object to study the physics of matter under extreme conditions. Magnetic properties are crucial to understand the exterior and interior environment of the pulsars. Magnetosphere of the neutron star emits magnetic dipole radiation. We introduce the electrodynamical approach intensity within a length domain and to setup a relationship between magnitude of star and magnetic dipole moment. The present study is based on the radioflux at a distance of 10 parsec of the variable star.

Public Outreach and Education

PO-01

Venue : Bhartiya Shaheed Sainik Vidyalaya (BSSV), Nainital [March 22, 2023 | Time : 11:30]

Speaker : Bhuwan Joshi

Affiliation : Udaipur Solar Observatory, Physical Research Laboratory, Udaipur

E-mail : bhuwan@prl.res.in

Title : Missions for Space Exploration

Abstract : Space agencies monitor the Sun and interplanetary space 24/7 with a fleet of observatories, studying coupling of complex processes from the Sun's atmosphere to the interplanetary medium and planetary atmosphere. The Sun provides energy that allows life to exist on our planet. However, the variable environment of the Sun continues to show mysterious behaviour that including phenomena like solar flares, coronal mass ejections of charged particles and the solar wind. It is important for scientists to have a better understanding of how the Sun behaves on a daily basis, because radiation and particles emanating from it can affect astronauts or satellites in space. This lecture will give an overview of space missions that have been phenomena on the Sun and interplanetary medium. I will also present the uniqueness of the upcoming ISRO's Aditya-L1 mission which will put India into a select list of countries having the capability of observing the Sun from space.

PO-02

Venue : Mohan Lal Sah Bal Vidya (MLSBVM) Mandir, Nainital [March 22, 2023 | Time : 13:00]

Speaker : Nilakshi Veerabathina

Affiliation : University of Texas, Arlington, USA

E-mail : nilakshi@uta.edu

Title : Light : A Visible and Invisible Messenger

Abstract : Light, my light, the world-filling light, the eye-kissing light, heart-sweetening light! Ah, the light dances, my darling, at the center of my life; the light strikes, my darling, the chords of my love; the sky opens, the wind runs wild, laughter passes over the earth." -Rabindranath Tagore Do you ever wonder what light is and if the light that we see with our eyes the only light? Do we give off any light? How do astronomers decode the code to learn information about closet objects to the farthest fringes of the Universe, from the most violent phenomena to very gentle events, and from the most prominent things to very subtle ones in the cosmos? This interactive session is geared towards young and curious minds, and any astronomy enthusiasts to not only get the answers to the above questions, but also to learn the role of the different types of telescopes, such as the telescopes located in Nainital/Devasthal to Hubble Space telescope to recently launched James Webb space telescope.

PO-03

Venue : St. Joseph's College Nainital [March 23, 2023 | Time : 11:00]

Speaker : Anwesh Mazumdar
Affiliation : Homi Bhabha Centre for Science Education (TIFR), Mumbai
E-mail : anweshmazumdar@gmail.com

Title : Worlds around distant stars

Abstract : It has long been established that our Sun is not an extraordinary star in the Universe. There are billions of stars very similar to the Sun in our galaxy itself. Just like our own Solar System, we expect at least some, if not nearly all, of these stars to have planets revolving around them. But we cannot normally see these planets around other stars because they are very small and dim compared to their host stars, and are very close to them in the sky. How do we then find these "exoplanets" around other stars? In this talk we shall describe the clever methods that astronomers use to find and characterize exoplanets. Indeed more than five thousand exoplanets have already been discovered around other stars! We shall also discuss the chances that any of these planets may harbor life.

PO-04

Venue : St. Mary's Convent College, Nainital [March 23, 2023 | Time : 11:00]
Speaker : Katrien Kolenberg
Affiliation : KU Leuven, Belgium
E-mail : katrien.kolenberg@kuleuven.be

Title : Echoes from the Cosmos

Abstract : All humans share the firmament, which shines with stars on a clear night. We all live on a small, hospitable planet, our Earth, on its orbit around a rather average yet special star, our Sun. The age-old question - whether life could also exist elsewhere - we can now, more than ever, try to answer in a scientific way. In this performance, we take a journey through the Cosmos, from planetary quakes to star singing to merging black holes, to finally coming back to that question: "Are we alone?"

PO-05

Venue : Birla Vidya Mandir, Nainital [March 22, 2023 | Time : 12:30]
Speaker : Sunil Chandra
Affiliation : South African Astronomical Observatory Astronomy, South Africa
E-mail : sunil.chandra355gmail.com

Title : What does the multi-wavelength sky tell us about the universe?

Abstract : The universe hosts many astonishing objects, starting from icy/gaseous planets and stars in the local neighbourhood to distant quasars and gamma-ray bursts. Some of these are visible in one band and totally dark in other bands. For example, the active centers of some of the galaxies generate enormous amounts of energy throughout the spectrum but the very thick layers of gas and dust around them hinders the direct view and they are seen via reprocessed emission only. In this lecture, I shall be focussing on observations of the enigmatic universe at different energies and try to give an overview of

how simple laws of Physics taught at school and college level are used to interpret the complex physical mechanisms at play.

PO-06

Venue : Sainik School Ghodakhal [March 22, 2023 | Time : 15:30]

Speaker : Gregg Wade

Affiliation : Department of Physics and Space Science, Royal Military College of Canada, Canada

E-mail : Gregg.Wade@rmc.ca

Title : Life and Learning at Royal Military College of Canada

Abstract : Royal Military College of Canada (RMC) is a Canadian military university with the responsibility of educating officers for the Canadian Armed Forces. RMC's officer cadets experience a "4-Pillar" program comprising academics, physical fitness, leadership, and bilingualism. The academic program is structured into three faculties (Engineering, Social Science and Humanities, and Science) offering 18 undergraduate programs and 12 graduate programs. I am a Professor in the Physics and Space Science Department, and in this talk I will describe my perspectives on life and learning at RMC.

PO-07

Venue : Lake International School, Bhimtal [March 22, 2023 | Time : 12:00]

Speaker : Margarita Safonova

Affiliation : Indian Institute of Astrophysics, Banglaore

E-mail : margarita.safonova62@gmail.com

Title : Space : the final frontier : From stargazers to starships

Abstract : Everyone is interested in space and astronomy. But why do we need astronomy and, most important, why from space? After all, the biggest show on Earth every night available for free to everyone is the night sky. Where IS space and how to reach it? What are the orbits around our planet to put the satellites into? I will describe what we are doing to reach space, to do astronomy from space, and some efforts of our Small Payload Group at IIA to reach space and the near-space.

PO-08

Venue : Hermann Gmeiner School, Bhimtal [March 22, 2023 | Time : 12:00]

Speaker : Priya Hasan

Affiliation : Maulana Azad National Urdu University, Hyderabad

E-mail : priya.hasan@gmail.com

Title : Exploring our Universe

Abstract : The universe is huge and fascinating, full of galaxies, stars, and other celestial bodies. In this talk, we will review our scientific understanding of the universe, including its origin, structure, and ultimate fate. We'll look at the most recent discoveries and speculations about anything from exoplanets to stars and galaxies. We'll also talk about present and future telescopes and space missions that are helping us learn more about the universe.

PO-09

Venue : Jawahar Navodaya Vidyalaya Rudrapur [March 23, 2023 | Time : 11:00]
Speaker : Janaka Adassuriya
Affiliation : Department of Physics, University of Colombo, Sri Lanka
E-mail : adassuriya@gmail.com

Title : Detecting Exoplanets

Abstract : Exoplanets are planets outside of our Solar System that orbit other stars. Scientists have found thousands of exoplanets using a variety of methods, such as studying the light from stars or using the radial velocity method. At present, scientists found more than 5000 exoplanets ranging from Earth size to Jupiter family. The data from two successful missions, Kepler and TESS, are being used to detect exoplanets. How scientists find exoplanets, I will be there to discuss with you.

PO-10

Venue : Himalayan Progressive School, Kichha [March 23, 2023 | Time : 11:00]
Speaker : Getinet Fleke Ayane
Affiliation : Kotebe Metropolitan University College of Natural and Computational Sciences
Department of Physics Addis Ababa Ethiopia
E-mail : getinet13@gmail.com

Title : Unexplained Mysteries in Modern Astronomy

Abstract : When astronomy concepts are properly thought, students' perception, comprehension, and thinking skills improve and this facilitates the learning of other abstract concepts in science education. For school and college students, astronomy can be used to illustrate many concepts of physics and also triggers an expansion of awareness to the environment they live in. Astronomy is also at the centre of our daily lives, guiding us in matters ranging from measuring time to forming calendars, understanding climate changes and up to understanding the deep universe. In this talk, I will raise many unsolved ideas under the title 'Unexplained Mysteries in Modern Astronomy' which helps students to incorporate it with other subjects they learn in schools or colleges, discuss about it to explain the mysteries, bring solutions to the society and the science world in general in their future carrier.

PO-11

Venue : Graphic Era Hill University, Bhimtal [March 23, 2023 | Time : 11:00]
Speaker : Dipankar Banerjee
Affiliation : ARIES, India

E-mail : dipu@aries.res.in

Title : ADITYA L1 Mission to study the Variability of our nearest Star

Abstract : Sun is a variable star and I will highlight how Aditya L1 mission can play a role in the understanding of this variability of different time scales. ADITYA-L1 is the first Indian mission that is dedicated to study the solar atmosphere with unprecedented spatial and temporal resolution. The satellite will carry seven payloads and is expected to be launched in 2023 by PSLV-XL from Sriharikota. In this presentation I will give an introduction to the Sun and explain why we need to study the variability of our nearest star, the Sun.

PO-12

Venue : Dept. of Physics, DSB, Campus Kumaun University Nainital [March 23, 2023 | Time : 11:00]

Speaker : Manfred Cuntz & Nilakshi Veerabathina

Affiliation : University of Texas, Arlington, USA

E-mail : cuntz@uta.edu

Title : Outreach Activity in Conjunction with 3rd BINA Conference Hosted by ARIES, Nainital : Opportunities at the University of Texas at Arlington, USA

Abstract : The University of Texas at Arlington (UTA; https://www.uta.edu/) boasts to be a R-1 Carnegie University (Very High Research Activity designation by the Carnegie Classification of Institutions of Higher Education). UT Arlington is the fifth most diverse university in the United States. It serves more than 40,000 students from USA and over 100 other countries. UT Arlington ranked among the top 100 universities worldwide in four areas of the year 2022 Times Higher Education Impact Rankings. The university offers robust undergraduate (bachelor's degree) and graduate (master's and doctoral degrees) programs in various fields. The presentation will focus on the fields of sciences, particularly Physics. The UT Arlington's Physics department specializes in seven to eight frontiers of top-notch research fields and welcomes Indian students to apply for undergrad and grad programs. The department also seeks to foster international collaboration in research and teaching. (https://www.uta.edu/academics/schoolscolleges/science/departments/physics)

PO-13

Venue : M. B. P. G. College Haldwani [March 23, 2023 | Time : 11:00]

Speaker : Maheswar Gopinathan

Affiliation : Indian Institute of Astrophysics, Bangalore

E-mail : maheswar.gn@gmail.com

Title : JWST : Peering at the universe through infrared eyes.

Abstract : To peep back in time to see the most distant galaxies in the universe, the Hubble Space Telescope is inadequate since we need to look at the universe in infrared light. Here lies the importance of the James Webb Space Telescope (JWST) which is a result of 25+ years of incredible planning and

engineering that went into its making and launching it into L2. In this talk I will discuss some of its technical features and early exciting results.

PO-14

Venue : Birla Institute of Applied Sciences, Bhimtal [March 23, 2023 | Time : 15:00]
Speaker : Kasur Vaidya
Affiliation : Birla Institute of Technology & Science (BITS), Pilani
E-mail : kaushar@pilani.bits-pilani.ac.in

Title : Knowing Our Magnificent Universe

Abstract : Night skies have always aroused a sense of curiosity, mystery, and awe in humans. No wonder the oldest records of Astronomy observations date more than several thousand years, including the last 400 years with telescopes. However, most of what we know about our universe and its contents today has been learned in the past 60 years only! The main reason for this quick and significant progress is the technological advancements that have allowed observing celestial objects across the electromagnetic spectrum, with bigger and better telescopes during this period. In this session, we will explore five contemporary questions that astronomers are trying to answer. We will learn how our best telescopes enable us to answer these questions.