# National conference on REcent Trends in the study of Compact Objects (RETCO-V): Theory and Observation

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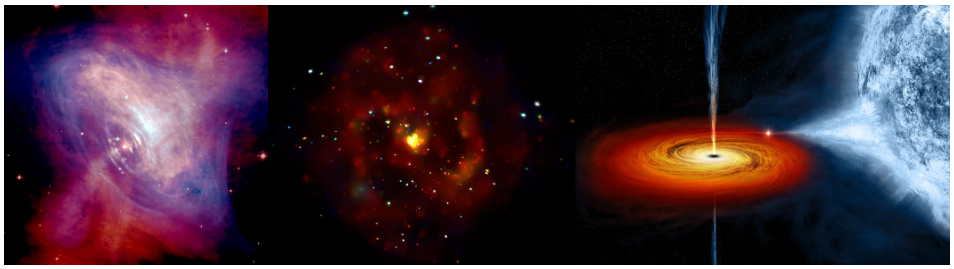
Kodaikanal Solar Observatory



# Book of Abstracts

# Contents

**Posters** / **9**

# Vertical Equilibrium Model for Accretion Flow: An Exact General Relativistic Self- consistent Analysis

**Authors:** Sangita Chatterjee[1]; Soumen Mondal[1]; Prasad Basu[2]

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We provide a complete general relativistic and fluid dynamical treatment to derive an expression of the relativistic accretion rate in curved space-time. We exploit the killing symmetry of stationary-axisymmetric space-time to obtain the conserved current using which we find an integral relation between mass flux and height of the accretion disk. In comparison with the existing different models of thin and slim disk approaches our analysis is self-consistent and mathematically rigorous. We reviewed the previous work and surveyed the recent status in this field. Our formula is different from the existing expression in the literature. The difference arises solely due to the rotation parameter of the compact star. The effect becomes important for slim/thick disks and for rapidly spinning compact stars. Thus one needs to alter the formula of $\dot{M} = 2\pi r H \rho u^r$ for Newtonian or spherically symmetric space-time while studying the accretion flows around Kerr black hole. Our formula can also be used to connect the variability of the vertical structure of the accretion disk through the luminosity variation of X-ray binaries (XRBs) and thereby explain the origin of the hysteresis loop of the spectral states.

**Presentation Type**:

Poster

**Posters** / **10**

# Studies on Accretion Dynamics around a black hole in Active Galactic Nuclei(AGN): Effects of galactic potentials.

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In this work, we present a detailed study and a complete analytical investigation of the critical behavior of the accretion flow and the nature of the phase trajectories corresponding to the transonic accretion in the context of these massive elliptical galaxies by incorporating the effect of the entire gravitational potential of the host galaxy in the presence of cosmological constant.

**Presentation Type**:

Poster

**Short Talks** / **11**

## Interpretation of GRB spectrum as an evolving Fireball

**Author:** Soumya Gupta[1]

**Co-author:** Sunder Sahayanathan [2]

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The time-averaged spectrum of Gamma-Ray Burst(GRB) is often well fitted by an empirical smooth broken power-law function term as the Band model. However, the physical interpretation of this Band function is still being debated. Two competitive models are the synchrotron emission from a non-thermal particle distribution accelerated at a shock front (synchrotron shock model) or a relativistically expanding fireball with a predominant thermal spectrum. Successful explanation of many GRBs using a multi-temperature black body spectrum support the latter while significant detection of polarised emission from the GRB favours the synchrotron shock model. We perform a detailed study of the evolving fireball model with its temperature evolving as a function of its radius. The numerical code developed under this scenario is coupled with X Spec as a local model and used to fit the time-averaged spectrum of GRB 221206B. The main fit parameters are the photospheric temperature and radius, the Lorentz factor of the expansion, and the index describing the temperature evolution. The best-fit parameters obtained are critically analysed to validate the fireball model.

**Presentation Type**:

Oral

**Posters / 13**

## ”Signatures of Modified Kerr-Newman black holes from the observed quasi-periodic oscillations”

**Author:** MEGHA DAS[1]

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Black holes (BH) represent the end stages of the evolution of stars with ZAMS > 15.0 M_{\odot}. These BHs are formed by the gravitational collapse of a massive star. BHs cannot be seen, but the effects of their strong gravity on the stars and the gases nearby can give us a lot of information. Astronomers' best hope has been to discover a BH in a nearby binary system. If the BH is in such a system, it will pull gas from the envelope of the normal companion star. The angular momentum of their orbital motion would cause a disk (accretion) of gas to form around the BH. As the gas spirals down toward the event horizon, it is compressed and heated up to millions of kelvins and emits X-rays from the innermost regions of the disk above the BH. In this study, various models that have been proposed in the literature are used to explain the observed QPO frequencies, which depend on the epicyclic motion of test particles and hence on the background metric (Modified Kerr-Newman). By performing a Chi-Square analysis between the theoretical and observed QPO frequencies, a conclusion has been reached that the Kerr BH in general relativity is more favored than BHs with charge parameters.

**Presentation Type**:

Poster

**Short Talks / 15**

## Double-barred discs - a possible source of energy in the active galaxies' central engines

**Author:** Debasish Mondal[1]

**Co-author:** Tanuka Chattopadhyay [1]

[1] *University of Calcutta*

This study examines the inflows and outflows of stars and gas in double-barred discs. For this, a 3D gravitational model has been set up and studied from the viewpoint of chaotic scattering in open Hamiltonian systems. In the phase space, a bar-driven outflow mechanism has been identified near the primary bar ends and further visualized using Poincaré maps to locate regular or chaotic basins. Our results show that the presence of secondary bars may scale up the inflow of gas towards the galactic centre. Again, the primary bar is responsible for bar-driven outflows that lead to the formation of spiral arms. As a result, for double-barred discs, extreme baryonic feedback is required to generate spiral patterns. Thus, double-barred discs may be one of the possible sources of energy generation in the central engines of active galaxies like Seyfert and AGN.

**Presentation Type**:

Oral

**Cataclysmic Variables / 16**

## SWIFT J0503.7-2819: a nearly synchronous intermediate polar below the period gap?

**Author:** NIKITA RAWAT[1]

**Co-authors:** J. C. Pandey [1]; Arti Joshi [2]; Simone Scaringi [3]; Umesh Yadava [4]

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Intermediate polars (IPs) are the low magnetic field strength ( B $\sim 10^6$-$10^7$ G) subclass of magnetic cataclysmic variables. IPs are asynchronous systems, and they follow the asynchronism relation as the spin period of the white dwarf (WD) is relatively less than the orbital period of the binary system. Most IPs have orbital periods longer than the 'period gap' of 2-3 h. However, there is a special class of IPs known as nearly synchronous IPs for which the spin period of WD is approximately in the range of (0.7-0.9) times the orbital period of the WD. These systems are thought to be in the process of attaining synchronism and evolving into polars. There is only one confirmed system, 'Paloma', which belongs to this class and lies in the period gap. Within this frame of reference, we will discuss the X-ray and optical properties of only other nearly synchronous IP, namely SWIFT J0503.7-2819. The X-ray and optical variations of this target have been found to occur at the period of $\sim$65 min, which we propose as the spin period of the white dwarf. The energy-dependent modulations at this period, which are due to the photoelectric absorption in the accretion flow, also assure this conjecture. If the proposed spin period is indeed the actual period, then SWIFT J0503.7-2819 could be the first nearly synchronous intermediate polar below the period gap.

**Presentation Type**:

Oral

**Neutron Stars** / **17**

## The curious case of subpulse drifting and nulling in PSR J0026-1955

**Author:** Parul Janagal[1]

**Co-authors:** Manoneeta Chakraborty [1]; N. D. Ramesh Bhat [2]; Samuel J. McSweeney [2]

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PSR J0026-1955 was recently independently discovered by the Murchison Widefield Array (MWA) and was quickly found to show both subpulse drifting and nulling. We have observed this pulsar with the upgraded Giant Metrewave Radio Telescope (uGMRT), covering a frequency range of 300-500 MHz. Our analysis shows that the pulsar exhibits two distinct subpulse drifting modes, with various evolutionary behaviour within the modes. With a nulling fraction of over 70%, the pulsar J0026-1955 is a welcoming addition to the subset of pulsars, which show subpulse drifting, nulling, and mode changing. The pulsar shows both rapid changes between modes and systematic evolution of drift rates within a mode. Further analysis revealed cases where within a mode, an evolution towards faster or slower drift rates was observed, a phenomenon which is exhibited by only a handful of known pulsars. We have also found compelling evidence of memory across nulls and a strong association between specific drift rate behaviour and nulling. We have studied the drift rate evolution of J0026-1955 in great detail and found that a carousel model with a variable carousel rotation rate would explain the drifting behaviour. With all these intriguing properties, J0026-1955 is an ideal and unique test bed for carousel models to uncover the intricacies of pulsar emission physics.

**Presentation Type**:

Oral

**Posters** / **19**

## Anisotropic charged compact stellar configurations in the perspective of gravitational decoupling approach

**Author:** pramesh tamta[1]

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We construct the physically admissible charged compact star models threaded with anisotropic matter contents via gravitational decoupling approach. Durgapal IV solution containing charge is considered as seed solution for applying minimal geometric deformation approach.We extend the isotropic seed solution into anisotropic domain by imposing suitable mimic constraints on the physical variables i.e. pressure and density. The extended solution is employed to frame the models of dense relativistic structures.We study the geometrical and thermodynamic behavior of the models and examine the physically admissible attributes of the models via graphical patterns. The stability status of the compact entities is examined through different stability criteria. The essential energy bounds are found to be satisfied within the compact star models.We performed the extensive analysis of the model for the star RXJ 1856-37 having mass 0.9MΘ and radius 6 km. The extended anisotropic solution is also compatible with observed masses as well as radii of some compact starsEXO 1785-248 and PSRJ1614-2230.

**Presentation Type**:

Poster

**Posters** / **20**

## Do pulsar and Fast Radio Burst dispersion measures obey Benford's law?

**Authors:** Pragna Mamidipaka[1]; Shantanu Desai[1]

[1] *Indian Institute of Technology, Hyderabad*

We check if the first significant digit of the dispersion measure of pulsars and Fast Radio Bursts (using the CHIME catalog) is consistent with the Benford distribution. We find a large disagreement with Benford's law with $\chi^2$ close to $80$ for $8$ degrees of freedom for both these aforementioned datasets. This corresponds to a discrepancy of about $7$. Therefore, we conclude that the dispersion measures of pulsars and FRBs do not obey Benford's law.

**Presentation Type**:

Poster

**Posters** / **22**

## The light bending phenomenon for a pulsar-black hole binary

**Author:** Jyotijwal Debnath[1]

**Co-authors:** Avishek Basu [2]; Manjari Bagchi [1]

[1] *IMSc*

[2] *Jodrell Bank Centre for Astrophysics*

We devise a full general relativistic formalism to study the delays caused by the light bending effect in the signal of a radio pulsar in a binary. This delay is non negligible for neutron star - neutron star binaries and even stronger for neutron star - black hole binaries. We calculate bending delays for hypothetical neutron star - black hole binaries. The values of the bending delays obtained in our method match with the values obtained by an approximate method already known. However, the old method is valid only when the pulsar is at the superior conjunction and our method is valid for any configuration. Moreover, our formalism results in some additional features like a discontinuity in the delay curve near the superior conjunction, etc. We also show that the bending distorts the intensity distribution across the beam and as a result change the shape of the pulse profile.

**Presentation Type**:

Poster

**Black Hole: Theory** / **23**

## Three Dimensional Simulations of Advective, Sub-Keplerian Accretion Flow onto Non-rotating Black Holes

**Author:** Sudip Garain[1]

[1] *Indian Institute of Science Education and Research Kolkata*

Observations of X-ray binaries containing black holes indicate the presence of geometrically thick, hot, dynamic Compton cloud around the black hole to satisfactorily explain it's spectral and temporal properties. In this work, I present results of a few high resolution, 3D hydrodynamic simulations of such Compton cloud around a non-rotating black hole. Our results demonstrate that the formation of stable, geometrically thick, torus is indeed possible for various accretion flow parameters.

**Presentation Type**:

Oral

**Posters** / **30**

## Evidence for profile changes in PSR J1713+0747 using the uGMRT

**Author:** Neel Kolhe[1]

[1] *On behalf of the Indian Pulsar Timing Array Collaboration*

PSR J1713+0747 is one of the most precisely timed pulsars in the international pulsar timing array experiment. This pulsar showed an abrupt profile shape change between 2021 April 16, (MJD 59320) and 2021 April 17 (MJD 59321). In this study, we report the results from multi-frequency observations of this pulsar carried out with the upgraded Giant Metrewave Radio Telescope (uGMRT) before and after the event. We demonstrate the profile change seen in Band 5 (1260 MHz–1460 MHz) and Band 3 (300 MHz–500 MHz). The timing analysis of this pulsar shows a disturbance accompanying this profile change followed by a recovery with a time-scale of ~159 days, We also briefly comment on the reasons for the profile change as the literature suggests profile changes may be caused due to re-organization of pulsar beams, and the recovery could be explained by the magnetosphere relaxing to it's original configuration.

**Presentation Type**:

Poster

**Neutron Stars** / **36**

## Broad-band mHz QPOs and spectral study of LMC X-4 with AstroSat

**Author:** Rahul Sharma[1]

**Co-authors:** Chetana Jain ; Ketan Rikame ; Biswajit Paul

[1] *Raman Research Institute*

LMC X-4 is a highly luminous and eclipsing high-mass X-ray binary pulsar which is known to exhibit variations in X-ray flux over a wide range of time scales. The Large Area X-ray Proportional Counter (LAXPC) and Soft X-ray Telescope (SXT) instruments onboard the *AstroSat* observed the source in August 2016. The source was found to emit an X-ray luminosity of $\sim 2 \times 10^{38}$ erg s$^{-1}$ in the energy range of 0.5-25 keV. The power density spectrum showed the presence of coherent pulsations at 13.5 s along with a $\sim$ 26 mHz quasi-periodic oscillation feature. From the joint analysis of the SXT and LAXPC spectral data, the 0.5-25 keV spectra were found to be comprised of an absorbed high-energy cut-off power law with a photon index of ~0.8 and cut-off at ~16 keV, a soft thermal component with $kT_{BB} \sim 0.14$ keV, and emission lines due to Fe K$\alpha$, Ne IX, and Ne X. We will discuss the implications of these results.

**Presentation Type**:

Oral

**Black Hole: Observations** / **40**

## Spectro-timing properties of the black hole X-ray binary MAXI J1348–630 using AstroSat Observations

**Author:** Jithesh V[1]

**Co-authors:** Gitika Mall [2]; Ranjeev Misra [3]

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We present broadband X-ray spectral and timing analysis of the black hole X-ray binary MAXI J1348–630, performed using five AstroSat observations. The source was in the soft spectral state for the first three observations and in the hard state for the last two. The power density spectra are substantially weak in the soft state compared to the hard state. In addition, we detected quasi-periodic oscillations at ~ 0.9 and ~ 6.9 Hz, belonging to the type-C and type-A classes. The three soft state spectra were modeled using a relativistic thin accretion disk with reflection features and thermal Comptonization. Joint fitting of the soft state spectra constrained the spin parameter of the black hole a* > 0.97 and the disk inclination angle ~ 32.9 degrees. The bright and faint hard states had a bolometric flux of ~ 6 and ~ 10 less than the soft state, respectively. Their spectra were fitted using the same model, except that the inner disk radius was not assumed to be at the last stable orbit. However, the estimated values do not indicate large truncation radii, and the inferred accretion rate in the disk was an order of magnitude lower than that of the soft state. The spectral and temporal analyses with AstroSat data provide a comprehensive picture of the evolution of the source.

**Presentation Type**:

Oral

**Neutron Stars** / **41**

## Study of High-Mass X-Ray Binary Pulsar SMC X-2 during the 2015 Outburst

**Authors:** Kinjal Roy[1]; Rahul Sharma[1]

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SMC X-2 is one of the high-mass X-ray binary (HMXB) pulsar in the Small Magellanic Cloud (SMC). After a long interval of 15 years, the source was observed in its third outburst in September 2015. The source reached a very high X-ray luminosity of ~5 × 10^38 erg s-1 at the peak of the outburst. The luminosity of the source slowly decayed over the course of a month. We will present results from analysing three XMM-Newton observations of SMC X-2. The bright outburst allowed us to perform a detailed spectral and temporal study of the data. The neutron star showed clear pulsation with a characteristic spin period of P_□□□□ ~2.37 seconds. The spectra were primarily modelled using a very hard powerlaw with a high-energy cutoff and a thermal component to model the soft excess. The powerlaw component became relatively soft with the progression of the outburst. Emission lines

from Fe K⊠ and highly ionized N and O were observed in all three observations. We will discuss our results' implications and the pulsar's emission properties during the outburst.

**Presentation Type**:

Oral

**Black Hole: Observations** / **42**

## Wideband spectral analysis of the brightest Black Hole X-ray Binary 4U 1543-47 in the 2021 Outburst

**Author:** Geethu Prabhakar[1]

**Co-authors:** Samir Mandal [1]; Bhuvana G. R. [2]; Anuj Nandi [3]

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[2] *Dayananda Sagar University, Bengaluru*

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4U 1543-47 is a galactic low-mass X-ray binary discovered in 1971. It has undergone five outbursts. The fifth outburst that happened in 2021 marks the source as the brightest X-ray binary source ever reported with a peak X-ray intensity of ∼11 Crab in 2-4 keV with *MAXI/GSC*. We aim for a comprehensive analysis of the wideband spectral characteristics of the source using *NICER, NuSTAR* and *AstroSat* Observations. We carried out phenomenological and reflection modelling using simultaneous reflection NICER-NuSTAR and AstroSat epochs. We found that the source was in HSS throughout, with a steep Γ due to a very small fraction (< 3%) of inverse-Comptonized photons. Reflection modelling reveals that the inclination of the system is between ∼32°-40°, disk possesses high ionization (log $\xi$ > 3) and overabundance of iron (3.6–10 $A_{Fe\odot}$). We reported the presence of strong and dynamic absorption features in the spectra between ∼8-11 keV throughout the outburst. This detection is the first of its kind for X-ray binaries. In addition, there exists a neutral absorption edge feature in the spectrum. We studied the evolution of the equivalent width of both components and found that these components follow the same trend with a delay of typical viscous timescale of 10-15 days. In this presentation, I plan to discuss the physical origin of the observed absorption feature and the accretion dynamics of 4U 1543-47 during the 2021 outburst.

**Presentation Type**:

Oral

**Neutron Stars** / **44**

## Detection possibility of continuous gravitational waves from rotating magnetized neutron stars

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In the past decades, several neutron stars (NSs), particularly pulsars, with mass $M > 2M_{\odot}$ have been observed. On the other hand, the existence of massive white dwarfs (WDs), even violating Chandrasekhar mass-limit, was inferred from the peak luminosities of type Ia supernovae. Hence, there is a generic question of the origin of massive compact objects. Here we explore the existence of massive, magnetized, rotating NSs with soft and steep equation of states (EoSs) by solving axisymmetric stationary stellar equilibria in general relativity. For our purpose, we consider the Einstein equation solver for stellar structure XNS code. Such rotating NSs with magnetic field and rotation axes misaligned, hence with non-zero obliquity angle, can emit continuous gravitational waves (GW), which can be detected by upcoming detectors, e.g., Einstein Telescope, etc. We discuss the decays of magnetic field, angular velocity and obliquity angle with time, due to angular momentum extraction by GW and dipole radiation, which determine the timescales related to the GW emission. Further, in the Alfv\'en timescale, a differentially rotating, massive proto-NS rapidly settles into an uniformly rotating, less massive NS due to magnetic braking and viscosity. These explorations suggest that detecting massive NSs is challenging and sets a timescale for detection. We calculate the signal-to-noise ratio of GW emission, which confirms that any detector cannot detect them immediately, but detectable by Einstein Telescope, Cosmic Explorer over months of integration time, leading to direct detection of NSs.

**Presentation Type**:

Oral

**Black Hole: Observations** / **46**

# Detection of possibly the heaviest black hole in Galactic X-ray binaries

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Masses of most black holes discovered in X-ray binaries lie within a narrow range of 5 - 20 $M_{\odot}$. The formation of these black holes is understood using scenarios involving collapse of massive stars. Contrary to X-ray binaries, black holes discovered using gravitational waves from merger events have masses going up to 200 $M_{\odot}$. This apparent dichotomy had given rise to a belief of different formation mechanisms for the two classes of black holes. In our recent study of an X-ray binary MAXI J1631-479, we find the black hole in the system to be highly massive, lying in the range of gravitational wave objects. We carried out a comprehensive spectral analysis of the source using data from NICER and NuSTAR observatories. After tracing the state evolution of disk physical parameters such as density, ionization and Fe abundance we constrained the black hole spin and disk inclination using reflection spectroscopy. With obtained estimates on spin and inclination we fitted the soft state NICER spectra with a relativistic disk model to infer black hole mass and distance. A Monte Carlo simulation using optical observations of the source was carried out to infer the distance. A very conservative lower limit on the distance was found to be 4.5 kpc which corresponds to a mass of 15 $M_{\odot}$. If true MAXI J1631-479 will be the heaviest Galactic stellar-mass black hole, consequently bridging the mass dichotomy and opening up merger scenarios for black holes hosted in X-ray binaries.

**Presentation Type**:

Oral

**Posters** / **47**

## Temporal and spectral properties of the source GRS 1915+105

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Our study of Quasi-Periodic Oscillation (QPO) in GRS 1915+105
and the relativistic dynamic frequency of a truncated disc to drive the high spin nature of the black hole source GRS 1915+105 using Large Area Proportional Counter (LAXPC) and Soft X-ray Telescope (SXT) data for about three years from 2016 to 2019. This study extends the previous study of the low Hard Intermediate state (HIMS) to the Low Hard (LH) state, the Steep Power Low (SPL)/high Hard Intermediate state (HIMS), and the High Soft (HS) state. This work covers a wide range of QPO frequency range from 2 Hz to 72 Hz. We observe a strong correlation between the QPO frequency divided by the mass accretion rate and the inner disc radius of the source

**Presentation Type**:

Poster

**AGNs & Blazars** / **48**

## What decides the characteristic emission of blazars?

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The radiative loss interpretation for the broken power-law spectra of blazars is often questioned since the difference between the indices does not support this inference. MKN 421 is one of the extensively studied high energy peaked blazars with its synchrotron component peaking at soft X-ray energies. The X-ray spectra, therefore, exhibits significant curvature and the spectrum is well described by a log parabola or a smooth broken power-law. Using a smooth broken power-law spectral fit, we show that the spectral indices before and after the characteristic photon energy are strongly anti-correlated which strongly refutes the radiative loss interpretation of spectral break. Further, the spectral curvature measured at the characteristic photon energy indicates an anti-correlation with the low energy spectral index while the high energy spectral index shows a positive correlation. These findings further question the validity of the radiative loss interpretation of the characteristic photon energy. We also approach to find alternative scenarios for the X-ray spectral curvature by considering the electron distribution accelerated under shock process.

**Presentation Type**:

Oral

**ULX Sources** / **49**

# Revealing the accretion scenarios of BH-ULXs with XMM-Newton

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We present the results of a comprehensive long-term spectro-temporal analysis of nine ultra-luminous X-ray sources (ULXs) with the central object being a black hole, using XMM-Newton monitoring of about a decade. Temporal studies reveal the existence of short-term variability in each source with fractional variance varying in the range of $1.42 - 27.28$ per cent. Five sources of the sample are found to exhibit Quasi-periodic Oscillations (QPOs) with frequency $\sim 8 - 667$ mHz. The thermal Comptonization component along with a disc component is found to be the best description of the energy spectra in $0.3 - 10$ keV energy range over other models. Some of the sources are found to exhibit a negative correlation between luminosity and disc temperature ($L_{\rm disc} \propto T_{\rm in}^{-\alpha}$), whereas rest of the sources show clear positive correlation ($L_{\rm disc} \propto T_{\rm in}^{+\alpha}$). A detailed spectro-temporal correlation study indicates significant contribution of Comptonized flux ($50-90\%$) in the total spectral flux as compared to disc contribution ($\sim 50\%$) in presence of QPO features in selected sources. Overall findings based on spectro-temporal correlation studies indicate that possibly Comptonization plays a viable role in the generation of QPOs. In addition, significant long-term spectral evolution is seen in each of the sources, indicating several spectral state transition. Finally, we employ a model formalism based on the relativistic, viscous, optically thin, advective accretion flow around black hole to infer the mass of the central black hole using the observed QPO frequency and luminosity of the selected ULXs.

**Presentation Type**:

Oral

**AGNs & Blazars / 50**

# Multiwavelength study of obscured AGN NGC 1365 using AstroSat X-ray/UVIT observations

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We present a multi-wavelength study of the active nucleus and the off-nuclear X-ray sources in the nearby spiral galaxy, NGC 1365 using three simultaneous UV/X-ray observations by AstroSat over a two months period and archival IR observations performed with Spitzer and Herschel. Utilising the data from the Soft X-ray Telescope (SXT) on-board AstroSat, we find spectral variability mainly caused by the variation in the X-ray column density, ($N_H$ ~ $10^{22}$ - $10^{23}$ $cm^{-2}$). With the accurate spatial resolution of the UVIT onboard AstroSat, We detect no significant variation in the NUV emission over the observation period. The AGN in FUV band is undetectable due to heavy intrinsic extinction. Further, the multi-wavelength IR/UV/X-ray AGN SED reveals that the AGN is in a low

uminosity phase with accretion rate ~ 0.01 $L_{Edd}$. The steady UV emission and strong X-ray absorption variability suggest that the obscuring clouds are likely compact and affect the compact X-ray source only and do not possibly cover the extended UV emitting region. In addition, the UVIT is able to resolve two bright spots at a radius of 7" (~ 6.3 Kpc) from the central nucleus in the South-West (SW) direction and also detect UV counterparts for one well- known ULX source.

**Presentation Type**:

Oral

**Black Hole: Observations** / **51**

## Exploring accretion disc dynamics in extragalactic stellar mass black hole X-ray binaries

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Extragalactic Black Hole X-ray Binaries (BH-XRBs) are the most intriguing X-ray sources as some of these systems are 'home'to the most massive stellar mass BHs ever found. Most of these sources accrete matter through a stellar wind, making them ideal for studying the dynamics of accretion disks in massive binary systems. In this work, we study the X-ray properties of three massive (MBH = 15-35 M⊙), eclipsing extragalactic BH-XRBs (M33 X-7, IC 10 X-1 and NGC 300 X-1) using observations carried out by *XMM-Newton* and *NuSTAR*. Study of X-ray lightcurves reveal that the eclipses are energy-dependent which confirms that the origin of eclipse is due to the presence of either an obscuring matter at the outer accretion disk or the stellar wind structure. Further, we carry out comprehensive spectral modelling by fitting the eclipse and non-eclipse spectra separately which showed that during the dip, thermal component is completely absorbed meanwhile non-thermal is partially absorbed. During non-eclipse period, we find the total luminosity to be sub-Eddington (< 13 % of LEdd) in all three sources. We find the non-eclipse spectra to be dominated by non-thermal component and characterized by a cooler (Tin = 0.1 - 0.2 keV) standard thermal disk and a 'hot'(Tin = 1 - 2 keV) slim-disc with radial temperature profile T(r) ∝ r^{-0.5}. Such spectral profile is distinct from that of other two extragalactic BH-XRBs i.e., LMC X-1 and LMC X-3 where the spectrum is mostly thermally dominant and consistent with standard disk + corona picture even though their luminosities are comparable to that of sources of our interest. Thus, we carry out a comparative study of all five extragalactic BH-XRBs in an attempt to provide a unified picture of accretion disk dynamics in extragalactic stellar mass BH-XRBs.

**Presentation Type**:

Oral

**Black Hole: Observations** / **53**

## AstroSat-NuSTAR monitoring of GX 339-4 and H 1743-322 : Broadband spectro-temporal analyses

**Author:** ANEESHA U[1]

**Co-authors:** Anuj Nandi [2]; Santabrata Das [1]; Tilak B Katoch [3]

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We present the results from X-ray broadband spectro-temporal analyses of recurrent outbursting sources GX 339−4 and H 1743−322 using AstroSat and NuSTAR archival observations carried out during 2016 − 2022. GX 339−4 was found to be making transition from quiescence to outburst, and the wide-band spectral analyses results during outbursts shows that GX 339−4 was in hard ($kT_{\rm bb} = 0.29 - 0.51$ keV, $\Gamma = 1.46 - 2.06$ and $L_{\rm bol} = 0.27 - 8.22\%$ of Eddington luminosity $L_{\rm Edd}$), intermediate ($kT_{\rm in} = 0.75 - 1.08$ keV, $\Gamma = 1.71 - 2.49$, $L_{\rm bol} = 6.74 - 9.11\%\ L_{\rm Edd}$) and soft states ($kT_{\rm in} = 0.51 - 0.93$ keV, $\Gamma = 1.67 - 3.74$, $L_{\rm bol} = 9.06 - 15.27\%\ L_{\rm Edd}$). Instead H 1743−322 found to make transition from quiscence to only hard state ($\Gamma = 1.57 - 1.73$, $L_{\rm bol} = 3.07 - 6.61\%\ L_{\rm Edd}$). Timing variability studies revealed the presence of Quasi-periodic Oscillations (QPOs) in GX 339−4 with frequencies varying between $0.10 - 5.37$ Hz along with harmonics. We detect type C QPOs in H 1743−322 with frequencies in the range $0.22 - 1.01$ Hz along with distinct harmonics. The energy dependent power density spectral study shows that, in GX 339−4 fundamental QPO and harmonics are present only in $3 - 20$ keV. Whereas in H 1743−322, the fundamental QPO is present only in $3 - 40$ keV energy band and the harmonic is not significant above $\sim 20$ keV. We discuss these observational findings in the context of accretion dynamics around black hole binary.

**Presentation Type**:

Oral

**Cataclysmic Variables** / **54**

# Studying the accretion physics of two unique magnetic cataclysmic variables using broadband X-ray data

**Author:** Anirban Dutta[1]

**Co-author:** Vikram Rana

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Asynchronous polars (APs) are an exceptional type of magnetic cataclysmic variables where there is a lack (~1-2%) of perfect synchronicity, unlike polars, between the spin period of the primary white dwarf star and the orbital period of the binary system. Also, there are a few unusual intermediate polars (IPs) where the difference between spin and orbital period is much less (~10-20%) compared to the traditional IPs (>~ 90%). We present the broadband X-ray study of two such unique systems – CD Ind and Paloma, which neither conform to Polars nor IPs. Using simultaneous data from XMM-Newton and NuSTAR observatories, covering 0.3-40 keV energy band, our works highlight the essential X-ray properties of these systems, like the multi-temperature continuum of the Post shock region (PSR), the complexity of intrinsic absorption, the strength of Fe K-alpha lines and presence of Compton reflection. We have found for CD Ind; the PSR can be described by a three-component plasma emission model, with a strong ionised Oxygen K-alpha line in the soft X-rays, indicating an extra optically thin plasma emission region near the base of PSR. We also noticed strong spectral variability for nearly one-third of the spin cycle. In the case of Paloma, we witness the presence of a powerful and complicated intrinsic absorber, varying with the rotation of the system. One distinguishing feature of Paloma appears to be a strong orbital peak and weak spin peak in the power spectrum. Regarding the shock height, we found, for both the sources a weak neutral Fe K-alpha line and weak Compton reflection in the hard X-rays implying a tall shock scenario.

**Presentation Type**:

Oral

**Posters** / **55**

## X-ray Spectral Modelling of some newly identified AGNs from Chandra Source Catalog

**Author:** Samrat Ghosh[1]

**Co-authors:** Samir Mandal [1]; Sudip Bhattacharyya [2]

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[2] *Tata Institute of Fundamental Research*

Active Galactic Nuclei (AGNs) are one of the most interesting objects in the extragalactic sky. They emit radiation in all wavelength ranging from radio to X-ray and Gamma rays. Through X-ray study we can probe very deep into AGNs because it comes from the vicinity of central Super Massive Black-Holes. Although the inverse compton scattering of the accretion disc's UV/Optical photon by hot electron cloud in corona is well established for the X-ray emission which constitutes a powerlaw in the X-ray spectrum, there are some other processes which contribute to the emission as well (e.g, Soft X-ray Excess, Reflection Hump, High Energy Cutoff etc).
In our current project, we are working with some newly identified AGNs from Chandra Source Catalog version 2.0. These AGNs were identified by Kumaran Shivam and collaborators using machine learning algorithm. We have selected some sources based on certain criteria. Various criteria have been used to remove any selection bias. Spectral modelling has been done for all the sources. Where there are multiple observations for a single source, for each observation spectral modelling has been done individually. Initially all of them were modelled using a single absorbed powerlaw (representing inverse comptonisation) using XSPEC (X-ray Spectral modelling software). In most of the cases the column density parameter could not be estimated which in turn represent an unobscured type AGN. Some cases however significant amount of obscuration has been found. For most of the AGNs only a single absorbed powerlaw suffices the modelling requirement however for some cases more complex model has been needed. Some AGNs needed to have "diskbb"model component representing the black-body emission of the inner portion of the accretion disk which accounts for the soft excess component. For some cases gaussian feature has been added on top of the continuum indicating some line emission.
Such study of large sample of new AGNs will help to repopulate the vast observational ground of them which motivates our theoretical uderstanding of these kinds of objects. Also we are planning to incorporate properties of these AGNs from other waveband of observations because a multiwavelength picture can give a full understanding.

**Presentation Type**:

Poster

**Neutron Stars** / **57**

## A detailed study of the thermonuclear X-ray Bursts source 4U 1728-34 with AstroSat

**Authors:** Anirudh Salgundi[1]; Utkarsh Pathak[1]; Suman Bala[1]; Varun Bhalerao[1]

[1] *IIT Bombay*

In Low Mass X-ray Binary (LMXB) sources, during the active accretion from the secondary star, the accumulated fuel (a mixture of Hydrogen and Helium) undergoes hydrostatic compression as more matter keeps piling up. When temperature and density conditions reach ignition levels (typically within a few hours to days), the entire fuel layer on the NS surface burns rapidly, leading to a thermonuclear burst. During these bursting episodes, the X-ray intensity rises by order of magnitude within a few seconds –reaching peak luminosities of 10^39 erg/s. The flux then exponentially decays at a slower rate (tens to hundreds of seconds). Studying the spectral and timing properties

of thermonuclear bursts helps us probe the Neutron stars' fundamental properties and the binary systems' accretion environment. This work presents our preliminary results of analyzing *AstroSat* data of well-known thermonuclear burst source 4U 1728-34. We have studied the source in different spectral states. We will present a detailed study of evolution of the source spectrum and analysis of bursts from the source over the years of observation.

**Presentation Type**:

Oral

**Neutron Stars** / **59**

## Probing thermonuclear flares on neutron stars and their interaction with accretion

**Author:** Manoneeta Chakraborty[1]

**Co-authors:** Unnati Kashyap ; Tolga Guver ; Biki Ram ; Z. Funda Bostanci ; Tugba Boztepe ; Ersin Gogus ; Peter Bult ; David R. Ballantyne ; R. M. Ludlam ; C. Malacaria ; Gaurava K. Jaisawal ; Tod E. Strohmayer ; Sebastien Guillot ; Mason Ng

[1] *IIT Indore*

Intense X-ray bursts (type-I bursts) originating from unstable thermonuclear conflagration, are observed from the surface of neutron star low-mass X-ray binaries (LMXBs) and they offer a promising tool to constrain the equation of state of the supra-nuclear matter at the neutron star core and to probe gravity in strong regime near the compact object. Recent observations show the burst spectra to deviate from the commonly used Planckian spectrum. Broad-band spectral studies of type I X-ray bursts can put strong constraints on the physics of burst spectra as well as their interaction with the environment. We present the results obtained from the broad-band time-resolved spectroscopy of 15 thermonuclear bursts detected simultaneously from the neutron star atoll source 4U 1636–536 using the Large Area X-ray Proportional Counter (LAXPC) and Soft X-ray Telescope (SXT) onboard AstroSat. We indeed observe an excess in the broadband burst spectra near the peak of the bursts. We discuss the implications of our results in the light of the re-emission/reprocessing of the photons by the accretion disc/corona or scattering of the photons in the neutron star atmosphere or the enhanced persistent emission due to the Poynting–Robertson drag. We further invetigate the 51 thermonuclear X-ray bursts observed from 4U 1636–536 by the Neutron Star Interior Composition Explorer (NICER) over the course of a 3 yr monitoring campaign. The time-resolved spectroscopy of theses bursts also show strong soft excess. We also present time-resolved spectral analysis of five X-ray bursts simultaneously observed by NICER and AstroSat, which confirm the softer excess with greater precision. This kind of study may provide a better understanding of the burst–accretion interaction and how the bursts influence the overall accretion process contributed by the accretion disc as well as the corona.

**Presentation Type**:

Oral

**Black Hole: Theory** / **60**

## Study of the relativistic accretion flow in a Kerr-Taub-NUT black-hole with shock

**Author:** GARGI SEN[1]

**Co-authors:** Debaprasad Maity [1]; Santabrata Das [1]

[1] *Indian Institute of Technology Guwahati*

We study the relativistic, inviscid accretion flow in a generic stationary axisymmetric Kerr-Taub-NUT (KTN) space-time in presence of the shock waves. Along with the mass, this KTN space-time contains the spin parameter or the Kerr parameter ($a_{\rm k}$) and the NUT parameter ($n$). Depending on the values of $a_{\rm k}$ and $n$ this space-time represents either black-hole or naked singularity. We obtain the global solutions by solving the governing equations that describe the relativistic accretion flow in KTN black hole. The flow experiences centrifugal repulsion that eventually triggers discontinuous shock transition provided the relativistic shock conditions are satisfied. The post-shock region contains high entropy over the pre shock flow, that prefers the shock-induced solution than the shock free solution. Due to shock compression, the post-shock flow (equivalently post-shock corona, hereafter PSC) becomes hot and dense, and produces high energy radiations after reprocessing the soft photons from the pre-shock flow via inverse Comptonization. Usually, PSC is characterized by shock location ($r_s$), compression ratio ($R$), and shock strength ($S$), which are dependent on the flow parameters, namely energy ($calE$) and angular momentum ($\lambda$). Therefore, we identify the effective region of the parameter space in the $\lambda - calE$ plane for shock and observe that shock forms for a wide range of flow parameters. We also find that $a_{\rm k}$ and $n$ act oppositely in determining the shock parameter space. Finally, we calculate the disc luminosity ($L$) considering free-free emissions and conclude that global shock solutions are energetically preferred as they are relatively more luminous compared to the shock free solutions.

**Presentation Type**:

Oral

**Short Talks** / **61**

## Probing the homogeneity / diversity in Type Ia supernova explosions

**Authors:** Anirban Dutta[1]; Anupama G. C.[1]; Devendra Sahu[1]

[1] *Indian Institute of Astrophysics*

Type Ia supernova (SN Ia) arises from the thermonuclear explosion of at least one carbon-oxygen white dwarf in a binary system. The most favored explosion model is the delayed detonation in a Chandrasekhar mas WD (single degenerate scenario). This explosion produces a stratification in the abundance structure of the elements present in the ejecta. The heavier elements, like Ni-56 and Fe, are present in the innermost layers, followed by the intermediate mass elements like Si, S, and Mg in the inner layers and unburned C and O in the lower-density outermost layers. We study five SNe for which the velocity of C is lesser than Si and is blue in the near-UV than a sample of normal SNe Ia. This can mean that the explosion mechanism is such that unburned materials are present in the inner layers. We perform 'Monte Carlo radiative transfer' simulations in one dimension by varying the density profiles and using the abundances from two competing explosion mechanisms - a violent merger of two CO WD's (double degenerate scenario) and delayed detonation in a Chandrasekhar mas WD. We consider various C abundance structures to simulate the C absorption feature in the pre-maximum spectra. We also simulated the light curves to find that -
All these five SNe Ia cannot be explained by a single explosion mechanism, even though they have some similarities in their observed properties. Hence, multiple explosion channels are proposed.

**Presentation Type**:

Oral

**Posters / 62**

# Spectral and Timing evolution of Cyg X-2 like source GX 340+0 •

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We present the result of the spectral and timing study of GX 340+0 which is a Cyg X-2-like source using AstroSat's SXT and LAXPC data. The source is found to be proceeding towards the flaring branch from the horizontal branch via normal branch as the observation progresses. Spectral analysis of SXT [1-7keV] and LAXPC data [4-25keV] in 1-25keV, reveals that the black body flux and flux ratio is increasing monotonically from HB to FB and interplay between the Compton flux and black body flux ratio decides the different position of the source in the Z track and not only the black body flux itself. The black body radius is found to be around 25 Km but a significant contraction of the radius has been observed in the FB, as we progress from LNB, with a marked increase in the blackbody temperature.
On the other hand, the 3-20keV LAXPC power density spectrum
reveals the existence of the lower hertz QPO of frequency ~ 42Hz in HB, HA, and UNB along with the presence of a broader feature, whose frequency increases as we progress from HB TO UNB. PDS also reveals the presence of 6 Hz and 6 HzHz QPO in soft apex and 6.56 Hz QPO in FB. The fractional rms is increasing with energy near the QPO frequency for all the QPOs whereas variation in the energy-dependent lag can be seen in the different branches which may be due to the lags between the variation of the input seed photons and the covering fraction.

**Presentation Type**:

Poster

**Black Hole: Observations / 63**

# Study of the spectral and temporal properties of EXO 1846-031 during the rising phase of its 2019 outburst

**Author:** Sujoy Kumar Nath[1]

**Co-authors:** Dipak Debnath [2]; Kaushik Chatterjee [2]; Riya Bhowmick [1]; Hsiang-Kuang Chang [3]; Sandip K. Chakrabarti [1]

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We study the recent outburst of the black hole candidate EXO 1846-031 which went into an outburst in 2019 after almost 34 years in quiescence. We use archival data from Swift/XRT, MAXI/GSC, NICER/XTI and NuSTAR/FPMA satellites/instruments to study the evolution of the spectral and temporal properties of the source during the initial rising phase of the outburst. Evolving type-C quasi-periodic oscillations (QPOs) are observed in the NICER data in the hard, and intermediate spectral states. We use the physical Two Component Advective Flow (TCAF) model to analyze the combined spectra. From the evolution of the spectral model fitted parameters, we find the source to evolve through four spectral states. According to the TCAF model, accreting matter is distinguished

into Keplerian and sub-Keplerian parts, and the variation in the observed spectra in different spectral states arise out of the variable contribution of these two types of accreting matter in the total accretion rate. We also determine the probable mass of the black hole to be $\sim 10 M_{\odot}$ from the spectral analysis with the TCAF model.

**Presentation Type**:

Oral

**Short Talks** / **64**

## Revisiting the Black hole binary XTE J1859+226 to understand the disk-jet coupling.

**Author:** SREETAMA DAS CHOUDHURY[1]

**Co-authors:** Bhuvana G.R [2]; Santabrata Das [3]; Anuj Nandi [4]

[1] *INDIAN INSTITUTE OF TECHNOLOGY GUWAHATI*

[2] *Dayananda Sagar University, Bengaluru*

[3] *IIT Guwahati*

[4] *URSC*

The source XTE J1859+226 is a black hole X-ray binary, which underwent outburst in 1999-2000. This source serves as a rich astrophysical laboratory to understand the connection between accretion disk and radio jet since it exhibits different types of Low Frequency Quasi Periodic Oscillations (LFQPOs) along with multiple radio flares.
We re-investigate the timing and spectral propertise of this source using the RXTE observations of its outburst. We model broadband RXTE (PCA+HEXTE) energy spectra ($3 - 150$ keV) using diskbb and thcomp models for thermal and non-thermal part respectively in order to understand evolution of spectral parameters throughout the outburst. To examine the variability properties and understand the accretion mechanism,we have carried out the energy dependent study of PDS by investigating the rms spectra of type-B and type-A QPOs. We correlate the timing properties of type-B QPO as well as rare and less studied type-A QPO with radio jet flux and with spectral parameters. We find a decrease in covering fraction ($0.55 - 0.4$) and increase in Type-A QPO freqency ($7.0 - 7.69$ Hz), X-ray ($3.4 - 6.1 \times 10^{-8}$ erg s$^{-1}$ cm$^{-2}$) and radio flux ($13 - 20$ mJy) near flare when compared to the one away from flares implies the reduction in size of corona as a result of evacuation of coronal material to the jet. We also find a direct correlation between frequency of type-B QPO and radio flux of jet. In addition to it, we constrain the spin of the source to be $\sim 0.15 \pm 0.05$ using continuum fitting method, and try to investigate the connection between the spin and jet generation. We discuss the implication of our results in the context of disc-jet coupling.

**Presentation Type**:

Oral

**Short Talks** / **65**

## Study of Hybrid Morphology Radio galaxies identified from VLA FIRST survey at 1400 MHz

**Author:** Shobha Kumari[1]

**Co-author:** Sabyasachi Pal [2]

[1] *Midnapore City College*

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Hybrid Morphology Radio Galaxies (HyMoRS) are found to be very rare subclass of radio galaxies. HyMoRS exhibits differing Fanaroff & Riley morphologies (FR I/II) in each of the two lobes. FR-I jets are generally shorter, have a high proportion of entrainment of thermal plasma close to the core region of the galaxy. On the other hand, FR-II radio galaxies are much extended (in the order of Mpc), luminous and have compact hotspots at the exterior edge of the structure. We identified 33 HyMoRS, the biggest sample found to date, with the help of the VLA FIRST survey at 1400 MHz. The majority of HyMoRS in our published article have steep radio spectral indices, as expected for typical lobe-dominated radio galaxies. The typical spectral index of normal radio galaxies is 0.70, which is the same as the average spectral index of our identified 33 HyMoRS. This suggests that, statistically, there is no difference in comparison to normal radio galaxies with HyMoRS. The average log L for reported sources is 25.30, which is near the borderline luminosity of FR-I and FR-II sources as expected due to the mixed morphology (FR-I and FR-II) of HyMoRS. The reasons for the unique nature of HyMoRS are still not known. It is believed that the asymmetric environment close to the host galaxy (difference in the nature of the central engine and/or the composition of the jets) and orientation are the main causes of this morphology of radio galaxies. Multi-wavelength follow-up observations are encouraged to comprehend the detailed nature of HyMoRS.

**Presentation Type**:

Oral

**Short Talks** / **68**

## An accurate pseudo-Kerr formalism and its application to study transonic flows around black holes

**Author:** Abhrajit Bhattacharjee[1]

**Co-author:** Sandip Chakrabarti [1]

[1] *ICSP, Kolkata*

Astrophysical black holes are remarkably simple objects, described completely by just two parameters –mass and spin. Although it is easy to determine the mass of a black hole from the far-field gravitational influence, the determination of spin is more subtle and it requires one to probe the strong gravity region close to the event horizon where the GR effects are prominent. However, to study all the physical processes in strong gravity limit using the exact Kerr metric is a formidable task, most certainly by theoretical means. There are numerical simulations which may have uncertain amount of dissipation in the numerical codes. For this reason we embarked on finding a very accurate pseudo-Kerr formalism which can be used in Newtonian equations and those not familiar with general relativity may also use it easily. We first apply this to study the transonic properties of accretion flows for all Kerr parameters and compare with exact solutions wherever available. We find the deviation from the exact results and found them to be negligible giving us confidence that numerical simulations with complete set of physical processes may be done using our formalism.

Reference: Bhattacharjee A., Chakrabarti S. K., Debnath D. 2022, RAA, 22, 035016

**Presentation Type**:

Oral

**Posters** / **69**

## Change in accretion flow in an Intermediate Polar V709 Cas

**Author:** Srinivas M Rao[1]

**Co-authors:** Jeewan C Pandey [1]; Nikita Rawat [1]

[1] *Aryabhatta Reasearch Institute of Observational Sciences, Nainital*

We have carried 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 found an orbital period of $5.332965 \pm 0.000007$ hr, a spin period of $312.7488 \pm 0.0004$ sec and a beat period of $317.9265 \pm 0.0004$ sec, which 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. The double peaked pulse profile nature shows it being a two pole accretor.

**Presentation Type**:

Poster

**Short Talks** / **71**

## Multi-wavelength emission from candidate neutrino blazars during different activity states

**Author:** Athira M Bharathan[1]

**Co-authors:** Blesson Mathew [1]; Stalin CS [2]; Sunder Sahayanathan [3]

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The broadband spectral energy distribution (SED) of blazars shows a two-hump structure. Understanding blazar SEDs has become increasingly possible over the last decade due to the capability to acquire near-simultaneous data from low-energy radio to high-energy gamma rays. Though the low energy hump in the broadband SED of blazars is understood to be from synchrotron emission processes, the origin of the high energy hump in the SED is under debate between two scenarios, namely leptonic and hadronic processes. Though the observed SEDs of blazars are generally explained by leptonic models, hadronic or lepto-hadronic models, too, are invoked in some sources. To put constraints on the high energy emission mechanism(s) in blazars, we have carried out an investigation on the broadband SEDs of a sample of blazars that are known to be neutrino candidate sources. These sources are good candidates to test blazar emission models due to the recent observation of a close association of IceCube neutrino detection with flaring blazars in the gamma-ray band. The results of our analysis on the SEDs of candidate neutrino blazars will be presented at the conference.

**Presentation Type**:

Oral

**Black Hole: Observations** / **72**

## An overview of outbursting black hole X-ray binaries

**Author:** Samir Mandal[1]

[1] *IIST, Trivandrum*

The study of X-ray binaries in the outbursting phase is crucial to understand the accretion process and the underlying physics. Every outburst is different regarding energy budget and the observed spectral-timing properties. In this presentation, I will summarise the lesson learned from the study of these systems. Also, I will discuss
some of the key issues in this topic based on our recent studies.

**Presentation Type**:

Oral

**Posters** / **73**

## Spectral properties of XTE J1701-462 using AstroSat

**Author:** Neal Thomas[1]

**Co-authors:** Bubbly S. G. [1]; Khushi Jirawala [2]; Shivappa Gudennavar [3]; Vaishnavi Nakra [1]

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Weakly magnetized low mass X-ray binaries (LMXB) with neutron star (NS) as a compact object are classified into Z sources and atoll sources based on their correlated spectral and temporal variability properties. The colour-colour diagrams (CDs)/hardness-intensity diagrams (HIDs) of atoll sources are characterized by isolated clumps called 'island states'which at times extend to form an elongated curve called the 'banana branch'that are traced out on timescales of weeks to months. On the other hand, the CD/HID of Z sources are characterized by the three main branches - horizontal branch (HB), normal branch (NB) and flaring branch (FB) - forming a Z shape that is traced out on timescales of hours to weeks. The physical mechanisms which drive these differences remain uncertain. The missing link of the Z - atoll puzzle was found in the NS-LMXB source: XTE J1701−462, which over the course of its 2006–2007 outburst, evolved through all subclasses of NS-LMXBs from a Cyg-like Z source at the highest luminosities to a Sco-like one, followed by a phase in the 'banana branch'. We have studied the spectral properties of XTE J1701-462 in the 0.3 - 25 keV energy range using data from the Soft X-ray Telescope (SXT) and Large Area X-ray Proportional Counter (LAXPC) instruments on-board the AstroSat mission. Using spectral properties, we have inferred physical parameters such as radius of inner disk, mass accretion rate etc. These results will be presented in the conference.

**Presentation Type**:

Poster

**Neutron Stars** / **74**

## Unravelling properties of GX 3+1 through AstroSat observations

**Authors:** Bubbly S. G.[1]; Neal Thomas[1]; Shivappa Gudennavar[2]

[1] *CHRIST (Deemed to be University)*

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Low mass X-ray binaries hosting weakly magnetized neutron stars (NS-LMXB) are classified as atoll sources and Z sources, based on their correlated spectral and temporal variability properties. Some atoll sources have been reported to exhibit type I X-ray bursts, characterized by a Fast Rise Exponential Decay (FRED) profile. One such atoll source is GX 3+1, which was first discovered in 1964. Since its discovery it has always been observed to be in the soft spectral state and on occasions, has exhibited type I X-ray bursts. The source has been observed for a total of four times by the Soft X-ray Telescope (SXT) and the Large Area X-ray Proportional Counters (LAXPC) on-board AstroSat between October 5, 2017 and August 9, 2018. One of the observations, shows the presence of a type I X-ray burst, having a double peaked profile. We have performed an in depth spectral and temporal analysis using ~ 110 ks data from the SXT and LAXPC instruments on-board AstroSat. In addition to this, we have also performed time-resolved spectral analysis of the type I X-ray burst. Through our analysis, we have estimated and put constrains on the physical properties of the system such as radius of neutron star photosphere, mass accretion rate, source distance, etc. In addition, temporal analysis of the burst showed burst oscillation candidates at ~317 Hz and ~338 Hz during the start and touchdown phase of the burst, respectively. These results will be presented during the conference. These results will be presented during the conference.

**Presentation Type**:

Oral

**Cataclysmic Variables** / **75**

## Ultra-violet variability of compact objects observed with UVIT

**Author:** RESHMA M[1]

**Co-authors:** Aditi Agarwal [2]; Stalin C S [3]

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The Ultra Violet Imaging Telescope (UVIT) is one of the payloads on board India's first multi-wavelength astronomical observatory AstroSat, launched by the Indian Space Research Organisation on 28th September 2015. Since its launch, UVIT has been observing several compact objects that includes X-ray binaries as well as active galactic nuclei (AGN). A systematic investigation is being carried out to characterize the UV flux variability nature of the compact objects observed with UVIT. As part of this investigation, we have initially focused on ten blazars, a category of AGN and one cataclysmic variable. All the blazars are found to show both flux and spectral variations on hour like time scales. Also, monitoring observations with the UVIT, has revealed UV variations in an intermediate polar cataclysmic star. Periodogram analysis of the UV light curves of the cataclysmic variable, lead to the detection of a prominent period of about 21 minutes in the UV, which is the spin period of the white dwarf. Analysis of the SXT and LAXPC light curves of the same object also reveals the presence of the 21 minutes period. Details of the work will be presented in the meeting.

**Presentation Type**:

Oral

**Black Hole: Observations** / **76**

# AstroSat view of Energy-dependent time-lag properties of High Frequency Quasi-periodic Oscillations (HFQPOs) of GRS 1915+105

**Author:** Prajjwal Majumder[1]

**Co-authors:** Anuj Nandi [2]; Broja G. Dutta [1]

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The enigmatic black hole X-ray binary GRS1915+105 exhibits diverse variability patterns (i.e., θ, β, δ, ρ, κ, ω, and γ classes) as observed with AstroSat. We present a generic feature of time-lag properties for the HFQPO observations which belong to the δ, ω, κ and γ variability class. For the first time, we detect soft-lag associated with the 67 Hz HFQPO for all four variability classes of this source using AstroSat observations as compared to the previous findings of hard-lag using RXTE. The soft-lag of the photons in 6-25 keV band w.r.t 3-6 keV band is found to be in the range 0.40-1.68 ms. We find a coherent lag-energy correlation for all variability classes where the soft-lag increases with energy upto 18 keV and decreases with higher energy. The energy dependent time-lag study exhibits maximum soft-lag of ~ 3ms for δ variability class which is the highest among all the variability classes. A generic time lag-rms correlation implies that the soft-lag increases with the rms amplitude of the HFQPO. The spectral analysis of all observations exhibits a linear correlation between optical depth of the Comptonizing medium and the time-lag of the HFQPO. We explain the results in the context of possible accretion models which can reveal the understanding of the responsible physical mechanism that produces HFQPO and corresponding accretion dynamics.

**Presentation Type**:

Oral

**Posters / 78**

# X-ray reverberation in accreting Black Hole systems : NGC 4593

**Author:** Shree Suman[1]

[1] *Phd Scholar*

X-ray reverberation in accreting Black Hole
systems : NGC 4593

Shree Suman(Ph21resch01009)
Supervisor :Dr Mayukh Pahari

Evidence like fast X-ray variability timescale, large rms fluctuations show that the light emiting source must reside closest to the black hole, however,its size, geometry and location are still elusive and usually associated with the base of the radio jet residing on the vertical spin axis of the black hole. Here we are working on NGC 4593 which is a type of seyfert galaxy.It is a spiral galaxy with redshift z=0.008 and situated at distance 37.9 Mpc towards constellation virgo .It has the apparent visual magnitude of 11.67. However, it has been realised that GR corrections are essential to consider when describing the radiation within few Rg radii of the black hole, e.g., Iron emission line at 6.4 keV are observed to have highly asymmetric profile due to the gravitational redshift.This kind of galaxy have strong Fe emission line activity ,so that having the signature of strong gravity is particular interest. Scope Among the observational evidence that embed the signature of strong gravity, X-ray reverberation is the most important where X-rays from the corona (emitting source)are reflected off the

inner part of the accretion disc and provide a delayed, reprocessed emission. The key idea of GR-motivated X-ray reverberation is that the delay timescale between the direct coronal emission and the reprocessed disc emission can be significantly longer than expected due to the bending of photon trajectories in the presence of the black hole. Therefore, the effect of excess delay is expected to be seen if the disc-corona geometry is very compact.
A attempt to understand the geometry of the NGC 4593 using GR photon ray-tracing model with the enhanced throughput and spectral resolution of modern X-ray telescope like CHANDRA,XMM-newton may provides a great exposure to all this type of galaxies in X-ray astronomy world.

**Presentation Type**:

Poster

**Black Hole: Theory** / **79**

## Properties of relativistic hot accretion flow around rotating black hole with radially varying viscosity.

**Author:** Monu Singh[1]

**Co-author:** Santabrata Das [1]

[1] *IIT Guwahati*

We examine the effect of variable viscosity parameter ($\alpha$) in relativistic, low angular momentum advective accretion flow around rotating black holes. Following the recent simulation studies of magnetohydrodynamic disk that reveal the radial variation of $\alpha(r)$, we theoretically investigate the properties of the global transonic accretion flow considering a one-dimensional power law prescription of viscosity parameter as $\alpha(r) \propto r^{\theta}$ , where the viscosity exponent $\theta$ is a constant. In doing so, we adopt the relativistic equation of state and solve the fluid equations that govern the flow motion inside the disk. We find that depending on the flow parameters, accretion flow experiences centrifugally supported shock transition and such shocked accretion solutions continue to exist for wide ranges of the flow energy, angular momentum, accretion rate and viscosity exponent, respectively. Due to shock compression, the hot and dense post-shock flow ( PSC ) can produce the high energy radiations after reprocessing the soft photons from the pre-shock flow via inverse Comptonization. PSC is usually described using shock radius ($r_s$ ), compression ratio ($R$) and shock strength ($S$), we study the role of $\theta$ in deciding $r_s$ , $R$ and $S$, respectively. Moreover, we obtain the parameter space for shock and find that possibility of shock formation diminishes as $\theta$ is increased. Finally, we compute the limiting value of $\theta$ (i.e., $\theta^{max}$ ) that admits shock and find that flow can sustain more viscosity when it accretes onto rapidly rotating ($a_k \to 1$) black hole in comparison to weakly rotating ($a_k \to 0$) black hole.

**Presentation Type**:

Oral

**Cataclysmic Variables** / **80**

## Multiwavelength observations and Optical spectra modeling of the extragalactic Novae M31N2008-12a

**Authors:** G.C. Anupama[1]; Judhajeet Basu[2]; K. P. Singh[3]; Pavana M[None]; Sudhanshu Barway[None]

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Nova outburst is an astronomical phenomenon accompanied by the ejection of matter, causing an increase in luminosity, leading to the appearance of a sudden bright star in the sky, which fades away over several weeks or months. They are interacting binary systems with a white dwarf (WD) primary and a main-sequence or sub/red-giant secondary. We have observed outbursts of the recurrent nova M31N from 2019-2022 using UVIT and SXT instruments onboard Astrosat and used archival long-time Swift UVOT and XRT data for a board analysis. The UV and X-ray data are complemented by optical imaging and spectroscopy from GROWTH-India Telescope (GIT) and the Himalayan Chandra Telescope (HCT). The light curves are seen to undergo a steep linear decline within the first 3 days from maximum before forming a plateau, marking the beginning of the super-soft source (SSS) phase. The SSS phase, which starts from day 6 after the eruption and lasts for about 14 days, was also detected every year by SXT and XRT. The optical spectra reveal a high-velocity ejecta with an overabundance of He compared to solar values.

I will present the analysis of multiwavelength light curves to understand the nova eruption mechanism and probe the nature of the primary WD. The optical spectra modeled using Cloudy will be used to constrain the temperature of the central WD and the morphology of the ejecta.

**Presentation Type**:

Oral

**Short Talks / 81**

## Decoding the X-Ray Flare from MAXI J0709−159 using multi-epoch optical spectroscopic observations.

**Author:** Suman Bhattacharyya[1]

**Co-authors:** Arun R [2]; Blesson Mathew [3]; Gourav Banerjee [4]; Hema Anilkumar [4]; Maheswer G [2]; Muneer S [2]; Pramod Kumar S [2]; Savithri H Ezhikode [4]; Selvakumar G [2]; Sreeja S Kartha [4]; Velu C [2]

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[4] *CHRIST (Deemed to be University), Bangalore*

Be/X-ray binaries (BeXRBs) form a major subclass of high-mass X-ray binaries that consist of a Be star and a compact object. The possible compact objects can be neutron stars, white dwarfs or black holes. However, neutron stars are the most frequently observed companion than other types. We performed a follow-up study (Bhattacharyya et al. 2022) on the recent detection of two X-ray flaring events by MAXI/Gas Slit Camera observations in soft and hard X-rays from MAXI J0709−159 in the direction of the Be star HD 54786, on 2022 January 25. The X-ray luminosity during the flare was around 10^(37) erg s^(−1) (MAXI), which got reduced to 10^(32) erg s^(−1) (NuSTAR) after the flare. We obtained low-resolution spectra of HD 54786 from the 2.01-m HCT and the 2.34-m VBT facilities of India, on 2022 February 1 and 2. By comparing the spectrum of this star with those from the literature, we found variability of He I emission lines. Using photometric techniques we estimated that HD 54786 has an effective temperature of 20,000 K. Though it is reported as a supergiant in previous studies, our analysis favors it to be evolving off the main sequence in the color-magnitude diagram. Interestingly, we could not detect any infrared excess for the star, ruling out the possibility of IR emission from a dusty circumstellar disc. Moreover, our study suggests that HD 54786 is a Be/X-ray binary system with a compact object companion, possibly a neutron star. We are presently monitoring this star through spectral and photometric observations to study its variability in more detail. Our follow-up study of line profile variability and spectral analysis will provide a better understanding of Be stars in such binary systems.

**Presentation Type**:

Oral

**AGNs & Blazars** / **82**

## On the properties of corona in Seyfert 1 galaxies

**Author:** Indrani Pal[1]

[1] *Indian Institute of Astrophysics*

In the radio-quiet category of active galactic nuclei (AGN), the observed X-ray emission is believed to originate in the hot corona close to the vicinity of the accretion disk. Despite the numerous X-ray studies on AGN, we still do not have a clear understanding of the nature of the corona, such as its geometry, shape, location and the physical processes that power it. Parameters that can put constraints on the nature of the X-ray corona in AGN are the power law index and the high energy cut-off in the observed X-ray continuum. During the last decade, there has been progress in our understanding of the corona in AGN, owing to the availability of high signal-to-noise data covering a wide range of energies from NuSTAR. Utilizing the data from NuSTAR, we have carried out a systematic investigation of the coronal properties of a sample of about 140 Seyfert 1 type AGN. Of these, we could determine the temperature of the corona in about 36 sources from the physical model fits to the observed X-ray spectra. We investigated various correlations between the corona's properties and the AGN's physical properties from these measurements. Also, from analysis of multi-epoch data available for a few sources, we found evidence for variation in the temperature of the corona in two sources, namely MCG+08-11-011 and NGC 3227. Details of the results will be presented in the meeting.

**Presentation Type**:

Oral

**Black Hole: Theory** / **83**

## Do plasma composition affect physics around compact objects?

**Author:** Indranil Chattopadhyay[1]

[1] *Aryabhatta Research Institute of Observational Sciences (ARIES)*

In the non-relativistic regime, fluid composition do not affect solution of equations of motion, until explicit cooling is considered. One of the main reason is that the information of composition is not included in the equation of state. We show that indeed composition affects solutions of accretion and jets around compact objects where the temperatures are transrelativistic. We also discuss the obesrvational consequence .

**Presentation Type**:

Oral

**AGNs & Blazars** / **84**

# Survey of Bare Active Galactic Nuclei in local universe (z < 0.2): On the origin of Soft-Excess

**Authors:** Prantik Nandi[1]; Arka Chatterjee[2]

**Co-authors:** Jana Arghajit [3]; Sachindranatha Naik [4]; Sandip K. Chakrabarti [5]; Hsiang-Kuang Chang [3]; Samar Safi-Harb [2]; Jeremy Samuel Heyl [6]

[1] *Post Doctoral Fellow in PRL*

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[5] *Indian Centre for Space Physics*

[6] *University of British Columbia*

The soft excess, an excess emission below 2 keV, is an extraordinary feature of the X-ray spectra for most of the Seyfert 1 AGNs. The origin of this feature remains debated, as several models have been suggested to explain it, including warm Comptonization, blurred ionized reflection and other models. From the long-term observations of Ark 120, a bare AGN, we found a strong correlation between soft-excess and primary continuum. This supports the idea that the soft-excess emission could be caused by a different number of scatterings in the Compton cloud or hot corona as compared to the primary continuum. Then we analyze a sample of 21 'bare'Seyfert 1 AGNs using Swift/XRT and XMM-Newton observations (the total number of observations:305). The X-ray spectral properties of these sources are studied using the powerlaw model, where this model fits the primary continuum and soft excess. Our spectral analysis reveals that the long-term intrinsic luminosities of the soft excess and the primary continuum are correlated for each source. We also studied the overall scenario from the spectral analysis of each source and found that these luminosities are tightly correlated. That implies that the soft excess and the primary continuum could be originated from the same physical process. Considering the Comtonization scenario for powerlaw emission, the higher number of scatterings may cause the primary continuum. On the other hand, the soft-excess part could be constructed by the photons, which suffered fewer scatterings. These results provide valuable insights into the nature of soft-excess emission and could guide future studies in this field.

**Presentation Type**:

Oral

**Short Talks / 85**

# Discovery of giant radio quasars from TGSS-ADR1: new sample and associated AGN properties

**Author:** Souvik Manik[1]

**Co-authors:** Sabyasachi Pal [2]; Netai Bhukta [3]; Sushanta K. Mondal [3]

[1] *MIdnapore City College, Vidyasagar University*

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Giant radio quasars (GRQs) are radio-loud active galactic nuclei (AGN) that propel megaparsec jets with projected linear sizes of more than 0.7 Mpc. We report the discovery of a sample consisting of more than a hundred giant radio quasars at high redshift (z >= 1) through crossmatching the TIFR GMRT Sky Survey Alternative Data Release 1 (TGSS ADR1). Due to the good sensitivity and

high resolution of TGSS at 150 MHz, we have detected fainter and larger samples than previous ones. We have identified the highly reliable optical or infrared cores of the detected GRQs using the likelihood ratio method. We investigated various radio properties of these sources, including angular and projected linear size, spectral index, total radio power, jet kinetic power, radio core prominence, and integrated and core radio luminosity. In optical and infrared wavelengths, we estimated the black hole mass and accretion rate of newly discovered GRQs. The spectral index of these GRQs is found to be steep or ultrasteep due to high redshift. We found no significant differences between GRQs and smaller radio quasars (SRQs) based on their spectral properties. It is found that SRQs have higher total radio power, radio core power, jet kinetic power, core dominance factor, and Eddington ratio compared to GRQs. The high core dominance factor of SRQs indicates that they are closer to the line of sight than GRQs. We also find a correlation of the accretion disc luminosity with the radio core and jet power of GRQs, which provides evidence for disc-jet coupling. However, we show that the majority of extended radio quasars belong to a quasar population of evolved AGNs with enormous black hole masses and modest accretion rates.

**Presentation Type**:

Oral

**AGNs & Blazars** / **86**

## Investigation of a small flaring event in NLS1 galaxy NGC 4051

**Author:** Neeraj Kumari[1]

[1] *Physical Research Laboratory, Ahmedabad, India*

A detailed broadband spectral and timing analysis of a small flaring event of a120 ks in a narrow-line Seyfert 1 galaxy NGC 4051 using simultaneous XMM-Newton and NuSTAR observations has been performed. The ~300 ks long NuSTAR observation and the overlapping XMM-Newton exposure were segregated into pre-flare, flare and post-flare segments. We found that during the flare, the NuSTAR count rate peaked at 2.5 times the mean count rate before the flare. We explored the variation of X-ray emission in different time scales using various phenomenological and physical models. The 0.3-50 keV X-ray spectrum of the source can be described by a composite model consisting of a primary continuum, reprocessed emission, warm absorber and ultra-fast outflows. From the spectral analysis, we found that the reflection fraction drops significantly during the flare, accompanied by the increase in the coronal height to ~12.2 Rg from ~9.6 Rg (during the pre-flare phase) above the disc. The spectrum became softer during the flare supporting the "softer when brighter"nature of the source. After the alleviation of the flare, the coronal height drops to ~7.4 Rg and the corona heats up to the temperature of 228 keV. This indicates that there could be inflation of the corona during the flare. We did not find any significant change in the inner accretion disc or the seed photon temperature. These results suggest that the flaring event occurred due to the change in the coronal properties rather than any notable change in the accretion disc.

**Presentation Type**:

Oral

**ULX Sources** / **88**

## A stellar mass ULX NGC 6946 X-1 and its super-Eddington accretion

**Author:** Tanuman Ghosh[1]

**Co-author:** Vikram Rana [1]

[1] *Raman Research Institute*

Ultraluminous X-ray sources (ULXs) are the brightest known non-nuclear X-ray binaries with luminosities exceeding the classical Eddington limit of a 10 $M_\odot$ black hole. Recent discoveries of neutron star cores in ULXs confirm that the Eddington ratio can be a few hundred. Broadband spectral studies are pivotal to deciphering the emission mechanism in these mysterious sources. Here we discuss the accretion mechanism in a soft ultraluminous X-ray source NGC 6946 X-1. The broadband X-ray spectra of this source show quasi-steady nature in different epochs of observation. Two thermal emission components primarily govern the continuum. One originates from the inner accretion flow from a slim accretion disk, and the other is associated with an optically thick wind due to super-critical accretion. We also discuss some physical properties of the source based on the assumption of a realistic inclination angle of the accretion disk. The implication of a low massive black hole ($\sim 6 - 10$ $M_\odot$) or a neutron star of weak magnetic field ($B \leq 2 \times 10^{11}$ G) confirms the super-Eddington accreting nature of this source.

**Presentation Type**:

Oral

**AGNs & Blazars** / **91**

## Gamma-ray Emission from Cosmic Beacons

**Author:** Vaidehi Paliya[1]

[1] *IUCAA*

High-energy (>100 MeV) emission is one of the defining characteristics of active galactic nuclei (AGN) hosting closely aligned relativistic jets, i.e., blazars. One of the key research problems in jet physics is constraining the evolution of these enigmatic sources. This talk will briefly discuss some of the recent discoveries of detecting $\gamma$-ray emission from a variety of jetted AGN, e.g., nearby low-luminosity Fanaroff-Riley type 0 (FR0) radio sources to the most luminous blazars at the cosmic dawn ($z > 4$). The talk will also summarize how the efficient utilization of the latest ongoing and upcoming wide-field multi-wavelength surveys will be crucial to understand the origin of relativistic jets in these cosmic beacons.

**Presentation Type**:

Oral

**Black Hole: Theory** / **93**

## Global structure of shock-induced general relativistic magneto-hydrodynamics accretion flows around black holes

**Author:** Samik Mitra[1]

**Co-author:** Santabrata Das [2]

[1] *IIT GUWAHATI*

[2] *IIT Guwahati*

We present the general relativistic magneto-hydrodynamic (GRMHD) accretion flow in Kerr spacetime in the presence of the shock waves. Adopting the relativistic equation of state, we solve the governing equations in the ideal MHD limit and obtain the shock-induced GRMHD accretion solution for the first time to the best of our knowledge. We find that the subsonic flow entering from the outer edge of the disk experiences centrifugal repulsion and a barrier due to the magnetic pressure that eventually triggers a discontinuous shock transition, provided the GRMHD shock conditions are satisfied. Due to shock compression, the post-shock flow (equivalently post-shock corona (PSC)) becomes hot and dense that eventually emits high-energy radiations after reprocessing the soft photons via inverse Comptonization. We characterize the PSC in terms of shock location ($r_s$), compression ratio ($R$), and shock strength ($S$). Afterwards, we evaluate the dynamics of PSC using flow parameters, namely energy ($\mathcal{E}$), angular momentum ($\mathcal{L}$), radial ($\Phi^r$) and azimuthal magnetic flux ($F_{\rm Iso}$) of the magnetized flow. We further notice that the shock dynamics is mainly governed by the toroidal magnetic pressure at the equatorial disk. We identify the effective region of the parameter space for GRMHD shock in $calL - calE$ plan and observe that shock parameter space is altered due to the change of both $\Phi^r$ and $F_{\rm Iso}$. Finally, we discuss the implication of present formalism in the context of astrophysical applications.

**Presentation Type**:

Oral

**Posters / 94**

## Spectro-timing properties of GX 13+1 using AstroSat

**Author:** Giridharan L[1]

**Co-authors:** Bubbly S. G. [2]; Neal Thomas [2]; Shivappa Gudennavar [3]

[1] *Christ Deemed to be University*

[2] *CHRIST (Deemed to be University)*

[3] *CHRIST (Deemed to be University), Bengaluru*

Low mass X-ray binaries hosting a neutron star (NS-LMXBs) have been classified as ‘Z’and ‘atoll’ sources based on the tracks they trace out in the hardness-intensity-diagram (HID) and their correlated X-ray spectral and X-ray fast-variability characteristics. Atoll sources have lower mass accretion rates and host a neutron star having lower magnetic field (< 10^9 G). The exact physical parameters that drive the changes in the source state that are responsible for these two classifications are yet to be substantiated. GX 13+1, is a NS-LMXB which is classified as an atoll source. However, the pattern that it traces in HID resembles that of Z source. In addition, it has high mass accretion rate (L ~ 0.5×LEdd) and Fridriksson et al. have hinted the presence of a 22-29 Hz quasi periodic oscillation (QPO) with 9 - 10% fractional rms value, which are the properties similar to Z sources. In order to investigate the spectro-temporal properties of this peculiar source, we conducted spectral and temporal analysis in 0.7 - 30.0 keV using data from the Soft X-ray Telescope (SXT) and the Large Area X-ray Proportional Counters (LAXPC) instruments onboard AstorSat. The spectra of the source could be adequately modeled with a disk blackbody model with the addition of three edge components. Through spectral analysis, we infer the physical properties of the source such as radius of inner accretion disk, mass accretion rate, magnetic dipole moment of neutron star in the system. The temporal analysis of the source yielded the detection of QPOs at ~60 Hz. These results will be presented in the conference.

**Presentation Type**:

Poster

**AGNs & Blazars / 95**

## Tracing the evolution of ultraluminous infrared galaxies into powerful radio-loud galaxies

**Author:** Sumana Nandi[1]

[1] *Manipal Centre for Natural Sciences, Manipal Academy of Higher Education*

Ultraluminous infrared galaxies (ULIRGs) are gas-rich merger remnants that are extremely luminous at infrared wavelengths, represent the final stage of the merging process of two comparable mass gas-rich galaxies that finally evolve into elliptical galaxies, and in some cases radio-loud AGN. Using the Giant Metrewave Radio Telescope (GMRT), we observed a large sample of ULIRGs that have optically identified AGN. This data has been combined with archival multifrequency radio observations to understand their radio spectra, spectral ages, and resolved structures. Deep, low frequency observations show marginal extension for few sources. However, the integrated radio spectra of many ULIRGs show characteristics that are similar to that of GHz Peaked Spectrum (GPS) , Compact Steep Spectrum (CSS) or young radio sources. According to the commonly accepted evolutionary scheme of radio-loud AGN, GPS and CSS radio sources are the early stages of the evolution. In this talk, I will discuss about these ULIRGs which are the possible progenitors of the powerful radio-loud galaxies.

**Presentation Type**:

Oral

**Neutron Stars** / **96**

## Probing thermonuclear bursts from millisecond pulsar MAXI J1816-195 using simultaneous NuSTAR and NICER observation

**Author:** MANOJ MANDAL[1]

**Co-authors:** Sabyasachi Pal [2]; Jaiverdhan Chauhan [3]; Anne Lohfink [3]; Priya Bharali [4]

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[3] *Montana State University*

[4] *Mahatma Gandhi Government Arts College*

In May 2022, MAXI made the discovery of the millisecond pulsar MAXI J1816−195. The unstable burning of accreted material on the surface of neutron stars results in thermonuclear (Type-I) bursts. During the 2022 outburst, MAXI J1816−195 generated a number of thermonuclear bursts. An exponential decay function and a sharp linear rise are used to model the burst profiles. The faster decay of the burst in a higher energy range implies that the temperature will decrease as the burst evolves. The NuSTAR measured the peak-to-persistent count rate ratio to be 26 and the duration of each burst to be roughly 30 s. The time-resolved spectra are successfully modelled with a combination of an absorbed blackbody along with a non-thermal component to account for the persistent emission. The spectral analysis does not show that the photospheric radius is expanding. The blackbody temperature and radius during the peak of the burst were 2.1 keV and 12.5 km, respectively. The empirical Eddington limit is assumed, and an upper limit of 8.7 kpc for the source distance is obtained. The alpha factor and mass accretion rate suggest the stable burning of hydrogen via the hot CNO cycle.

**Presentation Type**:

Oral

**Posters** / **97**

## Correlation study of spectral parameters using simultaneous multi-wavelength observations of Mkn 501

**Author:** Hritwik Bora[1]

**Co-authors:** Ranjeev Misra [2]; Rukaiya Khatoon [3]; Rupjyoti Gogoi [1]

[1] *Tezpur University*

[2] *IUCAA, Pune*

[3] *Centre for Space Research, North-West University, South Africa*

We performed the soft and hard X-ray analysis of high energy peaked (HBL) blazar source Mkn 501 using Swift-XRT and NuSTAR observations. The simultaneous Swift-XRT and NuSTAR observations between 2013 and 2018 are taken in this study. In order to quantify the correlation between spectral parameters using different particle energy distribution models, we fit the spectrum with the log-parabola model, power-law particle distribution with maximum electron energy, and energy-dependent acceleration (EDA) models, respectively. It has been shown that the correlation obtained from a single short flare (~5-days) of Mkn 421, can be used to distinguish the spectrally degenerate models. In our work, we are trying to compare the correlation results using the long-term observations including high and low flux states of HBL Mkn 501, with the results obtained from short-term flare of HBL Mkn 421 (Hota et al. 2021). In addition, we have also performed analysis in the Ultra-violet (UV) band, where the data have been taken from Swift-UVOT and have fitted the multi-wavelength spectrum with the spectral models. However, we are looking for some data in gamma band from fermi-LAT to see how well the spectrum gets fitted with the convolution models.

**Presentation Type**:

Poster

**Posters** / **98**

## Unveiling spectral properties of 4U 1820-30 using AstroSat

**Author:** Neal Thomas[1]

**Co-authors:** Bubbly S. G. [1]; Shivappa Gudennavar [2]; Sidharth Nath [3]

[1] *CHRIST (Deemed to be University)*

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[3] *CHRIST(Deemed to be University)*

Based on the X-ray flux variability on color-color diagrams (CDs)/hardness-intensity diagrams(HID) of low mass X-ray binaries hosting neutron stars as compact objects (NS-LMXBs) classified as Z and atoll sources. 4U 1820-30 is an atoll type NS-LMXB located in the globular cluster NGC 6624. It is one of the most well-studied NS-LMXBs and is reported to have kilohertz quasi periodic oscillations (kHz QPOs) existing in the upper banana and lower banana branches, as well as in the island state for the source. We have attempted to study the spectral properties of 4U 1820-30 in the 0.3 −25.0 keV energy range using the data from the Soft X-ray Telescope and Large Area X-ray Proportional Counter instruments on-board AstroSat. The spectral parameters of 4U 1820-30 obtained in our study will be discussed during the conference.

**Presentation Type**:

Poster

**Neutron Stars** / **99**

## Spectro-temporal studies of GX 9+1 using AstroSat

**Author:** Shivappa Gudennavar[1]

**Co-authors:** Bubbly S. G. [2]; Neal Thomas [2]

[1] *CHRIST (Deemed to be University), Bengaluru*

[2] *CHRIST (Deemed to be University)*

GX 9+1, an atoll type neutron star low-mass X-ray binary (NS-LMXB), was observed by the Soft X-ray Telescope and the Large Area X-ray Proportional Counters on-board AstroSat during May 2 - 4, 2019. The hardness-intensity-diagram (HID) of the source showed it to be in the soft spectral state during the observation. Flux-resolved spectra of the source could be adequately modelled with an absorbed multi-temperature disk blackbody model 'diskbb'and a Comptonization model 'thcomp' . The photon index (⊠) and covering fraction decreased monotonically; whereas the inner disk kTin and the mass accretion rate exhibited a gradual increase along the banana branch. The ratio of the disk flux to total flux > 0.93 revealed the source to be disk dominated. The true inner disk radius Rin ~ 11.9 km pointed that the accretion disk was truncated at the Alfven radius. The upper limit of the magnetic dipole moment and the magnetic field strength at the poles of the neutron star in the source were calculated. Temporal analysis in the 0.02 - 100 Hz range revealed the presence of noise components, which could be characterized by broad Lorentzian components. These results will be presented during the conference.

**Presentation Type**:

Oral

**Neutron Stars** / **101**

## A study of the 2018 and 2021 outbursts of XTE J1946+274 and it's phase dependent cyclotron line

**Author:** Ashwin Devaraj[1]

**Co-authors:** Biswajit Paul [1]; Rahul Sharma [1]; Shwetha Nagesh

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In the presence of strong magnetic fields, such as in the accretion columns of Neutron Stars, the electrons get quantized into circular orbits, and Cyclotron Resonant Scattering Feature (CRSF) is observed as absorption features in the X-ray spectrum as photons scatter off these electrons at the resonant energies. CRSF or cyclotron lines are the best diagnostic tools that we have to probe the magnetic fields of Neutron stars. It is, therefore, essential to study the dependence of the cyclotron line parameters on factors like luminosity, pulse-phase and time. XTE J1946+274 is a transient Be/X-ray binary showing several outbursts in the last three decades. It is an X-ray pulsar with a 15.7 s spin period with an eccentric ~170 day orbital period. It underwent outbursts in 1998, 2010, 2018 and most recently in 2021. It is also among the subset of sources that exhibit a CRSF in it's hard X-ray spectrum. We had previously investigated the pulse-phase dependence of the cyclotron line at ~38 keV using data from NuSTAR, which had observed it during the 2018 outburst. We further investigate the cyclotron line feature using data from Insight-HXMT and Astrosat of the 2018 outburst and Astrosat data of the 2021 outburst. The NuSTAR observation was made during the declining phase of the

2018 outburst, while Insight-HXMT and Astrosat observations are during the peak. We present a comparative study exploring the evolution of the spectral and temporal features of the 2018 and 2021 outbursts and the dependence of the cyclotron line parameters on pulse-phase and luminosity in this work.

**Presentation Type**:

Oral

**Posters** / **102**

## Spectral studies of 4U 1636-536 using AstroSat

**Author:** Neal Thomas[1]

**Co-authors:** Bubbly S. G. [1]; M VARUN [1]; Navya Jacob [1]; Shivappa Gudennavar [2]

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4U 1636–536 is an atoll type neutron star low mass X-ray binary (NS-LMXB) first observed by the Uhuru and Copernicus missions in 1974. It is a frequent burster which has shown a total of 664 unique bursts between 1996 to 2012. Some of these bursts have been short waiting time bursts with a mean burst rate of 0.26 $hr^{-1}$. Given its frequent bursting nature, this source provides us with an opportunity to study the evolution of spectral properties of the system during thermonuclear bursts, and put constraints on the physical parameters of the system. 4U 1636–536 has been observed on several occasions by the Soft X-ray Telescope (SXT) and Large Area X-ray Proportional Counter (LAXPC) instruments aboard AstroSat since 2016. We have carried out the spectral and temporal analysis on one such observation, during which the source has exhibited three thermonuclear bursts one of which is a photospheric radius expansion (PRE) burst. We present the results obtained from the broadband time-resolved spectroscopy of thermonuclear bursts in the energy range 3.0 - 25 keV detected using LAXPC. We have studied the spectral properties of 4U 1636-536 in the 0.3 - 25 keV energy range using the simultaneous data from SXT and LAXPC. Using the obtained spectral properties, we have inferred physical parameters such as the radius of the neutron star photosphere, mass accretion rate, source distance, etc. These results will be presented at the conference.

**Presentation Type**:

Poster

**Black Hole: Theory** / **103**

## Viscous accretion flows around the black hole.

**Author:** Sanjit Debnath[1]

**Co-author:** Indranil Chattopadhyay [1]

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Viscosity plays a vital role in accretion flows around black holes. It helps in the transport of angular momentum outwards allowing matter to get accreted into the potential well formed by the central compact object. Apart from angular momentum transport, viscosity also heats up the matter. In viscous transonic flows, both with and without shock solutions are possible. Many numerical simulations have shown that with the increase in viscosity, shock moves outwards. However, all these

simulations have been done with supersonic injection. Moreover, these simulations used a fixed adiabatic equation of state. We use a relativistic equation of state proposed by Chattopadhyay & Ryu (2009). We have built a simulation code in which the thermodynamics is expressed by the Chattopadhyay & Ryu equation of state. In this work, we have shown analytically as well as numerically that depending on the injection radius, the shock location will move inwards or outwards with the viscosity. Also, we have seen viscous flow showing shock oscillation. It may explain the QPOs seen in black hole candidates.

**Presentation Type**:

Oral

**Posters** / **105**

## In depth variability study of the Galactic transient XTE J1550-564 during the 2000 outburst

**Author:** SANGITA MAITI[1]

**Co-authors:** Anuj Nandi [2]; Broja G. Dutta [1]

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The evolution of time-lag and low frequency quasi-periodic oscillations (LFQPOs) in outbursting black hole sources can be explained by the systematic drifting of the outer boundary of the Compton cloud during rising and declining phases of the outburst. We study the fast variability properties of Galactic Soft X-ray Transient (SXT) XTE J1550-564 during 2000 outburst using RXTE instruments and compare the accretion scenario with the 1998 outburst. This variability study includes the study of Power Density Spectrum (PDS) and Fourier Frequency dependent lag spectra with the variation of photon energy. We observe QPO frequency increases from ~ 0.26 Hz to ~ 6.92 Hz in ~ 30 days and immediately starts to decrease gradually in the declining phase and also it disappears after ~ 13 days. We find a smooth variation in time-lag with QPO frequency and the lag becomes soft-lag after the QPO frequency > 3Hz. The time-lag again becomes hard-lag and increases gradually. In the previous 1998 outburst, the source took ~ 12 days to reach QPO frequency from 81 mHz to ~13.1 Hz and in next 7 days it decreases to ~ 2.62 Hz. A similar time-lag variation is also observed during rising phase where time-lag transition frequency was also >3 Hz. We explain this transitional frequency implies a specific size of the Comptonizing region and subsequently it gives rise to a characteristic length scale where the lag changes its sign. We expect, this transitional frequency can't be an universal one for all sources as the inclination angle and mass of the black hole could determine the length scale of the specific accretion geometry.

**Presentation Type**:

Poster

**Black Hole: Observations** / **107**

## Spectral and temporal analysis of the BHC MAXI J1348-630 during two major outbursts of 2019

**Author:** Riya Bhowmick[1]

**Co-authors:** Dipak Debnath [2]; Arghajit Jana [3]; Kaushik Chatterjee [2]; Sujoy Kumar Nath [1]

[1] *Indian Centre for Space Physics*

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[3] *National Tsing Hua University*

The Galactic BHC MAXI J1348-630 was discovered by MAXI/GSC and Swift/BAT satellites in 2019. The source had undergone two major outbursts in 2019, shortly after its discovery. Using archival data from multiple satellites (including Swift, MAXI, NICER, NuSTAR, and AstroSat) we have performed a detailed spectral and temporal analysis of both the outbursts. The first outburst lasted for four months. The two component advective flow (TCAF) model is used to investigate the combined 1-150 keV Swift/XRT, Swift/BAT, and MAXI/GSC spectra. Using the spectral fits the dynamics of accretion flow were investigated. We have analysed the flux variation in soft and hard X-ray ranges, the hardness ratio, TCAF model fitted accretion rates and accretion rate ratio (ARR). We have studied the evolution of the four spectral states (hard, hard-intermediate, soft-intermediate and soft states) in rising and declining phases of the outburst. During the first outburst the source evolved through all the four spectral states and was complete in nature. Low-frequency quasi-periodic oscillations (QPO) were found in two observations during the rising phase. From the spectral analysis, the mass of the black hole is estimated to be 7.9 - 10.7 solar mass and from state transition luminosity the distance of the source is estimated as 5-10 kpc. The second outburst lasted approximately two and a half months. We have analysed the spectral properties from the Swift/XRT, MAXI/GSC, NICER and NuSTAR spectra. We have studied the evolution of the photon index from power-law model and the flow parameters from the physical model, TCAF. From the detailed spectral analysis we conclude that unlike the first outburst there was no transition to soft or intermediate spectral states during the second outburst. The second outburst is failed in nature. Throughout the second outburst, the source was in hard state with high dominance of non-thermal photons. Also there was a presence of weak reflection in the NuSTAR spectrum. To account for the reflection, we have also used PEXRAV model. The inclination of the source was estimated to be varied in between 30°- 46°. We have done the timing analysis with the archived data from AstroSat. Low frequency quasi-periodic oscillations were detected in two successive dates 2019 June 14 and 2019 June 15.

**Presentation Type**:

Oral

**Short Talks** / **108**

## Spectral and timing properties of GX 17+2 using AstroSat and NICER simultaneous view

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**Co-authors:** Biplob Sarkar [2]; Jayashree Roy [3]; Ranjeev Misra [4]; Yashpal Bhulla

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We report the analysis of the Z-track NS-LMXB GX 17+2 using the simultaneous data from the AstroSat (LAXPC/SXT) and NICER mission data. On segmenting the HID into three slices—horizontal branch, hard apex, and normal branch- we investigate the source's variability and spectral state evolution throughout the observation. We performed the timing analysis in all the branches separately to probe the presence of aperiodic variability. We determined the photon lag behavior, which is found to follow a hard lag trend. The variation of the spectral parameters like the coronal temperature, photon index, blackbody temperature, and other obtained parameters along the track will also be represented. Then we compare the results of the two missions.

**Presentation Type**:

Oral

**Neutron Stars** / **109**

## Ambiguous Nuclear Transients

**Author:** Rupak Roy[1]

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With the advent of the time-domain astronomy brilliant transients have been discovered near the centers of the galaxies. Photometric and Spectroscopic follow-ups of these objects by transient surveys like ePESSTO, ZTF, ASASSN have shown that spectral evolutions of these objects are different from that of supernovae, and their temporal evolutions can be explained to some extent as a stellar-disruption event due to the tidal force of the supermassive black hole (SMBH) at the center of the host. However, recently several nuclear transients, with ambiguous spectral and temporal evolution, have been discovered. The characteristics of these ambiguous nuclear events are neither like canonical TDEs nor like regular AGNs. Here, I will summarize the characteristics of some of these ambiguous events, and particularly describe the evolution of AT2020ohl which has been followed by us using various multi-wavelength facilities throughout the world. I will discuss about the probable progenitors and explosion geometries of these explosions. The role of SMBH in triggering such transient nuclear phenomena will also be discussed.

**Presentation Type**:

Oral

**Black Hole: Theory** / **110**

## Numerical simulation of radiatively driven jets around black holes.

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The central engine in active galactic nuclei (AGNs) and microquasars
is a black hole. As the black hole does not have any hard surface the jet must originate from the inner part of the accretion disc. The radiation field of the accretion disc interacts with the jet material as the jet travels through the radiation field. Various steady-state investigations have shown that the radiation field can play a crucial role in the acceleration and collimation of the jets. It can also produce steady shocks very close to the jet base. However, the numerical simulations of the radiatively driven jets are very limited. Hence, in order to bridge this gap we perform the numerical simulations of jets under the influence of the radiation field of the accretion disc. Along with the relativistic equations of motion we use a relativistic equation of state (EoS) for multispecies fluid which enables us to study the effect of composition on jet dynamics. Our results show that starting from very low injection velocities, the jets can achieve high Lorentz factors. The composition of the jet plasma significantly influences the acceleration process. For sub-Eddington luminosities, lepton-dominated jets can be accelerated to ultra-relativistic Lorentz factors while the electron-positron jets need super-Eddington luminosities to achieve relativistic terminal Lorentz factors.

**Presentation Type**:

Oral

**Neutron Stars** / **112**

## AstroSat and NICER view of Be/X-ray binary 1A 0535+262 & Swift J0243.6+6124

**Author:** Birendra Chhotaray[1]

**Co-authors:** Gaurava Jaisawal [2]; Sachindranatha Naik [3]; Neeraj Kumari [3]; Prantik Nandi [3]; Arghajit Jana [4]

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Be/X-ray binaries represent the largest population of high
mass X-ray binaries (HMXBs) consist of a Be star and mainly a neutron star as a compact object. In this talk, I will discuss the results obtained from the X-ray studies of the Be/X-ray binary 1A 0535+262 during the 2020 October giant X-ray outburst using AstroSat. The pulsar was detected at a pulsation period of ~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 0.7-90.0 keV range confirmed the presence of the known cyclotron resonance scattering feature at ~46.3 keV. I will also discuss Swift J0243.6+6124, the first galactic ultraluminous X-ray source discovered during 2017-18 giant outburst studies. Currently, we are using Neutron Star Interior Composition Explorer (NICER) data to investigate the post-gaint (Type II) outburst phase. We performed timing and spectral analysis covering four normal (Type I) outbursts. The pulsation period is detected around 9.8 s. QPOs are detected in the power spectra for a particular luminosity range. The break frequency evolved in a V-shape with luminosity. The pulse profiles were found to be luminosity dependent. The 1.2-10.0 keV spectra were best fitted with an absorbed cutoff power law, and an iron line was required above certain luminosities. The photon index and cutoff energy were found to be correlated with luminosity. We also find the correlation between different timing and spectral parameters to understand the accretion geometry around neutron stars during these outbursts.

**Presentation Type**:

Oral

**AGNs & Blazars** / **114**

## Multi-wavelength study of the AGN MCG-2-58-22 with AstroSat

**Author:** Savithri H Ezhikode[1]

**Co-authors:** Pierre-Olivier Petrucci [2]; Susmita Chakravorty ; Gulab Dewangan [3]; Ranjeev Misra [3]; Giorgio Matt [4]; Akhil Krishna R [1]; Ujjwal Krishnan [1]; Ritesh Ghosh

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We study the multi-wavelength properties of the bare Seyfert 1.5 galaxy MCG-2-58-22 using the multi-epoch AstroSat observations taken simultaneously in the X-ray and UV bands. Previous studies reported X-ray variability in MCG-2-58-22 on both short and long time scales. The source was in a high X-ray flux state in 2007 and 2016 with a 2-10 keV flux of ~5×10^-11 erg/cm^2/s. The AstroSat monitoring observations show clear X-ray spectral and flux variability over three years with a softer-when-brighter behaviour. The far UV (FUV) emission is also variable and correlates with X-ray flux and hard X-ray photon index (Γ). By incorporating the archival data from other missions, we investigate the long-term spectral and temporal evolution of X-ray and UV emission components from the source. The multi-wavelength (optical/UV-to-X-ray) SED analysis of these observations using various physical models like JED-SAD and optxagnf provides us insights on the inner disc geometry of the source. We also study the origin and evolution of the unusually weak soft X-ray excess in MCG-2-58-22.

**Presentation Type**:

Oral

**AGNs & Blazars** / **115**

## Gamma ray emission from extended jets of low luminosity AGNs

**Author:** Gunjan Tomar[1]

**Co-authors:** Nayantara Gupta [1]; Raj Prince [2]

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Despite occupying ~ 40% of the local Universe, Low Luminosity Active Galactic Nuclei (LLAGNs) are less explored due to their faintness. Detection of a few in gamma rays by Fermi-LAT allows us to constrain the physical parameters of the jet by modeling their spectral energy distributions from radio to gamma-ray energies. While a one-zone model explains the broadband emission up to a few GeV, another component is required to explain the excess. An extended jet for both NGC 315 and NGC 4261 has been seen in radio and X-ray. While the spectral index of X-ray emission implies a synchrotron origin, we find that the excess at GeV energies can be successfully explained by the inverse Compton scattering of the starlight from host galaxy by the same electron population, in both cases. This observation suggests that electrons can be accelerated to ultra-relativistic energies at extended scales.

**Presentation Type**:

Oral

**Posters** / **116**

## RADIO-PROPERTIES OF QUASARS IN SDSS

**Authors:** Jumana Muhammad Abdul Ashraf[1]; Linsha fathima[1]; Nadha fasili[None]; SHABIRA KK[1]; Shamna V[2]

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The study examines the radio properties of quasars discovered in the data release 17 of Sloan Digital Sky survey(SDSS).The main idea of the study is to find how many of the SDSS quasars emit in the radio band, what fraction of quasars are radio-loud, is there a radio loud/radio-quiet dichotomy and what is the radio morphology of the radio loud quasars in SDSS. This involves searching for the radio information of SDSS Quasars in one particular website and noting the result returned by the website. Using 1.4 GHz FIRST and 2-4 GHz VLASS catalogues, we would find out the radio detection in SDSS by examining samples of 1500 Quasars.

Key words: Radio properties of Quasars, SDSS,FIRST, VLASS

**Presentation Type**:

Poster

**AGNs & Blazars** / **117**

## Coronal Properties of Low-Accreting AGNs using NuSTAR Observations

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**Co-authors:** Prantik Nandi [3]; Neeraj Kumari [3]; Claudio Ricci [4]; Sachindra Naik [3]; Samar Safi-Harb [1]; Rubinur K. ; Hsiang-Kuang Chang [5]

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We studied the broadband X-ray spectra of Swift/BAT selected low-accreting AGNs using the observations from NuSTAR and Swift/BAT in the energy range of 3 – 150 keV. Our sample consists of 24 AGNs with Eddington ratio, $\lambda_{Edd} < 10^{-3}$. We extracted several coronal parameters from the spectral modelling, such as the photon index, hot electron plasma temperature, cutoff energy and optical depth. We tested whether there exists any correlation/anti-correlation among different spectral parameters. We observe that the relation of hot electron temperature with the cutoff energy in the low accretion domain is similar to what is observed in the high accretion domain. We did not observe any correlation between the Eddington ratio and the photon index. We studied the compactness-temperature diagram and found that the cooling process for extreme low accreting AGNs is complex. The jet luminosity is observed to be related with the bolometric luminosity as $_{jet}{}^{0.6}_{bol}$ which is consistent with the standard
radio-X-ray correlation.

**Presentation Type**:

Oral

**Posters** / **119**

## Millimeter wavelength observation of black hole X-ray binary MAXI J1803–298

**Author:** Arijit Manna[1]

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The Galactic black hole X-ray binary candidate MAXI J1803−298 was first discovered with the nova search system of MAXI (Serino et al. 2021). NuSTAR and NICER found periodic absorption dips, and Swift detected absorption lines likely originating in a disk wind, both suggestive of a high inclination angle above ~ 70°. A sign of an outflow was also detected in optical spectroscopy, where p Cygni-like profiles were detected in hydrogen Balmer lines (Buckley et al. 2021). The X-ray binaries also show the two other fundamental ingredients of accretion onto compact objects: relativistic jets and hot, dense winds. To study the millimeter wavelength jets from the X-ray binary, we have used the Atacama Large Millimeter/Sub-millimeter Array. We have studied the (sub)millimeter-wavelength physical properties of MAXI J1803−298. We detect the unresolved millimeter wavelength continuum emission from the above X-ray binary candidate. We also find that the peak flux varies from $6.949 \pm 0.094$ $\mu$Jy beam$^{-1}$ to $7.446 \pm 0.033$ $\mu$Jy beam$^{-1}$ and global spectral index from SED model is $1.14 \pm 0.05$. We study the jet-disk coupling and broadband characteristics from X-ray to radio wavelengths.

**Presentation Type**:

Poster

**Posters / 120**

# Effect of the fluid composition on the Magnetized Astrophysical flows

**Author:** PRIYESH KUMAR TRIPATHI[1]

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Time-dependent fluid equations can describe a wide range of astrophysical problems like accretion flow around a compact object, outflows emanating from Young stars, or Active Galactic Nuclei (AGN). The strong gravity and high magnetic fields present in these flows make them particularly interesting for study. Numerical simulation of fluid equations provides an efficient way to study these complicated problems by allowing us to go beyond the steady-state approach.
While most simulation codes are based on the fixed adiabatic index equation of state (EoS), which can be a poor approximation in transonic flows. To address this issue, we have developed a new MHD simulation code with Chattopadhyay & Ryu EoS (2009) having a variable adiabatic index, which allows us to consider the composition and thermodynamics of multispecies plasma. We use this code to show that for a jet having the same injection parameters, its propagation speed and internal structures significantly vary depending on the plasma composition, whether it is made of a pure electron-proton pair or pure electron-positron pair, or a mixture of electron, proton, and positron.

**Presentation Type**:

Poster

**Black Hole: Observations** / **122**

# Hard X-ray spectral states in Cygnus X-1 and its polarisation dependence using AstroSat

**Author:** Abhay Kumar[1]

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Cygnus X-1 is a well-known galactic accreting black hole binary that shows several observational features suggesting a complex interaction between the accretion disk, its atmosphere called Corona, and the jet. The polarisation characteristics of the Corona and the jet are different. To understand the high energy emission mechanism and the system's geometry, we have carried out a spectro-polarimetric study of Cygnus X-1 using AstroSat data. AstroSat-CZTI detectors are of 5 mm thickness and hence have good efficiency for Compton interactions (double pixel events) beyond 100 keV and are utilized for the polarisation study in 100 to 380 keV.
We measure the flux and spectral index in the 22 –100 keV energy band and the short-term spectral and flux correlation index. The distinct accretion modes corresponding to different spectral states, are consistent with the recent INTEGRAL results. Detailed investigation of polarization in different spectral states suggests a strong spectral state dependence of polarisation. We interpret these results to understand the coronal and jet emission mechanism.

**Presentation Type**:

Oral

**Posters** / **125**

# Understanding the large amplitude X-ray variation of GRS 1915+105 by RXTE-PCA and ASTROSAT-LAXPC

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To understand the X-ray spectra of one of the superluminal X-ray binaries, we used RXTE/PCA and AstroSat/LAXPC data of GRS 1915+105.Where we can see significant photon counts variability in the X-ray light curves within 3.0–80.0 keV energy range.Out of 12 classes of X-ray variability, only few classes have significant higher and lower photons count.So We extract the higher(High flux) and lower(Low flux) photon counts from the light curves for different observations(For $\alpha, \lambda, \theta$ classes).We jointly fitted those extracted spectra with compton scattered multi-temperature disk blackbody(index is 0.75) model along with some absorptions simultaneously for each observations, which give best fit in the 3.0-22.0 keV energy range.We observed that, some relativistic reflection component is also there.These variation of photon counts are in few millisecond to few second, it is possible that these three component are independent for all these classes even without any changes in parameters.But we see that, only for $\alpha, \theta$ classes it's right and in the case of $\lambda$ the values of parameters are also changing.It's verified that, these model dependency/independency are similar for both RXTE/PCA and AstroSat/LAXPC data.

**Presentation Type**:

Poster

**Posters** / **126**

# Studies of variability mechanism in Blazar Jets using X-ray Data

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Blazars are highly variable on all timescales ranging from a few minutes to years. Variability studies in blazars is one of the important tools to understand the blazar jets. To study flux and spectral variability on intra-day and long term timescales we have used XMM-Newton and SWIFT satellite X-ray data. On short-term timescales emission from jets are dominating whereas on longterm timescales the emission might have imprints of accretion disc. Flux distribution of blazars can be used to understand the variability imprint of the accretion disk onto the jet. Around the synchrotron peak, SED is curved and can be well described by log parabolic model and the corresponding spectral parameters i.e.peak energy Ep, peak luminosity Lp and the curvature β varies with different flux states. Correlations between these spectral parameters during different flux states could provide tight observational constraints upon the acceleration and injection processes of the emitting electrons. XMM-Newton data is used to study flux distribution of blazars and Swift-XRT data is used to study the spectral parameters derived from X-ray spectral fitting.

**Presentation Type**:

Poster

**Black Hole: Observations** / **127**

# Type-B and type-C QPOs and their association with Comptonization region and jet

**Author:** Harikrishna Sripada[None]

Studying the nature of type-B/C QPOs in different scenarios can decipher their production mechanism. We have analyzed the appearance or disappearance of type-B ~4.5 Hz and type-C ~9.5 Hz QPOs of BH source H1743-322 and found no change in the disk inner radius but power-law indices are varying. Quasi-simultaneous radio observations indicate that either a corona or a jet is responsible for the events. We have also analyzed consistent near 6 Hz type-B/C QPOs in several black hole X-ray binaries using the data from RXTE & NICER. We found that the structure of the Comptonization region has to be different for type-B/C QPOs. QPO width, radio flux density, soft to hard flux ratio and inner disk temperature are following certain trends. Quasi-simultaneous radio observations and spectral studies suggest that the type-B QPOs can be related to the precession of a weak jet, though a small and weak corona is present at its base, and the type-C QPOs are associated with the base of a relatively strong jet. To explain the spectral and timing variations the geometrical Lense-Thirring precession model with a hot flow and a jet in the inner region was incorporated.

**Presentation Type**:

Oral

**Short Talks** / **128**

## An optical follow-up study of the classical symbiotic outburst of TCP J18224935-2408280

**Author:** Sonith L S[1]

[1] *Indian Institute of Astrophysics*

TCP J18224935-2408280 is a transient discovered by Tadashi Kojima in May 2021 and later classified as a symbiotic star. Our follow-up study shows that the newly discovered symbiotic star (TCP J1822) was undergoing a Z-And type outburst (classical symbiotic outburst). To understand the nature of the outburst, low-resolution spectroscopic observations from HCT were obtained from May 2021 to September 2022, covering the evolution of the outburst to its quiescent phase. We also analysed photometric data from GAIA and ASAN-SN and obtained the orbital period to be ~599 days. Multiband photometric data available was used to find the nature of the cool-giant present in the system by constructing and fitting a SED using ARIADNE. The nature of the outburst was studied using the spectral evolution of the system during the outburst. We showed how the temperature, luminosity and radius of the hot component (white dwarf) in the system evolved during the outburst, using which we constrained the possible cause of the outburst in the system as a combination nova. We also examined the emission line profiles and flux variations during the outburst. I will present the above results in detail.

**Presentation Type**:

Oral

**Posters** / **129**

## Study of transient sources with twin Devasthal 4-m class Telescopes

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Cataclysmic variables are one of the most energetic transients of the Universe. After the activation of 4-m International Liquid Mirror Telescope (ILMT) and previously operational 3.6-m Devasthal Optical Telescope (DOT), Devasthal site offers an excellent opportunity to monitor faint transit detection and immediate followup observations. Such kind of coordinated monitoring will enable us to identify the physical nature of the transients with a unique complementary setup existed at one of the best site in India. The photometric and spectroscopic observations together in optical-near-infrared bands can be very useful to deduce some important information about the possible progenitors of these transient sources as well as their host galaxy properties such as the color, metallicity, star formation rate, stellar population, mass, age, etc.

**Presentation Type**:

Poster

**Posters / 130**

# Long term optical variability monitoring of γ-ray emitting AGN 1ES 0647+250

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Active Galactic Nuclei are among the most highly energetic objects in the universe. The BL Lac object 1ES 0647+250 is one of the few distant γ-ray emitting blazars detected at very high energies (100 GeV) during a non-flaring state. This object is among the favoured candidate extragalactic sources in the very high-energy regime due to the presence of high-energy electrons and adequate seed photons. The presence of high energy electrons is established from the location of the synchronous peak in the spectral energy distribution of the blazars. It was detected with the 30 inch telescope at VBO, Kavalur, India during a period from January 2020 to March 2020 using I, V and R filters. The presence of adequate seed photons is determined by the flux in optical wavebands. The redshift of 1ES 0647+250 has been tentatively reported as 0.45, thus the detection of very high-energy gamma-ray emission from this object could make significant contributions to the understanding of the extragalactic infrared background light. We evaluated the variability of the emission in the different energy bands with the fractional variability as well as its spectral evolution in γ rays.

**Presentation Type**:

Poster

**Posters / 131**

# Spin-down induced neutron star to quark star conversion

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The existence of quark stars is an open problem in astrophysics, and their formation is possible in several astrophysical scenarios via the quark-hadron phase transition. We addressed the spin-down induced phase transition scenario, wherein magnetic braking drives neutron stars from their birth (Keplerian rotation) to later stages of life (slow spin). The central density rises during the slowing down stages, and on reaching a critical phase transition density, the neutron star transits to a hybrid star branch, and a quark core is seeded. We computed the mass and size of the quark core during different stages of evolutionary history. The phase transition onset leads to an anomalous change in the magnetic braking index. Also, it can excite the star's f-mode oscillations, leading to burst-type gravitational wave signals in the range of present detectors. The other emissions could be neutrino bursts and GRBs. Detection of these signals and their sky localization may help in finding the quark/hybrid stars formed via phase transition events.

**Presentation Type**:

Poster

**Neutron Stars** / **132**

## Spin evolution of millisecond pulsars

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An understanding of spin frequency evolution of neutron stars I the low-mass X-ray binary (LMXB) phase is essential to explain the observed spin distribution of millisecond pulsars (MSPs), and to probe the stellar and binary physics, including the possibility of continuous gravitational wave emission. I will discuss the crucial effects of transient accretion on the spin evolution of neutron stars. Then, using numerical computations I will conclude that spin frequency can evolve in two distinctly different modes in a way which is counter-intuitive. This implies that the traditional way of spin evolution computation is inadequate in most cases.

**Presentation Type**:

Oral

**Black Hole: Theory** / **133**

## 3D global General Relativistic MHD simulations of strongly magnetized thin accretion disks

**Author:** Bhupendra Mishra[1]

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The radiation pressure supported standard accretion disk model (Shakura Sunyaev 1973 model) is prone to classical thermal and viscous instabilities. However, these instabilities are not observed in astrophysical systems as disks remain thermally stable for astronomical time periods. In this talk, I will show some of the key findings of strongly magnetized accretion disks simulated using 3D global radiative GRMHD simulations. We used a set of initial magnetic field configurations to produce an enhanced magnetic field amplification and hence stabilize the radiation pressure dominated accretion flows around stellar mass black holes. We also found that despite the magnetic pressure support, the luminosity and mass accretion rates do match with what is expected from a standard accretion disk model.

**Presentation Type**:

Oral

**AGNs & Blazars** / **134**

## High Energy Studies of Blazar: Challenges

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The broadband spectral study of blazars has provided significant information regarding the emission processes and the blazar jet environment. Inputs derived from the temporal study are often conflicting with the processes responsible for the flux variation not being consistent with the statistical flux distribution. Besides these, even after decades of research, the matter content of blazar jets and the associated energetics are still largely unknown. In this talk, I will be reviewing the efforts undertaken to provide answers to these questions and the issues which and yet to be addressed.

**Presentation Type**:

Oral

**Black Hole: Theory** / **135**

## Review of accretion: spherical to magnetized and disk accretion, and explaining soft to hard X-ray sources

**Author:** Banibrata Mukhopadhyay[1]

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Accretion is one of the ubiquitous mechanisms involved in astrophysics. Underlying model was developed from its simplistic spherical symmetric. form, namely Bondi accretion, in 1952, to the disk accretion with nonzero angular momentum in 1990s, to modern magnetically arrested accretion disk flow in the last decade. I will try to touch upon how with the improved and novel observations the accretion model has been required to modify over the 70 years to understand the Physics involved in the processes. If time permits, I will compare results from multiple models to explain same astrophysics, as observed, as is the case on some occasions.

**Presentation Type**:

Oral

**Review Talk** / **136**

## Journey of X-ray Astronomy: Indian Perspectives

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**Black Hole: Theory** / **138**

## Origin of core radio emissions from BH in the realm of relativistic shocked accretion flow

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We study the relativistic, inviscid, advective accretion flow around the black holes and investigate a key feature of the accretion flow, namely the shock waves. We observe that the shock-induced

accretion solutions are prevalent and such solutions are commonly obtained for a wide range of the flow parameters, such as energy ($calE$) and angular momentum ($\lambda$), around the black holes of spin value $0 \leq a_{\rm k} < 1$. When the shock is dissipative in nature, a part of the accretion energy is released through the upper and lower surfaces of the disc at the location of the shock transition. We find that the maximum accretion energies that can be extracted at the dissipative shock ($\Delta calE^{\rm max}$) are $\sim 1\%$ and $\sim 4.4\%$ for Schwarzschild black holes ($a_{\rm k} \rightarrow 0$) and Kerr black holes ($a_{\rm k} \rightarrow 1$), respectively. Using $\Delta calE^{\rm max}$, we compute the loss of kinetic power (equivalently shock luminosity, $L_{\rm shock}$) that is enabled to comply with the energy budget for generating jets/outflows from the jet base ($i.e.$, post-shock flow). We compare $L_{\rm shock}$ with the observed core radio luminosity ($L_R$) of black hole sources for a wide mass range spanning $10$ orders of magnitude with sub-Eddington accretion rate and perceive that the present formalism seems to be potentially viable to account $L_R$ of $16$ Galactic black hole X-ray binaries (BH-XRBs) and $2176$ active galactic nuclei (AGNs). We further aim to address the core radio luminosity of intermediate-mass black hole (IMBH) sources and indicate that the present model formalism perhaps adequate to explain core radio emission of IMBH sources in the sub-Eddington accretion limit.

**Presentation Type**:

Oral