Vasto Accretion Meeting 2025

Palazzo D'Avalos, Vasto

23 June – 4 July, 2025

Week 1: Binaries
23 June – 27 June

Week2: AGN
30 June – 4 July

Book of Abstracts

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Abstracts

Week 1 – Binaries

Unveiling the optical and infrared emission components of MAXI J1348−630 with XB-NEWS

Talk

Kevin Alabarta

New York University Abu Dhabi (NYUAD)

MAXI J1348−630 is a black hole X-ray transient discovered in January 2019 that underwent a reflare and several mini-outbursts at the end of its main outburst. In this talk, we present the first multiwavelength study of the system during outburst, reflare and mini-outbursts based on the long-term optical monitoring of the system with the Las Cumbres Observatory (LCO) network. The full optical coverage, including the mini-outbursts, represents one of the most well-sampled datasets for black hole transients. We show that the optical emission of MAXI J1348−630 is dominated by the outer parts of the accretion disc. In particular, the spectral slope in the spectral energy distributions and the colour-magnitude diagram suggest that the optical emission comes from viscous-thermal processes (the spectral index is $\alpha \sim 0.3$). However, the optical/X-ray flux correlation is consistent with both viscous-thermal emission and that expected from an irradiated accretion disc (slope $\sim 0.3-0.4$). We also show that during the decay of the reflare and mini-outbursts, the disc temperature is below 7000 K, which suggests that we are observing the cooling front propagate through the disc. We investigate a possible jet contribution to an infrared excess in the hard state. Finally, we show that the radio/optical correlation, one of the first reported for an X-ray binary, is steeper than expected. Since, during the reflare and mini-outbursts, the source remained in the hard state, these results will help to constrain models of mini-outbursts and failed-transition outbursts.

Talk

Black holes or neutron stars? A clustering approach to explore the nature of the compact objects in ULXs

Roberta Amato
INAF OAR

The nature of the compact object in ultraluminous X-ray sources (ULXs) is still a matter of debate. Only a few of these extreme luminous X-ray binaries show coherent pulsations, indicating that the compact object is a neutron star accreting at super-Eddington rates. However, the vast majority of ULXs either do not display pulsations or their time series do not have enough statistics to obtain meaningful results from pulsation searches. Moreover, pulsating ULXs do not display characteristic spectral signatures compared to the remaining ULX population. Consequently, alternative techniques are needed to distinguish between ULXs with black holes and neutron stars. To this aim, we applied clustering techniques to catalogued data of ULXs. We found that all pulsating ULXs are assigned to one cluster, on the basis of observational parameters that are usually overlooked in more traditional analysis techniques. The same cluster also contains non-pulsating ULXs, making them promising candidates for future pulsation searches. This approach holds great potential in identifying good pulsating ULX candidates as targets for future observational campaigns and in obtaining data-driven estimates of the ULX demography.

Talk

Observing and Modelling Low Ionisation Winds in Black Hole X-ray Binaries

Alessandra Ambrifi
Instituto de Astrofísica de Canarias

Accretion disc winds are observed in accreting systems across several orders of magnitude in mass. Accreting black holes in X-ray binaries (BHXBs) are no exception, exhibiting wind-type ejecta in two main forms: high and low ionisation winds. The former are typically detected as blue-shifted absorptions in high ionisation X-ray lines, while the latter are identified through characteristic emission line profiles in the optical and infrared (OIR) spectral range. Simultaneous multiwavelength observations suggest a scenario in which these two wind types coexist in pressure equilibrium, possibly with clumps of colder material embedded within a hotter outflow.While several studies have focused on modelling the properties of high ionisation winds in BHXBs, the low ionisation counterpart remains largely unexplored. In this talk, I will provide a brief overview of the state-of-the-art research on BHXB winds and present results from Monte Carlo radiative transfer and photoionisation simulations of their OIR spectra. I will discuss the constraints on the outflow mass obtained for both optically thick and optically thin wind regimes, highlighting how our findings support the idea that winds carry away a significant amount of mass, thereby impacting the accretion process.

A detailed spectral-timing NUSTAR view of the HMXB 4U 1901+03

Talk

Elena Ambrrosi
INAF IASF Palermo

Energy-resolved pulse profiles have proven to be a powerful tool for a deeper understanding of the spectral properties of accreting pulsars, as demonstrated in Ferrigno et al. (2023, F23). In this paper we apply the method described in F23 to four NuSTAR observations taken during the 2019 giant outburst of the high-mass X-ray binary (HMXB) 4U 1901+03. These observations cover a wide range of luminosities, each of which reveals distinct patterns in the energy-phase matrix, pulse harmonic decomposition, and pulse fraction spectrum (PFS). In particular, in the 30-40 keV energy range, where the detection of a cyclotron resonance scattering feature (CRSF) is both model dependent and uncertain based on spectral analysis, the PFS shows distinct features. The observed variations across the luminosity states provide key insights into how accretion dynamics, magnetic field geometry and emission processes shape the spectral behaviour of the system. To fully interpret the observed properties, a limited range of observer angles relative to the system geometry must be considered.

The highs and lows of transitional millisecond pulsars

Talk

M. Cristina Baglio
INAF-OAB

Transitional millisecond pulsars (tMSPs) bridge the evolutionary gap between accreting neutron stars in low-mass X-ray binaries and millisecond radio pulsars, providing a unique laboratory to study the interplay between accretion and pulsar activity. These systems exhibit a distinctive sub-luminous X-ray state, characterized by alternating high, low, and flaring emission modes.Recent multi-wavelength campaigns on the prototype tMSP, PSR J1023+0038, have significantly advanced our understanding of how tMSPs operate and are powered.In this review talk, I will provide an overview of the main properties of tMSPs during their sub-luminous X-ray state. I will highlight the discovery of optical pulsations in PSR J1023+0038 and the crucial role of fast-timing multi-wavelength observations in uncovering the physical mechanisms at play. Additionally, I will discuss the recent detection of X-ray polarization from PSR J1023+0038. Finally, I will explore the latest models attempting to explain the puzzling behavior of these sources in their X-ray state, shedding light on recent advancements in the field and outlining key unresolved questions, including the critical role of outflows in tMSPs.

Talk

Evidence of hot-spot drift in the accreting millisecond pulsar SAX J1808.4-3658: the first simultaneous X-ray/UV timing study

Caterina Ballocco

INAF - OAR

SAX J1808.4-3658 is the prototype of accreting millisecond X-ray pulsars and the first of this class to also show optical/UV pulsations during a bright accretion event. Before returning to quiescence at the end of its accretion outbursts this source shows several reflares of particular interest to provide insights into the physics of the accretion disk under low accretion rates. I will present the first simultaneous X-ray/UV timing and spectral study of XMM-Newton and Hubble Space Telescope observations of the source during the final stage of its 2022 outburst, focusing on the final flaring phase.Using XMM-Newton data we find shifts in the pulse phase and amplitude, with a distinct jump of approximately 0.4 in phase. The continuous coverage of XMM-Newton allowed unprecedented monitoring of this phenomenon. These phase shifts are among the most intriguing ever observed from this source and tightly correlate with the X-ray flux. We interpret such a correlation in terms of hot-spot drift on the neutron star surface, driven by variations in the mass accretion rate. I compare these results with NICER observations that covered the entire 2019 and 2022 outburst, which also show a pronounced evolution of the pulse phase over the course of the outburst.I will also discuss the multi-band study in X-ray and ultraviolet bands aimed at investigating the physical mechanisms driving the latter phenomenon.

Talk

Exploring burst-driven winds during photospheric radius expansion bursts in 4U 1820-303

Francesco Barra

Università degli Studi di Palermo — Center for Astrophysics - Harvard & Smithsonian — INAF - IASF Palermo

Type-I X-ray bursts are highly energetic events triggered by the unstablethermonuclear burning of accreted material on a neutron star's surface, oftenreaching luminosities that exceed the Eddington limit. This can drivephotospheric radius expansion (PRE) and the ejection of a burst-driven wind.In this talk, I will present the X-ray spectral analysis results of several PREevents observed in the well-known Type-I X-ray burster: 4U 1820-303. Usingdata from NICER, I explored the plasma properties underlying of these powerfulprocesses and tracked their evolution on the shortest timescale possible.During the bursts peak, significant statistical features in both emission andabsorption were detected, with properties varying across bursts, and theirimportance was evaluated through extensive Monte Carlo simulations. For thefirst time, a thorough exploration of the temperature-velocity parameter spacewas performed for each burst, aiming to investigate Doppler shifts and gaininsights into the plasma characteristics under various equilibrium conditions.This was made

possible thanks to the state-of-the-art photo/collisionalionisation model, which accurately accounts for the strong emission andabsorption features detected. The features appear more pronounced as theneutron star's photosphere expands during bursts. In most cases, the resultssuggest a near-rest-frame emitting gas; during the most extreme PRE cases, anadditional absorbing gas component moving at 20−30% of the speed of lightappears, confirming the presence of outflows.

Direct Impact Accreting Ultra-Compact Binaries with eROSITA

Poster

Sumari Barocci-Faul
Universität Hamburg, Hamburger Sternwarte

Ultra-compact binaries are binary systems with orbital periods less than 1 hour. In the most extreme cases these binaries systems can reach orbital periods as short as five minutes, and physical separations between components smaller than the Earth-Moon distance. These extreme systems are expected to be the strongest Galactic sources of gravitational waves in the LISA regime. The most compact binary known so far is HM Cnc with an orbital period of 5.4 min. HM Cnc was first identified as an X-ray variable source with a pulse profile consistent with 100 percent modulation on a period of 5.4 min. HM Cnc, can be explained by a semi-detached system where the donor star fills its Roche Lobe and directly accretes onto the surface of the accreting white dwarf without forming an accretion disc due to its compact nature. The X-ray modulation originates from the impact point of the accretion stream on the surface of the accreting white dwarf moving in and out of view. As such, large scale X-ray surveys, such as eROSITA, are an ideal tool to identify impact accretors across the Galaxy and our work aims to utilise data from the German eROSITA section to identify and characterise the population of direct impact accretors and put constraints on their population properties. This poster presentation will outline our steps toward refining our sample for multi-wavelength studies.

The Orbit of the Most Extreme ULX Pulsar

Talk

Andrea Belfiore
INAF IASF-MI

NGC 5907 ULX1 is the brightest accreting pulsar known to date, making itthe most striking example of a super-Eddington accretor.Although pulsations are elusive, we used all the available X-ray datataken by XMM-Newton and NuSTAR to investigate its orbit.This orbital ephemeris, also compared with those of other X-ray binaries,including other ULX pulsars, provides an insight into the geometry andnature of this system.Most likely we are observing face-on a high-mass X-ray binary,with a neutron star accreting through a disk from a OB supergiant.

Talk

An imaginary QPO in the soft-to-hard transition of the black hole X-ray binary MAXI J1820+070: a new window into the corona evolution

Candela Bellavita

Kapteyn Astronomical Institute (RUG, NL) - Instituto Argentino de Radioastronomía (ARG)

Fast X-ray variability in black hole X-ray binaries (BHXBs) is key to understanding the accretion/ejection mechanism in these sources. Among the most notable features of this variability are quasi-periodic oscillations (QPOs) which, due to their well-defined frequencies, provide a unique insight into the innermost regions of the accretion flow. Recent work reported a sudden increase in the lag frequency spectrum and a sharp drop in the coherence in the BHXBs Cygnus X–1, MAXI J1820+070, and MAXI J1348–630 during the soft-to-hard transition. In MAXI J1348–630, these features are explained by the presence of a type-C QPO detected in the power spectrum (PS). In MAXI J1820+070 and Cygnus X–1, however, no significant QPO is observed in the PS. In this talk I will present the analysis of NICER observations of MAXI J1820+070 during the soft-to-hard transition. Using a novel technique, we reveal a hidden variability component in the PS that we call "imaginary QPO." This feature naturally explains the coherence drop and phase-lag increase. We also found that this imaginary QPO smoothly evolves, morphing from a type-C QPO in earlier (softer) observations. The presence of a similar imaginary QPO in Cygnus X–1, and its possible link to the type-C QPO in MAXI J1348–630, suggests a deeper connection between these timing features and the accretion dynamics during state transition. The analysis of this variability offers valuable information about the evolving geometry of the Comptonizing region surrounding the black hole.

Poster

The accretion ejection interplay in GX 340+0: Insights from joint X-ray and radio campaign

Yash Dilip Bhargava

TIFR, Mumbai, and INAF OA Cagliari

Accreting low-mass X-ray binaries (LMXBs) provide a unique testbed to investigate the complex interplay between accretion flows and relativistic jets. In both neutron star and black hole LMXBs, X-ray and radio emissions are observed to be correlated, though neutron star systems exhibit significantly lower radio fluxes at comparable X-ray luminosities. Among neutron star LMXBs, Z-sources are particularly notable for their rapid X-ray variability, often accompanied by correlated changes in radio emission. To explore the accretion geometry and jet properties of the enigmatic Z-source GX 340+0, we conducted a multi-wavelength observational campaign using various X-ray and radio observatories. In this talk, I will present how polarimetric measurements with IXPE, along with spectro-timing studies using AstroSat and NICER, provide critical insights into the accretion flow components and the geometry of the Comptonizing medium. Additionally, simultaneous radio observations allow us to track the evolution of the radio spectrum, identify spectral breaks, and examine how the jet properties evolve along the Z-track. These results offer new constraints on the coupling between accretion processes and jet formation in neutron star X-ray binaries.

MCVSPEC: A Next Generation XSPEC Model of mCV Accretion

Talk

Gabriel Bridges
Columbia University

Above the surface of the white dwarf (WD) in a magnetized cataclysmic variable (mCV) a standing shock forms with typical temperatures of $\gtrsim 10$ keV. The precise temperature of this shock is determined by the mass of the WD, making X-ray spectroscopy a robust tool for measuring WD mass. However, the ability to measure mass this way has been limited by the lack of physically realistic and user-friendly models of mCV accretion. In this presentation, I will introduce MCVSPEC, an XSPEC model that predicts broadband x-ray emissions from mCVs. MCVSPEC uses a small set of physical parameters, such as WD mass, to generate physically accurate plasma temperature and density profiles of mCV accretion columns and the corresponding X-ray spectra. MCVSPEC improves upon previous models by (1) modeling both thermal bremsstrahlung and cyclotron cooling effects, (2) self-consistently calculating the accretion column height, (3) using the ATOMDB database for atomic line emissions, (4) accounting for the finite magnetospheric radius of intermediate polars, (5) computing accurate X-ray reflection from the WD surface, and (6) including thermal Doppler line broadening (essential for XRISM/Resolve data). Broadband NuSTAR spectral analysis of several mCVs (most recently EF-Eri) using MCVSPEC has yielded the most accurate WD mass measurements. I will discuss the theoretical basis of our model, provide a tutorial on fitting X-ray spectra with MCVSPEC, and present our recent WD mass measurements along with the ultra-high resolution Xray spectroscopy data of AM Her obtained by XRISM/Resolve.

Photon counting spectroscopy; From SuperSMART to the Time Domain Telescope

Talk

Kieran O'Brien
Durham University

SuperSMART is a novel concept to enable medium resolution optical and near-IR spectrophotmetry for a wide range of science cases, with a specific focus on the field of Time Domain Astronomy. It is based around an array of 'small' (0.6-1.0m) commercial telescopes which each feed light independently via one or more fibers to a cryostat containing an array of Microwave Kinetic Inductance Detectors (MKIDs). This array forms a number of channels of a medium spectral resolution (R=5-10,000) wide passband (350-1800nm) spectrograph, using the KIDSpec concept (O'Brien, JLTP, 2020). The array of telescopes can either be pointed at different targets across the visible sky, or pointed at the same target and the light from each channel can be (incoherently) combined to form an equivalently larger aperture telescope. As MKIDs are read-noise free, photon counting detectors this combining/stacking does not pay the same penalty as it would for similar (semiconductor-based) instruments, such as ESO's X-Shooter. SuperSMART leverages the much improved cost/aperture of prosumer robotic telescopes, compared to standard 4-8m monolithic telescopes. SuperSMART's big sister is the Time Domain Telescope, which leverages the full potential of photon-counting spectroscopy. The initial concept for the TDT is 100x 2m class telescopes. This is a planned proposal to ESO's Expanding Horizon's program. In this talk, I will present the concept and the science case for both SuperSMART and the TDT.

Talk

Transient Radio Astronomy in the SKA Era: The Importance of Dedicated Transient Interferometers

Joe Bright
Oxford

X-ray binary astronomy has been revolutionised by our ability to rapidly respond to high energy triggers with spacecraft such as Swift, as well as early outburst warnings provided through optical monitoring. These capabilities have drastically increased the number of XRBs with high quality early time optical and X-ray data. The results of this followup are often released rapidly, resulting in further observations across the electromagnetic spectrum. Followup radio observations are essential, as they are uniquely capable of probing the jets produced in XRBs, how these jets couple to accretion disk properties, and the structure of environments within which XRBs occur. By comparison with optical/X-ray facilities, time on appropriately sensitive radio interferometers (often preferable over single dishes due to resolution requirements) is precious, making rapid followup and regular monitoring of transient astrophysical sources hard to achieve. This issue becomes increasingly problematic as (necessarily) larger interferometers are built, and community interest is focussed onto a smaller pool of facilities. In this talk I will discuss the importance of 'agile' interferometers, which are able to dedicate a significant percentage of their observing time to transient discovery and monitoring, while taking observing pressure away from more sensitive instruments. Particularly, I will highlight the successes of the Arcminute Microkelvin Imager Large Array and the potential of the Allen Telescope Array in enriching our understand of XRBs, with these comparatively modest arrays often able to compete with or surpass international facilities in their scientific impact.

Towards a volume-limited sample of accreting compact binaries

Poster

Jaco Brink
AIP

The eROSITA all-sky surveys have uncovered about three million new X-ray sources. Accreting compact binaries (ACBs) form a small but important subsample of these sources. By incorporating machine learning techniques, we have identified roughly 11,000 potential ACB candidates in the eROSITA data sample. Optical spectroscopic observations are, however, now required to determine whether these candidates are true ACBs. For this project we are, therefore, conducting follow-up optical spectroscopic observations of these candidate systems using various instruments across the world, including SDSS, ESO and SAAO facilities. However, identification spectra are not enough to determine the probable subclass of ACBs. Therefore, following the positive identification of an ACB, time-resolved photometric observations are obtained, primarily using the SPECULOOS-south and STELLA telescopes, to determine the orbital periods of these systems, which would enable further subclassification. The primary goal of these observations is to obtain a complete 150pc volume-limited sample of all ACBs, after which we intend to extend to a 500pc complete sample. Having these complete volume-limited samples will enable us to better understand the evolution of close binary systems, as well as constrain the contribution of ACBs to the total high-energy output of the Galaxy. All of these observations are ongoing, and has already yielded around 160 new ACB systems. In this talk I will give an overview of these observations, talk about some of the results, and discuss the future prospects of this project.

White Dwarf Pulsars and Propellers

Talk

David Buckley
South African Astronomical Observatory

I will review our current understanding of the detached white dwarf "pulsars", for which AR Sco is the prototype. The wealth of multi-wavelength observations of this system and the more recent discovery of an analogous, though far from identical system, J191213.72-441045.1, will be reviewed. For AR Sco there seems to be no sign of accretion and the luminosity of the system, which is dominated by non-thermal emission, can be explained by dipole emission of a spinning down magnetic white dwarf. In contrast, J191213.72-441045.1 shows distinct signs of accretion (e.g. flickering), but also of note is its much narrower radio pulse compared to AR Sco. The analogy between AR Sco-like system and other propeller systems, like AE Aqr, will also be discussed. The recent discovery of a new intermediate polar from the Einstein Probe mission, EP J115415.8 −501810, which shows evidence of episodic blue-shifted emission, seems to be consistent with a propeller outflow.

Talk

X-ray variability and transient jets in the black hole X-ray binary MAXI J1348-630

Francesco Carotenuto
INAF/OAR

Black hole X-ray binaries (BH XRBs) can launch powerful outflows in the form of relativistic jets. During outbursts, the properties of these outflows change dramatically between different spectral/accretion states. Compact jets, connected to the accretion flow, are observed during the hard state and are absent during the soft state, while discrete ejecta are launched during the hard-to-soft state transition. Currently, we still do not understand what triggers the formation and destruction of compact jets or the launch of ejecta. In this context, a close link has been established between the jet radio emission and the X-ray variability, which is directly connected to the fundamental accretion/ejection coupling in these systems.In this talk, I will show that a brief but strong radio re-brightening during a predominantly soft state of the BH XRBs MAXI J1348-630 was contemporaneous with a significant increase in the X-ray rms variability observed with NICER in 2019. Shortly after, the variability dropped and the system went back to the soft state. At the same time, MAXI J1348-630 launched a pair of apparently superluminal discrete ejecta that we spatially resolved with the MeerKAT and ATCA radiointerferometers. We propose that short-lived compact jets were re-activated during this excursion to the hard-intermediate state and were switched off before the ejecta launch, a phenomenology that has been very rarely observed in these systems. In the talk, I will discuss what these data can tell us on how rapid changes in the accretion process drive relativistic outflows in BH XRBs.

Talk

High-resolution X-ray view of the changing wind in ultraluminous X-ray source NGC 5204 X-1

Simona Caserta
Università degli Studi di Palermo

X-ray binaries (XRBs) are pairs of stars that emit in the X-ray band as mass is transferred from a normal star to a compact object. The most extreme XRBs are the ultraluminous X-ray sources (ULXs), non-nuclear objects with X-ray luminosities above 10^{39} erg/s, exceeding the Eddington limit of a stellar-mass black hole. The nature of these objects has been highly debated with the early scenario of sub-Eddington intermediate-mass black holes progressively superseded by that of stellar-mass black holes and neutron stars accreting at super-Eddington rates. This was confirmed by the discovery of pulsations and relativistic outflows driven by radiation pressure in nearby bright sources. The outflows are detected in the form of absorption and emission lines in high-resolution X-ray spectra. Until now, exciting discoveries have been made in this field, although there are several unsolved questions, such as the dependence of the wind on the accretion rate and its effects on the source appearance. In an attempt to tackle these issues, we have triggered deep campaigns with XMM-Newton to study the disc-wind connection in variable

ULXs. Here, I will show our results obtained for the cornerstone ULX NGC 5204 X-1. Using a moving Gaussian line in the spectra we identified spectral features which show a variation with the spectral state of the source. Additionally, using physically-motivated plasma models, we found for the first time 1) a significant ($> 4\sigma$) detection of outflows, 2) a biconical collisionally-ionised relativistic (about 0.3c) component and 3) a slower likely-thermal wind component.

The connection between Type I burst rate and accretion geometry

Talk

Yuri Cavecchi
Universitat Politecnica de Catalunia

Studying the geometry of nova shells using MUSE

Talk

Lientur Celedón
Universidad de Valparaíso, Chile

Nova eruptions occur when a white dwarf has accreted a critical amount of material from a companion.As a result of the eruption, material is expelled into the interstellar medium forming a nebular structure around the system, a nova shell.The spectra of these shells are dominated mainly by Balmer emission and forbidden transitions. Once they have expanded enough for us to resolve them, we can study their geometry in detail.Nova shells present a variety of geometries, including equatorial rings, polar filaments, and clumpy structures.Especially for the younger novae, these structures must have their origin in the nova eruption itself. Thus, by studying nova shells we can gain insights into the processes that occur during a nova eruption.We have observed several nova shells using the MUSE instrument: an integral field spectrograph with spectral coverage between 465 and 930 nm, and a field of view of 1'x1', hence allowing us for a complete characterization of a shell both spatially and spectroscopically.By comparing these observations with previous ones we can study how the shells have been expanded during the last decades, therefore helping us to understand how they evolve.A 3D view of the shell can be obtained if we know the distance to the system and we assume that the shell has expanded freely since the nova eruption.This 3D view allows us to overcome projection effects, allowing for a cleaner analysis of the shell.Here I present what is up to date the largest sample of nova shells observed with MUSE, and the results we have obtained from it.

Talk

J2008, you still speak in riddles': have we found a highly asynchronous polar?

Andrei Alexandru Cristea
Institute of Science and Technology Austria (ISTA)

Time-domain surveys like the Zwicky Transient Facility (ZTF) have been extremely successful in discovering peculiar and rare systems at different stages of compact binary evolution, from eclipsing white-dwarf-main-sequence binaries to cataclysmic variables, to double white dwarf binaries, to merger remnants, that are shedding light on the properties and evolutionary paths of these populations. The compact binary ZTF J200832.79+444939.67, hereafter J2008, is possibly one of the most exotic discovered so far. J2008 contains a hot ($\approx 30,000$ K) and massive (≈ 1 $M_{\odot}$) white dwarf, which shows broad and shallow absorption features in its spectrum, typical of highly magnetized white dwarfs ($\geq$\{},100 MG). The Balmer $H\alpha$ emission feature present in its spectrum is suggestive of accretion, its double-peaked shape indicating the presence of Doppler shifts as high as 2,000\{},km/s. This particular combination of observational properties makes J2008 reminiscent of polars. However, its optical light curve and hydrogen emission lines both display peculiar variability on a 6.57 minute period, pointing towards the possibility that, unlike most known polars, the spin of J2008's white dwarf is $\approx$ 90\{}% asynchronous with respect to the system's orbital period. Thus, the system might be in a rare evolutionary stage, in which the white dwarf has only recently started accreting from the donor and its rotation is not yet synchronized with the orbital period of the binary. J2008 is potentially the first highly asynchronous polar to have been found, making it an invaluable source for probing the physics of magnetic accretion and spin-orbit synchronization of compact accretors in binaries.

Talk

Outflows from accreting white dwarfs: insights and future directions in accretion studies

Virginia Cúneo
Leibniz-Institut für Astrophysik Potsdam (AIP)

Accretion is one of the fundamental processes in the Universe, driving a diverse range of compact objects. However, critical questions about its workings remain. The study of outflows—relativistic jets, hot X-ray winds, and optical accretion disc winds—has been crucial in advancing our understanding of accretion flows in X-ray binaries, though key aspects such as the launching mechanisms behind these outflows remain debated. Intriguingly, optical wind features similar to those observed in X-ray binaries have also been detected in some accreting white dwarfs, particularly in nova-like sources. Accreting white dwarfs are roughly 1000 times more abundant than X-ray binaries and are often relatively bright, making them ideal targets for detailed accretion studies. Their discs produce strong UV emission that can drive outflows via the line-driven mechanism—a process considered inefficient in X-ray binaries. Nonetheless, the similarity in wind features suggests shared underlying mechanisms, offering an exciting opportunity to gain new insights into the fundamental processes governing accretion onto compact objects. In this talk, I will review our current knowledge of outflows in accreting white dwarfs and their parallels with X-ray binary winds, and outline future steps to advance our understanding of accretion, including comprehensive studies of optical disc winds, investigations of potential links to UV wind phenomena, and multi-wavelength observations in the near-infrared and X-ray bands.

The disk instability model

Talk

Guillaume Dubus
IPAG, CNRS Univ. Grenoble Alpes

The major predictions of the disc instability model are the stability limit and the outburst-quiescence cycle. I will present how Gaia has opened up new ways to approach and test the stability limit, strengthening the disc instability model. However, the transport mechanisms responsible for the eruption cycle remain poorly understood, particularly in quiescence. I will discuss the possible role of large scale magnetic fields and how they may dominate accretion processes in quiescence.

A systematic search for orbital periods of magnetic Cataclysmic Variable stars with TESS

Poster

Santiago Hernández Díaz
Institut für Astronomie und Astrophysik, Eberhard-Karls Universität Tübingen

Determining the orbital periods of Cataclysmic Variable stars (CVs) is essential for the confirmation of candidates and for the understanding of their evolutionary state. The Transiting Exoplanet Survey Satellite (TESS) provides month-long photometric data, enabling a systematic period analysis of these systems. We use a comprehensive catalog of Magnetic Cataclysmic Variables (mCVs), compiled through extensive literature research, which serves as the basis for our systematic search for orbital periods in TESS two-minute cadence light curves. The catalog includes previously reported periods, which we use to validate our detections. We provide a robust methodology for period detections, implementing multiple period-search algorithms and investigate the correlation between noise levels and TESS magnitude, providing insights into the expected intrinsic noise based on an object's brightness. Additionally, we have developed a probabilistic framework to evaluate the detection success across signal-to-noise ratios in the power spectral density of observed light curves, allowing to evaluate the reliability of period detections in TESS light curves. We find that for TESS magnitudes $\geq$17 mag, period detections of CVs become increasingly unreliable.Our study shows that TESS light curves can efficiently determine orbital periods in CVs. The developed methodology for period detection, noise characterization and reliability assessment can be systematically applied to other variable stars. As a matter of proof, we present a newly detected period and a corrected orbital period for two of the Compact White Dwarf Binaries detected by Schwope et al. 2024 in the sky area of eFEDS, the eROSITA Final Equatorial Depths Survey.

Talk

Detecting fast stochastic polarisation variability in X-ray sources

Melissa Ewing
Newcastle University

The Imaging X-ray Polarimetry Explorer (IXPE) provides, for the first time, sensitivity to X-ray polarisation in the 2-8keV band, offering two new diagnostics with which to study the extreme physics of accreting matter around compact objects: polarisation degree (PD) and polarisation angle (PA). X-ray polarimetry timing - the study of rapid variability in the polarisation properties - can provide unprecedented insight into the physical mechanism driving the X-ray variability observed from accreting compact objects, including quasi-periodic oscillations (QPOs). The origin of the Type-C QPO has been debated for decades, and one leading theory is the Lense-Thirring precession of the inner accretion flow. This describes a general relativistic nodal precession induced when the inner flow, or corona, is misaligned with the black hole spin axis and precessess as a result of the twisted up space-time. This model also predicts QPOs in the polarisation properties, a detection of which would provide smoking gun evidence in favour of this model. I will present a novel method of fast stochastic X-ray polarimetry timing capable of making such a detection, demonstrating that it is successful in measuring polarisation variability in X-ray sources such as Pulsars, and show how we can reconstruct polarisation variability over the QPO period, circumventing the issues associated with phase folding techniques. Furthermore I will present the results of searches for rapid polarisation variability from black hole sources, including Cygnus X-1 and Swift J1727.8−1613.

Poster

X-ray spectral and timing evolution during the 2023-2024 outburst of GX 339-4

Federico Ferretti
Università degli Studi Roma Tre

GX 339−4 is a low-mass X-ray binary often used as an archetype, showing typical source behaviors. The source undergoes a full outburst every 2-3 years, passing through all known accretion states. The 2023-2024 outburst was monitored as part of a multiwavelength campaign, which included X-ray observations by IXPE and NICER. IXPE polarization measurements in the soft-intermediate state allowed for constraining the geometry of the corona, suggesting an extended structure in the plane of the disk and perpendicular to the jet. IXPE observations are limited to the soft-intermediate and soft states, while NICER observed a broader range of states. We will use NICER data to analyze the spectral-timing properties of GX 339-4. This spectral-timing information will be used to characterize the evolution of the source during the outburst and to search for time-lags in the X-ray light curves. We will present the preliminary results of this analysis.

Multiwavelength Investigation of the Black-Hole X-ray Transient MAXI J1803-298

Poster

Katerina Fialova
NYU Abu Dhabi

MAXI J1803−298 is a black hole X-ray transient discovered in May 2021 during an outburst, which lasted for ∼6 months. The source was one of the brightest X-ray transients of recent times, and exhibited unusual, periodic X-ray dips, indicating a high-inclination system. Radio images and optical spectroscopy have revealed relativistically moving jets, and disc winds, respectively.

We present the first multiwavelength study of MAXI J1803−298 primarily based on optical monitoring from the Las Cumbres Observatory (LCO) network, and the ATLAS survey, complemented with quasi-simultaneous X-rays from Swift/XRT and NICER observations. We study the long-term optical and X-ray evolution of MAXI J1803−298 through the whole outburst.

The optical spectral energy distributions could be fitted with a power law having an index in the range of $\alpha = 0.4$–0.9 (where $F_\nu \propto \nu^\alpha$) suggesting that the optical emission is due to disk reprocessing. This is also supported by the Color-Magnitude Diagram, whose evolution follows that of a blackbody with a varying temperature. However, the optical/X-ray correlation is much steeper than expected from reprocessing, a unique property that has only been seen in MAXI J1820+070 before. While steep correlations usually suggest a jet contribution to the optical emission, it is unlikely to be the case here as these observations were during the soft state. Our findings provide hints for some interesting, hitherto unknown phenomena, that steepens the optical/X-ray correlation in the soft state.

New Views of Thermonuclear Bursts

Talk

Duncan Galloway
Monash University

Thermonuclear (X-ray) bursts, arising from ignition of accreted fuel on the surface of neutron stars in low-mass X-ray binaries, have a half-century history of observations to this year. Many aspects of the remarkable diversity of burst behaviour among the 115-strong burster population yet defy explanation. In recent years, several new avenues of probing the burst physics have emerged. New instruments have regularly offered new observational opportunities, and polarisation is another dimension that is now able to be explored. The first detection of bursts in radio wavelengths has also led to a new way to probe the link between accretion and jet production. At the same time, improved monitoring and target-of-opportunity scheduling has for the first time revealed strong candidates for H triggered bursts. Finally, long-standing efforts to comprehensively match burst observations to numerical models are starting to bear fruit, suggesting a surprising range in the fuel composition.

Talk

From ULXs to HLXs: Are Neutron Stars the Key to Extreme Accretion?

Tanuman Ghosh
Inter-University Centre for Astronomy and Astrophysics

Ultraluminous X-ray sources (ULXs) defy conventional accretion models, exhibiting luminosities surpassing the Eddington limit for stellar-mass black holes. Initially considered prime candidates for hosting intermediate-mass black holes (IMBHs), recent breakthroughs−including the detection of neutron stars in ULXs and broadband X-ray studies−point toward super-Eddington accretion onto stellar-mass compact objects as the dominant mechanism. Hyperluminous X-ray sources (HLXs), an extreme subclass with luminosities exceeding 10^{41} erg/s, remain strong IMBH contenders. However, identifying neutron stars (NSs) within this population could fundamentally challenge this paradigm. This talk examines the spectral, timing, and polarization characteristics of ULXs and HLXs, highlighting a novel physical model that favors neutron stars as the primary accretors. A focused analysis of NGC 470 HLX-1−a highly variable HLX with a thermal component and high-energy synchrotron emission−reveals accretion parameters consistent with an NS host. These findings suggest that, much like ULXs, HLXs may also harbor stellar-mass compact objects, undermining the IMBH hypothesis. With broadband X-ray observations playing a crucial role, this study reshapes our understanding of extreme accretion physics and the true nature of these enigmatic sources.

Talk

New period-bounce candidates among eROSITA-selected \{}textit{Gaia} white dwarfs

Daniela Muñoz Giraldo
Institute of Astronomy and Astrophysics Tübingen (IAAT)

Period-bounce cataclysmic variables (CVs) are systems in which a white dwarf accretes from a brown dwarf donor, having reached a point where the degeneracy of the donor reverses the orbit period evolution. A large portion of the CV population, between 40% and 70%, is predicted to be made up of period-bouncers. However, only a few of these systems have been confidently identified so far. A promising approach to identify period-bounce CVs is an X-ray detection. It provides proof of accretion from the substellar companion onto the white dwarf because the coronal emission of a brown dwarf donor is below the sensitivity of current instruments.Based on the known multiwavelength properties of period-bouncers, we have constructed a "scorecard" that assigns to a system its probability of being a period-bouncer. Additionally, confirmed period-bouncers detected by the extended ROentgen Survey with an Imaging Telescope Array (eROSITA) onboard the {\{}it Spektrum-Roentgen-Gamma} spacecraft (SRG) are used to establish X-ray selection cuts that reflect the typical X-ray emission of period-bouncers. Applying both the scorecard and X-ray selection cuts to our catalog of known CVs around the period-bounce, introduced in Muñoz-Giraldo et al. (2024), resulted in the confirmation of

12 new period-bouncers, a promising 63% increase in their population. However, the search for the missing population of period-bouncers continues. Considering that the contribution from the substellar companion in period-bouncers at optical wavelengths is expected to be negligible, the next step is to search for new candidates among \{}textit{Gaia} white dwarf catalogs using the same scorecard and X-ray selection cuts applied to our catalog of known CVs around the period-bounce. Using this method we have identified 153 strong new candidates. To advance their classification as period-bouncers we require follow-up in order to: obtain orbital periods, determine their status as a CV and confirm the brown dwarf nature of the companion.

Hydrodynamic instability, warping, and verticall oscillations in tidally distorted accretion disks

Talk

Loren E Held

DAMTP, University of Cambridge

Accretion disks are often modeled as being circular and co-planar with the star onto which they accrete. However, observations have revealed many disks that are distorted (e.g. warped or eccentric), either due to a misalignment in the system or due to a tidal interaction with a companion star in a binary system. Crucially, such eccentric, warped, and tidally distorted disks are not in vertical hydrostatic equilibrium, and thus exhibit vertical oscillations in the plane perpendicular to the disk. In extreme cases, this is manifested as a vertical "bouncing" of the gas leading to shocks and heating, as observed in recent global numerical simulations.Surprisingly, despite the intuitively "global" nature of distorted disks, much of their dynamics can actually be understood using the local approximation of disks. In this talk we will isolate the mechanics of vertical disk oscillations by means of quasi-2D and fully 3D hydrodynamic local (shearing-box) models. To determine the numerical and physical dissipation mechanisms at work during a bounce we start by investigating unforced oscillations, determining the effect of initial bounce amplitude, as well as resolution, boundary conditions, and vertical box size on the dissipation and energetics of the bounce. We then drive the oscillations by introducing a time-dependent gravitational potential. A novel - and surprising - result is that even a purely vertically oscillating (bouncing) disk is (parametrically) unstable to developing internal waves and bending modes which ultimately cause the disk to warp. If time, we will also present some extensions to include MHD, and also disk breaking.

Talk

Probing accretion geometry and disk reflection in accreting millisecond pulsars

Giulia Illiano
INAF-OAB

Accreting millisecond pulsars serve as unique laboratories for probing accretion physics in strong gravity regimes. Their X-ray spectra arise from multiple components, including the accretion disk, a Comptonizing electron corona, and the neutron star surface, with relativistic effects shaping their observed properties. We present recent investigations of the X-ray spectral properties of two such systems, IGR J17498-2921 and SRGA J144459.2-0604207, with a particular focus on their disk reflection components and the discovery of relativistically broadened iron lines in both sources. For the first source, we used NICER and NuSTAR, while for the second, XMM-Newton and NuSTAR were employed. For IGR J17498-2921, we also examine the spectral evolution around a sudden jump in the pulse phase, which may be linked to changes in the accretion geometry and a reconfiguration of magnetic field lines. In the newly discovered SRGA J144459.2-0604207, we detect an absorption edge at ∼9.7 keV, consistent with a Fe XXVI edge blueshifted by an ultrafast outflow. This system proved to be a prolific burster, offering a valuable opportunity to perform broadband time-resolved analysis of the burst emission. We find no evidence of photospheric radius expansion and observe a remarkably pronounced dependence of the burst recurrence time on the count rate, the steepest ever reported in these systems. These findings provide new insights into accretion dynamics, disk reflection physics, and burst mechanisms in accreting millisecond pulsars.

Talk

GR-RMHD Simulations of Super-Eddington Accretion Flows onto a Neutron Star with Dipole and Quadrupole Magnetic Fields

Akihiro Inoue
Osaka University

Although ultraluminous X-ray pulsars (ULXPs) are believed to be powered by super-Eddington accretion onto a magnetized neutron star (NS), the detailed structures of the inflow-outflow and magnetic fields are still not well understood. We perform general relativistic radiation magnetohydrodynamics (GR-RMHD) simulations of super-Eddington accretion flows onto a magnetized NS with dipole and/or quadrupole magnetic fields. Our results show that an accretion disk and optically thick outflows form outside the magnetospheric radius, while inflows aligned with magnetic field lines appear inside. When the dipole field is more prominent than the quadrupole field at the magnetospheric radius, accretion columns form near the magnetic poles, whereas a quadrupole magnetic field stronger than the dipole field results in the formation of a belt-like accretion flow near the equatorial plane. The NS spins up as the angular momentum of the accreting gas is converted into the angular momentum of the electromagnetic field, which then flows into the NS. Even

if an accretion column forms near one of the magnetic poles, the observed luminosity is almost the same on both sides with the accretion column and the side without it because the radiation energy is transported to both sides through scattering. Our model suggests that galactic ULXP, Swift J0243.6+6124, has a quadrupole magnetic field of 2×10^{13} G and a dipole magnetic field of less than 4×10^{12} G.

Wobbling around the clock: a magnetic origin for the mHz QPOs in pulsating ULXs?

Talk

Matteo Imbrogno
INAF - OAR

The discovery of pulsating ultraluminous X-ray sources (PULXs) has shown that accreting neutron stars (NSs) can shine at luminosities as high as 500 times their Eddington limit. The detection of quasi-periodic oscillations (QPOs) in the mHz range in the X-ray flux of a few PULXs has also shown that this type of variability, previously interpreted as the footprint of a ULX powered by an accreting intermediate-mass black hole, is ubiquitous to black holes and NSs alike and could represent a signature of super-Eddington accretion. The models historically proposed to explain mHz QPOs in ULXs either do not work or require a high level of fine-tuning in the case of the mHz QPOs detected in PULXs. We recently tested an alternative model, in which the observed mHz QPOs arise from a magnetically driven precession of the inner accretion flow. I will show how this model can self-consistently reproduce the observed NS spin and QPO frequencies and recover mass transfer rates and magnetic fields in agreement with other independent measurements. In particular, this model can reconcile the different observed properties of PULXs without requiring general relativistic effects or strong beaming. I will show the current limitations of the model and how new detections of mHz QPOs in pulsating ULXs could allow us to test (or refute) the model.

Accretion disk variability in black hole X-ray binaries

Talk

Adam Ingram
Newcastle Univertsity

I will review some observational and theoretical aspects of accretion disk variability in black hole X-ray binary systems. We see both aperiodic broadband noise as well as quasi-periodic oscillations (QPOs). I will review how the aperiodic variability enables reverberation mapping, since fluctuations in the luminosity of the central accretion flow imprint themselves on the signal reflected off the accretion disk with a small light-crossing delay. I will then briefly review the observational tests of low frequency QPO models, mainly in the context of testing the precession model, whereby the QPO results from relativistic precession of the inner accretion flow.

Talk

A Unified Description of the Timing Features of Accreting X-ray Binaries Using Gaussian Processes

Zackery Irving

University of Southampton

We present a new method for analysing the timing features of accreting binaries in the time domain using Gaussian processes (GPs). Similar to Belloni et al. (2002), this method is based on a superposition of “Lorentzian” components representing broad-band noise and quasi-periodic oscillations (QPOs). We employ a Bayesian inference framework to identify the best combination of Lorentzian terms for a given light curve and optimise their parameters simultaneously. In the limit of uniformly sampled time series, we find that parameter recoverability is generally comparable between GP regression and periodogram fitting; in cases where data gaps prevent the computation of a single periodogram, we find that GP regression is more confidently able to identify QPOs than modelling the averaged periodogram. We demonstrate our framework on MAXI J1348−630’s 2019 outburst, as observed by {\{}it NICER}, where we confirm previous previous reports of type-C QPOs, though our method is applicable to a wide range of accreting systems. Given our findings, we suggest that GPs be used wherever possible to detect and characterise QPOs in cases where the time series is not uniformly sampled.

Talk

Novae as Galactic lithium factories: further confirmations from multi-wavelength observations

Luca Izzo

INAF/OACn

Classical Novae have been proposed as one of the main factories of lithium in our Galaxy. In this talk, I will present further evidences for the presence of lithium in the ejecta of classical novae from a multi-wavelength analysis of bright events. While the lithium yield derived from these observations are about one order of magnitude greater than theoretical predicitons, they solidify novae as main Lithium producers in the Milky Way, and likely in the Universe.

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nDspec: a new Python-based modelling software for multi-dimensional model fitting

Poster

Matteo Lucchini
University of Amsterdam

The wealth and complexity of X-ray data provided by modern observatories has seen a dramatic improvement in recent years, in part due to new facilities like NICER and IXPE. This trend will accelerate further with new techniques like polarimetry timing, as well as future missions like eXTP and Athena. On the other hand, the software modelling tools utilized by the community to model spectral timing data are mostly legacy stand-alone packages tailored to one-dimensional spectral analysis. In this talk, I will discuss the development and initial release of nDspec, a new Python-based modeling package designed to enable Xspec-style forward folding of models with multi-dimensional data in a computationally efficient fashion, and at the same time enabling users to utilize modern inference libraries for model fitting. I will demonstrate a sample application to a set of existing NICER data, and highlight how nDspec allows users to easily constrain a model impulse response function. Finally, I will discuss planned features for the software and the development time table.

Timing Analysis of the Black-Hole Candidate Swift J1727.8−1613: Detection of a Dip-like Feature in the High-Energy Cross Spectrum

Poster

Pei Jin
The Kapteyn Institute

The energy-dependent variability of black hole X-ray binaries (BHXRBs) provide crucial insights into the physical processes at play in the accretion flow of these systems. We analyze the rapid X-ray variability of the BHXRB Swift J1727.8−1613 during its 2023 outburst, using observations from the Hard X-ray Modulation Telescope. We detect, for the first time, a dip-like feature in the Real part of the Fourier cross spectrum of this source from the >25 keV and <10 keV X-ray light curves in the 3-15 Hz frequency range. This feature implies a phase lag between $\pi/2$ and π. We modeled the variability and found that a Gaussian phase-lag model provides a better fit than simpler models, reducing ambiguities in interpreting the data. Interestingly, both the fractional-rms and phase-lag spectra of the dip exhibit a change in trend around 15 keV, closely aligning with predictions from the time-dependent Comptonization model vKompth under a low feedback factor scenario. I will discuss these findings, and their consequences upon the current understanding of the mechanisms that produce the fast X-ray variability.

Talk

Accretion-ejection coupling in accreting stellar-mass compact objects

James Miller-Jones

International Centre for Radio Astronomy Research - Curtin University

In this talk I will give an overview of our current understanding of the connection between the accretion flow and the jets around accreting neutron stars and stellar-mass black holes. I will discuss the compact jets that are ubiquitous in the hard and quiescent accretion states, including recent advances derived from deep radio observations, high-angular resolution imaging, high time-resolution radio photometry and polarimetry. I will outline the changes observed as the jets move through the hard and soft intermediate states, culminating in the ejection of bright, relativistically-moving transient ejecta. I will show how new algorithms are now allowing us to pinpoint the ejection times to within a few tens of minutes, and discuss what would be required to finally ascertain the causal sequence of events that lead to the launching of relativistic jets at the peak of an outburst.

Talk

High-mass X-ray binaries in the Large Magellanic Cloud detected with eROSITA

David Kaltenbrunner

Max Planck Institute for extraterrestrial Physics

The Magellanic Clouds are our closest star-forming galaxies with low Galactic foreground absorption. This makes them a unique laboratory to study the population of high-energy sources. The SMC hosts a large population of Be/X-ray binaries associated with high star formation activity 25-40 Myr ago. It has been proposed that the HMXB population in the LMC is associated with more recent star formation. However, due to the large angular extent and resulting insufficient coverage of the LMC, this association with SFR is not well established yet.An essential asset for studying the HMXB population in the entire LMC was the launch of eROSITA. eROSITA scans the sky in great circles crossing at the ecliptic poles. Due to the vicinity of the south-ecliptic pole, sources in the LMC are monitored for up to several weeks during each all-sky survey, leading to a deep total exposure and the possibility of studying long-term temporal behaviour. This allowed us to discover several new HMXBs, verify candidate HMXBs and construct a complete, flux-limited catalogue. During my presentation, I will first focus on the classification scheme we adopted using multi-wavelength properties of all objects in the catalogue. Then I will discuss HMXB population properties in the LMC.

Type I X-ray Burst Emission Reflected into the Eclipses of EXO 0748-676

Talk

Amy Knight
Durham University

The neutron star X-ray binary, EXO 0748-676, was observed regularly by the Rossi X-ray Timing Explorer (RXTE) and XMM-Newton during its first detected outburst (1985 - 2008). These observations captured hundreds of asymmetric, energy-dependent X-ray eclipses, influenced by the ongoing ablation of the companion star and numerous thermonuclear X-ray bursts. In this talk, I will present the light curves of 22 Type I X-ray bursts observed by RXTE that coincide, fully or partially, with an X-ray eclipse. There are nine instances where the burst occurs entirely within totality, seven bursts split across an egress, and six cases interrupted by an ingress. All in-eclipse bursts and split bursts occurred while the source was in the hard spectral state. I will demonstrate that we are not observing direct burst emission during eclipses since the companion star and the ablated outflow entirely obscure our view of the X-ray emitting region. Instead, we observe burst emission reflected in our line of sight. I will discuss how the outer accretion disc, even if maximally flared, cannot explain all observations of in-eclipse X-ray bursts. Subsequently, I will explore several plausible scenarios for how the X-ray bursts are scattered/reflected into our line of sight.

Is there disk truncation in the hard states of Swift J1727.8-1613?

Talk

Ole König
Center for Astrophysics — Harvard-Smithsonian

The NICER monitoring campaign of the black hole X-ray binary Swift J1727.8-1613 is one of the few datasets where coverage of the poorly understood back-transition from the soft state into the dim hard state is available with high fidelity. We deploy continuum fitting techniques to investigate the evolution of the inner disk radius throughout the outburst. Taking a temperature-dependent color-correction factor into account, we see apparent evolution of the disk inner radius by a factor of a few comparing the hard states to the thermal/soft state; we are investigating to discern whether this trend is real or a modelling artifact, and how it differs between the bright and dim hard state. Large-scale truncation with $r \gg r_{\rm ISCO}$ is incompatible with our results. In the high-luminosity soft-intermediate state, standard thin-disk models do not fit the data well, which may be an indication of ”slim-disk” manifestations. I will discuss model systematics, the impact of these constraints on the hard state disk truncation debate, and on the IXPE measurements of this source.

Poster

Quiescent evolution of WZ Sge

Paula Kvist
University of Oulu

WZ Sge, a period-bouncer candidate and the archetype of WZ Sge-type objects, is probably one of the most famous and well-studied dwarf novae. Mass-transfer from the donor stars has a significantly lower rate in the WZ Sge-type objects than in ordinary dwarf novae, resulting in still poorly understood physical properties of their accretion disks. In particular, existing theories seem incapable of explaining what is the physical mechanism behind the onset of a superoutburst in WZ Sge-type objects and how their disks switch from a low-viscosity to a high-viscosity regime.WZ Sge has recorded superoutbursts in 1913, 1946, 1978 and 2001. Its outburst intervals have been 33, 32 and 23 years, and, if the next outburst is following the shorter interval, we could expect it to go into outburst soon. We present spectroscopy and photometry of WZ Sge throughout its quiescent period from 2002 until 2024, especially paying attention to the evolution of the accretion disk properties. We also revise the system parameters and show the temporal evolution of most important spectral lines. Studying the accretion disk evolution during quiescence may help us understand how outbursts are triggered in low mass-transfer rate systems.

Talk

Optical Spectral Features of Transitional Millisecond Pulsars

Rebecca Kyer
Michigan State University

Transitional millisecond pulsars (tMSPs) are the only class of neutron star observed to transition between a radio pulsar state and an accretion disk state. In the disk state, tMSPs are strongly variable in X-ray and optical emission, and their unique set of multiwavelength phenomenology has been used to identify compelling candidate tMSPs in which transitions have not yet been observed. Most candidates have been discovered by optical follow up of X-ray sources located within the error ellipses of unassociated Fermi-LAT gamma-ray sources. Confident classification of a candidate tMSP has largely relied on detection of bimodal state switching and flaring in the X-ray. For distant systems, these signatures are not always accessible with current instruments. We instead consider the potential for optical spectral features to distinguish tMSPs from other accreting compact binaries. With a current population of nine confirmed and likely tMSPs in the Galactic field, we characterize their optical spectra collectively and compare to the spectral features of typical neutron star low-mass X-ray binaries and accreting white dwarfs. This analysis provides a powerful tool for classification and enhances our understanding of the contributions to optical emission in these rare systems.

Stingray: your friendly Python library for spectral-timing

Talk

Eleonora Veronica Lai
INAF OAC

Stingray is a Python library able to perform time series analyses with a focus on high-energy astrophysics.Comprising the most commonly used Fourier analyses techniques, it also supports a range of additional extensions able to analyse pulsar data, simulate data sets and perform statistical modelling. With the latest release of the code, new Fourier methods and support for additional missions have been implemented, making Stingray more easily adaptable and extendable to other use cases. I will illustrate how Stingray effectively eases the learning curve for young researchers and accelerates the analysis process for experienced astronomers.

Are jets from stellar mass black holes as fast as those from supermassive black holes?

Talk

Clara Lilje
University of Oxford

Jets from stellar mass black holes in X-ray binaries (XRBs) and supermassive black holes in blazars provide distinct opportunities to study the jets of black holes across two different mass regimes. They also represent samples with very different selection effects. Historically, the apparent speeds of XRB jets have been observed to be lower than those of blazars, leading to the assumption that this reflects the underlying distributions of Lorentz factors, i.e. stellar mass black holes produce slower jets. In this talk, I will present our detailed modelling of the parent population for large-scale XRB jets, which accounts for the selection effects present in the observed sample. Using nested sampling, we determined that the Lorentz factors of the parent population of XRBs are best described by a power law with a slope of $b = -3.01^{+0.89}_{-1.23}$ where $N(\Gamma) \propto \Gamma^b$, the same form of model which has been historically applied to blazar jets. We can reject several other potential Lorentz factor distributions, such as Gaussian and Exponential distributions, using Bayes factors. When we compare our findings to the parent Lorentz distributions of Blazar jets documented in the literature, it is notable that we cannot rule out the possibility that both XRBs and Blazar jets share the same parent population Lorentz factor distribution. In other words, based on kinematics alone, jets from stellar mass black holes are broadly consistent with being just as relativistic as those from supermassive black holes, and the lower apparent speeds can be just a result of the typically much large angles to the line of sight.

Poster

Shock-free super-Eddington accretion onto magnetized neutron stars

Galina Lipunova

Max Planck Institute for Radio Astronomy

Strong magnetic fields allow accreting neutron stars (NSs) to form magnetically controlled funnel flows. Because of the strong geometrical factor, such a flow exceeds the local Eddington limit at rather moderate luminosities and becomes radiation-pressure-supported. A conventional funnel flow has a nearly free-falling transonic outer part, a radiation-mediated shock, and a subsonic optically thick part responsible for the bulk of the observed X-ray radiation, known as the accretion column. The height of the shock wave is controlled by the cooling of the column. Here, we consider the case when the expected height of the column is too large for a self-consistent transonic solution, and the entire funnel flow is subsonic and supported by radiation pressure. We derive the solution analytically and reproduce it in one-dimensional time-dependent numerical simulations using HACol (https://github.com/pabolmasov/HACol.git). The solution is realized for rapidly accreting NSs with pulsar-scale magnetic fields $B \sim 10^{11} - 10^{12}$G. Most of the observed emission comes from the plasma leaving the columns above the NS surface.

Poster

Radial and vertical structure of accretion disc penetrated by magnetic field of neutron star

Galina Lipunova

Max Planck Institute for Radio Astronomy

We analytically investigate of the radial and vertical structure of accretion discs around magnetized neutron stars, taking into account interaction between the α-disc and the stellar magnetic field. Assuming partial penetration of the dipole field into the disc, we develop a model that interpolates between fully diamagnetic and magnetically-threaded disc scenarios. Our approach modifies the angular momentum transport equation to include magnetic torques and allows for a self-consistent determination of the inner disc radius. The vertical structure is numerically solved using realistic opacities and equations of state, incorporating magnetic pressure effects. We examine how the magnetic field influences disc thickness, pressure, temperature profiles, and S-curves associated with thermal-viscous stability. Our results show that while the magnetic field only weakly affects the normalized vertical profiles, it can significantly alter the radial structure and inner radius location, as well as the thermal stability of discs.

Spectral-Timing Analysis of Swift J1727.8–1613 Using *Insight*-HXMT Observations

Talk

Ruican Ma
University of Southampton

We present a detailed spectral and timing analysis of the newly discovered black hole candidate Swift J1727.8–1613, utilizing the broadband (1–150 keV) observations from *Insight*-HXMT during its 2023 outburst. We employed the flexible energy-conserving SSsed model to analyze the spectral properties of the source, identifying the coexistence of two Comptonization components, with the hard component dominating in this state. We also track the evolution of the truncated accretion disc radius, $R_{\rm tr}$, which decreases from $45\,R_{\rm g}$ to $6\,R_{\rm g}$, consistent with the source transitioning from the hard state to the intermediate state. We further investigate the correlation between $R_{\rm tr}$ and the centroid frequency of quasi-periodic oscillations (QPOs) to test the hot flow Lense-Thirring (LT) precession model. The overall trend is consistent with LT precession predictions, showing a decrease in the scale height-to-radius ratio (h/r) as the source evolved. However, deviations in the hard state suggest additional contributing factors, including limitations of the SSsed model, which does not account for the vertical structure of the corona, similar limitations within the LT model, and the potential influence of additional jet emission.

All X-ray eyes on a new black hole transient discovered < 1 parsec from Sgr A*

Talk

Shifra Mandel
Columbia University

The Galactic center is home to a rich array of exotic sources, including the highest concentration of accreting compact objects identified in our Galaxy. A bright new transient – located < 1 parsec from Sgr A* – outbursted in early 2025, sparking much excitement, as well as an unprecedented multi-wavelength monitoring campaign involving virtually every major X-ray observatory. We present the result of historic simultaneous ToO observations of MAXI J1744-294 by the NuSTAR, Chandra, XMM-Newton, Swift, and XRISM observatories, which captured the outburst features in exquisite detail. Together, these complementary observations boast a combination of the broadest energy band, fastest timing resolution, and highest energy resolution X-ray dataset ever obtained for an accreting compact object. The spectral and timing properties of this bright transient ($L_X > 10^{37}$ erg/s/cm^2) are characteristic of a low-mass X-ray binary (LMXB) hosting a black hole (BH). As a tracer for an underlying population of many more quiescent, mostly undetected BH LMXBs, the discovery of this new transient has significant implications for our understanding of binary formation and evolution in the deep gravitational well of the Nuclear Star Cluster (NSC).

Talk

The extreme phase viariability of the cyclotron line in the X-ray pulsar 4U 1538-52

Dimitrios K. Maniadakis
INAF - IASF Palermo

We present a comprehensive study of the accreting X-ray pulsar 4U 1538−522, utilizing timing analysis as a diagnostic tool to probe spectral features. Our custom pipeline, developed for the NuSTAR mission, enables the generation of pulsed fraction spectra (PFS) with energy resolution tailored to the instrument's capabilities. We identify a broad feature near the cyclotron line energy, which differs significantly from the features commonly observed in the PFS of other sources at cyclotron line energies. By performing phase-resolved spectroscopy, we highlight extreme variability at the cyclotron line, explaining the origin of the pulse-fraction feature. Physical radiation modeling using a realistic cross-section in the magnetized medium shows that the beaming is variable in energy and escapes the usual classification of pencil vs. fan beaming. By inspecting how the beaming imprints its signature on the observed pulse profiles and spectra, we constrain the angles in the system, i.e., the inclination of the rotational and magnetic axes with respect to the line of sight. We place our findings in the broader context of other accreting pulsars that exhibit different behaviors, trying to reduce the geometrical parameter space. In this context, the pulsed fraction spectrum is a fundamental quantity for providing a direct comparison between models and observations.

Talk

The accretion flow in black hole X-ray binaries: insights from X-ray spectral-timing

Barbara De Marco
Universitat Politècnica de Catalunya

The study of black hole X-ray binaries (BHXRBs) offers a unique window into the evolving physical conditions of the accreting material across different accretion states. This evolution manifests as rapid and dramatic changes in both the X-ray spectral and timing properties of the source during an outburst. To develop a comprehensive understanding, it is essential to integrate the information from all available observational channels and construct self-consistent models. X-ray spectral-timing techniques allow us to map the accretion flow by combining the spectral and timing information across multiple variability timescales. In this talk, I will explore the state-of-the-art of X-ray spectral-timing studies of BHXRBs, highlighting their connection to recent results from X-ray polarimetry and discussing novel spectral-timing models.

A MeerKAT view of the parsec-scale jets in the black hole X-ray binary GRS 1758-258

Talk

Isabella Mariani
INAF-OABrera

Jets from accreting black-hole X-ray binary systems (BH-XRBs) are powerful outflows that release a large fraction of the accretion energy and power to the surrounding environment, providing a feedback mechanism that may alter the properties of the interstellar medium (ISM). Studying accretion processes alongside their feedback on the environment is crucial, as it enables the estimate of the matter and energy input/output around accreting BHs. Signatures of jet feedback from BH-XRBs have been confirmed in a handful of sources, such as GRS1758-258. At radio frequencies extended structures around the binary position - a core and two elongated blobs - were first observed in VLA data from 1992 to 2016. These features are believed to originate from the jet-ISM interaction, leading to the formation of parsec scale jets that create a peculiar Z-shape structure.I will present the most recent results obtained from 9hr of observations taken in 2024 in the L band at 1.28 GHz using the MeerKAT radio interferometer. We identified several regions forming the extended structures seen in the radio image, characterized by either synchrotron or bremsstrahlung emission. Comparing these data with those from VLA we observed the jet's motion and measured its velocity, corresponding to a few thousands of km/s. Following a calorimetry-based method originally proposed for AGN, and later applied to a few XRBs, we estimated the time averaged jet power transferred to the ISM to be on the order of 10e36 erg/s, comparable to the accretion energy typically released by XRBs in outburst.

Einstein Probe discovery of the Be-White Dwarf EP J005245.1-722843

Talk

Alessio Marino
ICE-CSIC Barcelona

EP J005245.1-722843 was a new transient X-ray source discovered by the Einstein Probe (EP) mission in the Small Magellanic Cloud. Prompt follow-up with the EP Follow-up X-ray Telescope, the Swift X-ray Telescope and NICER have revealed a super-soft, thermally emitting source (kT0.1 keV at the outburst peak) with an X-ray luminosity above 10\{}^{}38erg/s.ThankstoourdenseX−rayobservingcampaign, wewereabletotr
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Talk

Polarization properties of direct radiation in stellar-mass black hole accretion disks

Lorenzo Marra
INAF - IAPS

The X-ray polarimetric observing window re-opening is shedding new light on our current understanding of compact accreting sources. This is true, in particular, for stellar-mass black hole sources observed in the thermally-dominated state, for which the polarization signal is expected to depend on the geometrical parameters of the accretion disk, its inclination and the black hole spin. Two main effects determine the polarization properties of the accretion disk emission: the absorption and scattering processes occurring before the radiation leaves the disk atmosphere, and the relativistic effects influencing its propagation towards the observer at infinity. In this work, we investigate these effects together considering only the contribution of direct radiation. We analyze how the ionization state of the disk surface layer, assumed to be either in collisional ionization equilibrium or photoionization equilibrium, can influence the spectro-polarimetric properties of the radiation at the emitting disk surface, and subsequently we study how these are modified by the propagation in a strong gravitational field. Finally, we compare our theoretical predictions with the polarimetric observations of stellar-mass black holes in soft state obtained by IXPE.

Talk

Probing the Inner Geometry of Stellar Mass Black Holes: Insights from the X-ray Polarization Measurement of GX 339-4

Guglielmo Mastroserio
Università degli Studi di Milano

During the outburst of accreting black hole binaries, the characteristic features of these sources vary due to the intrinsic changes in the system's geometry. The exact structure of accreting material around the black hole and its evolution during the outburst remain open questions. The Imaging X-ray Polarimetry Explorer has provided unprecedented measurements of the polarization degree and angle of the stellar mass black hole, offering valuable diagnostics to determine the preferential orientation of the regions closest to the black hole. I will present the recently published X-ray polarization detection of the famous black hole GX 339-4 in the context of the other polarization measurements. I will discuss what we can infer about the geometry of the system and how the results compare with other diagnostics, such as X-ray reverberation mapping.

Modelling disc winds in accreting binaries with SIROCCO: 5 key physics challenges

Talk

James Matthews
University of Oxford

Disc winds are ubiquitous in accreting binaries and have an intimate connection to the accretion disc; however, the driving mechanism of the winds and their impact on the observed spectrum both remain poorly understood. In this talk, I will first review the physics behind accretion disc winds and their observational signatures. I will then introduce the Monte Carlo radiative transfer code, SIROCCO (Simulating Ionization and Radiation in Outflows Created by Compact Objects) and describe how it can be used to calculate the ionization state of a disc wind and the emergent spectrum across multiple wavebands. I will also discuss our efforts to couple SIROCCO to the hydrodynamics code PLUTO, and how these radiation-hydrodynamic simulations can be used to study line-driven and thermal winds in CVs and X-ray binaries. Informed by these simulations, I will finish by conducting a brief tour of what I see as 5 key physics challenges we must address if we are to build a better understanding of the disc-wind connection in accreting compact binaries and other accreting sources such as Active Galactic Nuclei.

X-ray binary jet ejecta: A unique shock and particle acceleration laboratory

Poster

James Matthews
University of Oxford

Blast wave models are commonly used to model relativistic outflows from ultra-relativistic gamma-ray bursts (GRBs), but are also applied to lower Lorentz factor jet "ejections" from X-ray binaries (XRBs). We revisit the physics of blast waves and reverse shocks in these systems and explore the similarities and differences between the ultra-relativistic and moderately relativistic regimes. We show that reverse shocks are much longer-lived in XRBs and off-axis GRBs compared to on-axis GRBs. Reverse shock crossing should thus typically finish after 10-100 days (in the observer frame) in XRB ejections. This characteristic, together with their moderate Lorentz factors and spatially resolved core separations makes XRB ejections a unique laboratory for shock acceleration physics. Using new relativistic hydrodynamic simulations, we model the disruption of XRB ejecta and the dynamics of shock crossing in these systems, as well as showing that XRB jet ejecta are likely to be "PeVatron" particle accelerators. We show that identification of reverse shock signatures or lack of lateral spreading in XRBs could both provide new independent constraints on the Lorentz factor of the ejecta. Finally, we look to the future by presenting combined kinematic-radiative modelling of XRB jet ejecta, which allows us to identify a reverse shock signature in MAXI J1535-571 and obtain an improved energy estimate which is not degenerate with ISM density.

Talk

The dynamic link between the accretion disc, the X-ray corona and radio jets in black-hole binaries

Mariano Mendez

Kapteyn Astronomical Institute, University of Groningen

Black-hole X-ray binaries (BHXBs) undergo dramatic changes in their X-ray emission and jet activity as they accrete matter during outbursts. A key open question is how energy is distributed between the accretion disc, the hot X-ray corona, and the relativistic jets, and how jets are accelerated. Recent observations suggest that the corona and the jet may be fundamentally connected, with energy shifting between these components as the system evolves.In this talk, I will present results from a series of recent studies that explore this accretion-corona-jet coupling in multiple BHXBs, including GRS 1915+105, GX 339−4, Cyg X−1, MAXI J1348−630, MAXI J1535−571, MAXI J1820+070 and Swift J1727.84-1613.$Usingacombinationofspectral-$
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Poster

Optical spectroscopy of the transitional millisecond pulsar PSR J1023+0038

Marco Maria Messa

INAF-OAB, Merate

Transitional millisecond pulsars (tMSP) represent a dynamic category of celestial sources that establish a crucial connection between low-mass X-ray binaries and millisecond radio pulsars. These systems exhibit transitions from rotation-powered to accretion-powered states and vice versa, highlighting the tight evolutionary link expected by the so-called recycling scenario. In their active phase, these sources manifest two distinct emission modes named high and low occasionally punctuated by sporadic flares. In the talk I would like to present high-time resolution spectroscopic observations of the binary tMSP J1023+0038, in the sub-luminous disc state, showing evidence for a significant variability of the emission line properties over a timescale of minutes.

Jet modeling with ISHEM of the BH transient MAXI J1535-571

Talk

Carlotta Miceli
IASF/INAF Palermo

The multi-wavelength spectral energy distributions of low-mass X-ray binaries (LMXBs) in the hard state are thought to be determined by the emission from a jet (up to mid-infrared frequencies) and the emission from the accretion flow from optical to X-ray up to (possibly) the soft gamma-ray domain. In recent years, the flat radio-to-mid-IR spectra of black hole (BH) X-ray binaries have been described using the internal shocks model. This model assumes that the fluctuations in the velocity of the ejecta along the jet are driven by fluctuations in the accretion flow, as described by the X-ray Power Density Spectrum (PDS).In this work, we aim to apply an updated version of the internal shocks code for the ejection to a BH LMXB, specifically MAXI J1535-571. We used a multi-wavelength data set obtained during its outburst in 2017, comprising data from radio to gamma-ray. The old version of the code already allowed for changes in the geometry of the jet, accommodating non-conical jets, and took into account adiabatic cooling. The important change in the new version is the inclusion of the radiative cooling. We fit the spectral energy distribution (SED) of MAXI J1535 collected in different spectral states. Our results seem to favour a parabolic jet geometry over a conical one, unlike the results for other BHs analyzed previously, but similar to the findings for the only NS examined thus far.

Highlighting recent X-ray observations of magnetic cataclysmic variables

Talk

Kaya Mori
Columbia University

Magnetic cataclysmic variables (mCVs) are a class of highly magnetized interactive white dwarf (WD) binaries, categorized as intermediate polars (IPs) or polars. In mCVs, infalling gas is channeled along the WD magnetic field lines, forming an accretion column above the magnetic poles. A standoff shock forms above the WD surface, heating the gas and emitting copious thermal X-rays. Some of these primary X-rays may be reflected off the WD surface or accretion curtains, producing neutral Fe K lines and Compton scattering humps. X-ray observations of mCVs have a long history, dating back to the 1980s when the Einstein and Ginga observatories detected some of the brightest IPs and polars. As recognized in the 1970s, X-ray spectroscopy can be used for WD mass measurements, which are crucial for understanding the formation and evolution of mCVs. As demonstrated by XMM and NuSTAR observations of many IPs, broad-band X-ray data are essential to fully characterize the X-ray emission from mCVs and determine their WD masses accurately. After a brief historical review, I will highlight the latest X-ray observations of mCVs, mostly focused on polars. Studies of polars have been more challenging and conducted less frequently than IPs, as they are fainter and highly variable in the X-ray band. We utilize a combination of all-sky optical monitoring, Swift-XRT ToOs and Einstein Probe X-ray observatory data to enable timely X-ray observations of polars during their high accretion states. NuSTAR broadband X-ray spectra provide accurate WD mass measurements, whereas we can probe soft X-ray blackbody emission from the WD surface and long-sought X-ray QPOs with NICER data. Finally, I will present the most detailed Fe line data of AM Her, the prototypical polar, obtained with XRISM/Resolve, testing the conventional Fe line diagnostics for WD mass measurements. These high-quality X-ray data, combined with refined X-ray emission models for mCVs, will advance our fundamental understanding of how magnetically confined radiative cooling accretion flows emit X-rays.

Talk

State-of-the-art simulations of line-driven accretion disc winds

Amin Mosallanezhad

University of Southampton

Disc winds play a crucial role in many accreting astrophysical systems on all scales. In accreting white dwarfs (AWDs) and active galactic nuclei (AGN), one of the most promising mechanisms for driving these wind is radiation pressure acting on spectral lines. The efficiency of this line-driving mechanism is extremely sensitive to the ionization state of the flow. This sensitivity has been the major obstacle to the development of a reliable physical picture of line-driven disc winds via (radiation-) hydrodynamical (RHD) simulations. Recently, we present state-of-the-art numerical simulations based on realistic radiation hydrodynamics (RHD) calculations of line-driven disc winds. Our 2.5D RHD simulation includes a detailed treatment of the frequency-dependent radiative transfer through the wind, the corresponding ionization state, and the resulting radiative accelerations. Applying this method to AWDs, we find that it is much more difficult to power the outflows observed in this systems via line driving than previously thought. Physically, this is because the winds are much more prone to be over-ionized than suggested by quasi-1D treatments. The same issue also appears to affect AGN, where even moderate amounts of X-rays can over-ionize the outflow. This does not necessarily mean that line-driven winds are not viable. However, our work suggests that to arrive at a self-consistent model of line-driven disc winds, it will be critical to allow for a self-consistent treatment of radiative transfer and ionization in the next generation of hydrodynamic simulations.

The slow and fast jets from GRS 1915+105. A smoking gun for a new jet paradigm.

Talk

Sara E. Motta
INAF-OAB

Stellar-mass black holes in X-ray binaries are known to produce fast jets, with speeds ranging from mildly relativistic to superluminal, and Lorentz factors comparable to those seen in jets from supermassive black holes in Active Galactic Nuclei (AGNs). Recent studies have shown that jets from Galactic X-ray binaries (XRBs) can either precess and expand at mildly relativistic velocities or propagate in a fixed direction at very relativistic speeds, with the former being significantly slower than the latter. However, no system has exhibited both types of jets simultaneously until now.We present a large radio observing campaign, comprising data from 6 radio interferometers (e-MERLIN, VLBA, EVN, VLA, AMI, MeerKAT) we carried out the black hole X-ray binary GRS 1915+105, one of the best-studied Galactic X-ray sources, and the first to display superluminal jets within our galaxy. For over two decades, GRS 1915+105 consistently exhibited superluminal expanding jets, which ceased at the onset of a prolonged obscured phase in 2019. During this phase, only core activity persisted, marked by numerous and repeating bright flares in the radio band. Recently, the system exhibited extremely large radio flares, indicating the launch of new jets expanding to considerable distances from the core.We discovered that the subluminal jets from GRS 1915+105 were launched at projected angles inconsistent with those characterizing the superluminal jets observed before 2018. A different set of jets, launched at later times, expanded at significantly higher speeds along the same angle as the historical jets. This finding provides definitive evidence that X-ray binaries can launch two types of jets, either fast and in a fixed direction, or slow and precessing, confirming the new jet paradigm recently proposed by Fender & Motta.

Long-term photometric variability of magnetic cataclysmic variables from the Catalina Real-time Transient Survey

Poster

Mokhine Motsoaledi
University of Cape Town

Strongly magnetised cataclysmic variables without accretion discs, known as polars, transition between high and low states of mass transfer. Long-term light curves from the Catalina Real-time Transient Survey were used to characterise the long-term photometric behavioural patterns of polars into five groups that we identified. A set of criteria was developed to quantify these characterisations and systematically identify potential polars through their long-term light curves. We also carried out follow-up photometric and spectroscopic observations of polars with the 1-m and 1.9-m telescopes as well as the Southern African Large Telescope (SALT) at the South African Astronomical Observatory.

Talk

GRMHD simulations of accretion disks: QPOs, truncated disks and QPOs from truncated disks

Gibwa Musoke
Canadian Institute for Theoretical Astrophysics

Black hole X-ray binaries (BHXRBs) and Active Galactic Nuclei (AGN) transition through a series of accretion states in a well-defined order. The accretion states, each associated with different luminosities, spectral and variability characteristics, quasi periodic oscillations (QPOs) and outflow properties, are thought to be triggered by physical changes in the accretion disk around the central black hole. An initially hot and thick accretion disk is thought to transition into a transitional disk that has both a hot, thick and cool, thin component, before finally transitioning to a disk that is cool and thin. The mechanisms behind these disk transitions, the geometry of transitional disks and the physical mechanisms driving the emission characteristics we observe remain highly debated.General relativistic magneto-hydrodynamic simulations (GRMHD) are increasingly providing crucial insights into the accretion process, the launch of outflows and the physical processes driving state transitions in BHXRBs and AGN. Using GRMHD simulations conducted with the H-AMR code I: 1) Discuss how high and low-frequency QPOs can be produced by a highly tilted, geometrically thin accretion disk. 2) Present the first GRMHD simulation showing the self-consistent formation of a truncated accretion disk− a proposed disk model for the hard intermediate accretion state, in which the accretion flow is thick and hot close to the black hole, while the outer regions of the flow are thin and cool. 3) Describe how QPOs can be generated at the truncation radius (the radius at which the disk transitions from thick to thin) in a truncated accretion disk.

Talk

Recent development of the XILLVER reflection models

Edward Nathan
Caltech

The XILLVER X-ray reflection models are regularly used in the spectroscopic analysis of X-ray Binaries and AGN, either by direct use of the tables themselves or as part of more complicated models, such as RELXILL. Many varieties of XILLVER tables are public and in regular use, however development on of these models continues. I will outline recent and upcoming changes to these models, designed for the latest generation of X-ray telescopes (such as IXPE and XRISM), and improvements to the underlying physical calculations (accurate Compton scattering, and new atomic data).

Constraining the radial extent of the X-ray corona: a new relativistic reflection model and first application to ESO 033-G002

Poster

Alexey Nekrasov
Dr Remeis Observatory & ECAP, FAU

Relativistic X-ray reflection at the inner accretion disk has been observed in many black hole systems. Due to the vicinity of the black hole, strong gravity effects are imprinted in the observed spectrum, which allows the determination of characteristic parameters of the system such as the spin of the black hole and the location and size of the primary source of hard X-rays, often called the corona. The most simple and successful model that explains the majority of the observed spectra is the lamppost model, which assumes a point-like source on the rotational axis of the black hole. While being able to explain the observations, this geometric model does not allow to constrain the size of the corona. We extended the relativistic reflection model RELXILL, by implementing a radially extended, ring-like primary source, in a first step to enable modeling with general extended sources of the primary X-rays. This new model is applicable for both black hole binaries and active galactic nuclei. Applying this extended RELXILL model to XMM and NuSTAR data of the radio-quiet AGN ESO0033-G002, we constrain the radial extent of the corona to be less than two gravitational radii. Our results suggest that compact radially extended coronae can explain the observed relativistic reflection.

How do the accretion discs outburst in the WZ Sge-type stars?

Talk

Vitaly Neustroev
University of Oulu, Finland

It is widely accepted that dwarf nova outbursts observed in cataclysmic variables are caused by thermal instability developing in the accretion disc which switches the disc from a low-viscosity to a high-viscosity regime. This idea is encapsulated in the so-called disk instability model (DIM) commonly used to explain how outbursts start and end. Dwarf novae of the WZ Sge-type compose an extreme subgroup, which show very rare (approximately once a decade), large-amplitude (up to 9-10 mag) superoutbursts lasting for a few weeks, while normal (lower amplitude and shorter duration) outbursts are extremely sporadic or not observed at all. Despite its success in explaining and predicting many features of normal outbursts, the DIM fails to reproduce some of the fundamental properties of superoutbursts in the WZ Sge-type stars. To explain the large amplitude, long recurrence time, and the long duration of the superoutbursts, the DIM requires extremely low viscosity in the quiescent disc, the physical reason for which is not known, and/or the inner disc should be sufficiently truncated. Moreover, the superoutbursts in WZ Sge-type systems have to be triggered by an enhanced mass transfer from the companion, which should be kept during the superoutburst.Here I will report the results of the study of a sample of WZ Sge-type objects in deep quiescence and/or just before their superoutbursts. I will show that the mass-transfer rate in these objects is at least an order of magnitude lower than was considered earlier (a few$\times 10^{13}$ vs 10^{15} g s^{-1}), and that no evidence for the enhanced mass transfer rate just before the superoutburst was detected in most of them.

Talk

BlackGEM's Orphaned Binaries

John Paice
University of Durham

Explosive transients like Cataclysmic Variables and Low-Mass X-ray Binaries can leap several magnitudes in brightness during their frequent outbursts. Many of the more famous and well-studied transients reach around 15th magnitude and beyond, high above their 20th magnitude quiescent counterparts. But what if we went fainter?There are a hidden population of transients that are too far away to be seen by most of our surveys in their quiescent state, save for when their outbursts catapult them into a detectable range and a new, faint star appears in our sky. Here is where BlackGEM, a new optical telescope at La Silla, Chile, has proved valuable; its continuous sky-scanning work, reaching below 20th magnitude, is able to capture these distant, unknown objects at the peak of their luminosity, before they fall back into obscurity.In this talk, I will present the result of several months of BlackGEM monitoring of these 'hostless' or 'orphaned' transients. I will go over those that have been discovered so far, what a combination of monitoring telescopes, sky surveys, and spectra can tell us about them, and what these results mean for the population in general.

Poster

The persistent nature of the Be X-ray binary pulsar 4U 0728-25

Nicola La Palombara
INAF

The persistent BeXRBs are a peculiar class of HMXRBs, which are characterized by persistent low X-ray luminosities ($L_{\rm X} \sim 10^{34}$ erg s^{-1}) and wide ($P_{\rm orb} > 30$ d), almost circular orbits. In these sources the NS is slowly rotating (with $P_{\rm spin}$ well above 100 s) and accretes matter directly from the wind of the companion Be star, without the formation of an accretion disk.Very recently the X-ray binary pulsar 4U 0728-25 has been identified as a new member of this class of sources. Since the '70s, this source was detected several times at an almost constant X-ray flux over long timescales. While its timing properties were well constrained, the spectral ones remained poorly known, in spite of the observations performed with various telescopes.Here we report the report the results obtained with a recent XMM-Newton observation of this source, which allowed us to investigate its spetrum at an unprecedented detail level. We found that it is characterized by a significant thermal excess over the main power-law component, which can be described with a blackbody model of high temperature ($kT_{\rm bb} \simeq 1.5$ keV) and reduced size ($R_{\rm bb} \simeq 240$ m), contributing for about 25 % to the total source flux. The estimated luminosity was about 9×10^{34} erg s^{-1}.These spectral properties, together with the long spin ($P_{\rm spin} = 103.3$ s) and orbital ($P_{\rm orb} = 34.5$ d) periods, strongly suggest that 4U 0728-25 is a new member of the persistent BeXRBs.

AGN are not that boring anymore

Talk

Francesca Panessa

INAF

I will discuss recent findings in AGN, highlighting new classes of sources showing extreme cases of variability, changing look behaviour and tidal distruption like events. Such variability properties at different wavebands can make AGN look interesting also at the eyes of compact stellar objects people.

First XRISM results for BHLMXB outflows and the way forward

Talk

Maxime Parra

Ehime University

The first year and a half of XRISM science has led to a select number of observations of Black Hole Low Mass X-ray Binaries, most of which in very unusual states. We will discuss notably:-the complex time-dependent absorbers in a low luminosity soft state of 4U 1630-47.-the many faint emission lines seen in an extremely faint obscured state of V4641 Sgr, complemented with optical spectroscopy.-preliminary results of a campaign on IGR J17091-3624.We shall also give an overview of the most critical outflow-related science cases that remain, when considering ALL the sources and states that have been observed by the instrument until now, as well as accepted programs.

Talk

The binary system CD-30°11223, a new piece in the intriguing puzzle of SNe Ia progenitors

Luciano Piersanti
INAF-Osservatorio Astronomico d'Abruzzo

Recently, several binary systems made by a CO WD and a sdB companion burning He at the center have been fully characterized. Their orbital parameter are such that the two components are expected to come into contact in the next future. It has been suggested that, due to the mass deposition, the CO WD could develop a thermonuclear explosion resulting in a low-luminosity, low-energy SNe Ia. We will review the evolutionary scenario for this class of object by studying the future evolution of the case study CD-30°11223. By using the FUNs evolutionary code, we follow the future evolution of both the components in the binary systems and, by accounting for the effects of rotation on the physical and chemical properties of the accretor, we analyze in detail the mass accretion phase onto the CO WD. Basing on our results, we will address the potential of these objects as progenitors of thermonuclear events.

Talk

Accretion and ejection in ultra-luminous X-ray sources

Ciro Pinto
INAF - IASF Palermo

Most stars in galaxies are found in binaries, many of which are interacting systems, with matter transferring from the companion to the compact object. The transferred matter forms an accretion disc where friction heats it and makes it shine throughout the whole electromagnetic band, often peaking in X-rays. The brightest among them are the ultraluminous X-ray sources (ULXs), which reach luminosities of several hundred times the Eddington limit of a neutron star. The discovery of pulsations, winds and extremely soft X-ray spectra suggests that most ULXs in nearby galaxies are powered by neutron stars and stellar-mass black holes accreting well beyond Eddington. ULX winds appear to blow up to 30% of the speed of light. Therefore, they carry a huge amount of power, may regulate matter accretion onto the compact objects and are most likely the engine inflating the 100 pc superbubbles observed around many ULXs. Several fundamental questions still remain open on the nature of the spectral transitions, the fractions of black holes versus neutron stars, the structure of the winds and the net accretion rate onto the compact object. Here, I will provide an overview of the ULXs research field, highlight some recent results and show how future missions, and in particular, NewAthena will revolutionise the way we study ULXs.

Making order in the caos of highly variable ultraluminous X-ray sources

Talk

Fabio Pintore
INAF/IASF Palermo

Ultraluminous X-ray sources (ULXs) are accreting compact objects in binary systems, with isotropic X-ray luminosities well above 10^{39} erg s^{-1}. An unexpected population of pulsating ULX (PULX) has popped-up in the last decade, indicating uniquely the existence of extreme super-Eddington accreting neutron stars and challenging our knowledge of the accretion processes. The hunt for new PULXs is key to understand the physical mechanisms in play at super-Eddington rates. Pulsations in PULXs are transient, therefore other neutron stars in ULXs could be undiscovered yet. In case of a lack of pulsations, one approach to identify new candidate PULXs is to look for PULX-like spectral and temporal properties amongst the ULX population. The vast majority of ULXs show marked flux changes over time. However, a limited number of them, which include PULXs as well, present extremely high variability (orders of magnitude) on both short and long timescales, whose origin is still debated.In this talk, we investigate the properties of the ULXs in the galaxies NGC 4559 and NGC 7456. {\{}it Swift/XRT} and {\{}it XMM-Newton} observations shed light on their highly variable nature, with marked spectral changes and intriguing flaring activity, the latter not very common amongst ULXs. For one ULX, spectrally very hard, we found a hint of pulsation in two, well separated in time, XMM-Newton observations.We will discuss the properties of this ULX sample in the context of super-Eddington accretion, trying to discriminate amongst neutron star or black hole compact objects hosted in these sources.

Semi-coherent analyses: a new tool for EM pulsation searches

Talk

Riccardo La Placa
INAF - Osservatorio Astronomico di Roma

Timing neutron star systems is crucial to follow the evolution of binary and the interplay between the two objects, test strong-field general relativity, and study the neutron star itself. Following in the footsteps of the continuous gravitational wave community, we implemented a semi-coherent algorithm for searches of coherent pulsations in binary systems, especially those for which standard blind searches would prove computationally unfeasible. I will explain the main workflow of the technique and show our first results in the application of semi-coherent searches to optical data low mass X-ray binaries and spider systems.

Poster

Charting CVs in eROSITA sky: A Machine Learning and Bayesian Framework for CV identification and characterization in all-sky X-ray surveys.

Kala G Pradeep

Leibniz Institute for Astrophysics, Potsdam (AIP)

Cataclysmic Variables (CVs) are unparalleled laboratories for studying accretion physics and binary evolution. Historically, all sky X-ray surveys have revolutionized the discovery of CVs, with ROSAT expanding the known population dramatically. eROSITA, on-board Spektrum-Roentgen-Gamma (SRG) advances this legacy with its multiple all-sky surveys. With each scan five times deeper than ROSAT, eROSITA offers an unprecedented spatial and spectral resolution. Thousands of CVs across sub-types are forecasted in the eROSITA sky, promising the largest, unbiased sample of CVs to date. A key challenge, however, lies in robustly identifying the CV content in all-sky X-ray surveys such as eROSITA. We present a machine learning-enhanced Bayesian framework for the accurate identification, cross-matching, and characterization of CVs in eROSITA data and discuss the preliminary results of itsimplementation on the deepest eROSITA catalogue, eRASS:5. Early results demonstrate a pure and complete sample of CVs, recovering known systems and predicting thousands of new candidates. This framework enables volume-limited studies with GAIA, critical for constraining the space densities and luminosity functions of CVs. We discuss synergies with optical follow-up programs and the prospects for probing unresolved questions in CV evolution and their contribution to the Galactic Ridge X-ray emission. The eROSITA sample of CVs thus sets the stage for a giant leap in our understanding of these exotic systems in particular and accreting compact binaries in general.

Poster

Evolution of the Comptonizing medium of the black-hole candidate Swift J1727.8−1613 along the accretion state transition using NICER

Divya Rawat

Observatoire astronomique de Strasbourg, France

We investigate the properties of the Comptonizing medium in Swift J1727.8−1613 using the time-dependent Comptonization model vkompth, with NICER observations of type-C QPOs in the hard and hard-intermediate states. By simultaneously fitting the time-averaged spectrum of the source and the rms and lag spectra of the QPO (which evolves from 0.3 Hz to 7 Hz), we derive the evolution of the disk and corona parameters. Initially, the inner radius of the accretion disk is truncated at $\sim 30 - 40\ R_g$ (assuming a 10 solar-mass black hole) and, as the QPO frequency increases, the truncation radius decreases down to 10 R_g. Our results suggest that the observed rms and lag spectra are consistent with presence of two coronas, varying in size from $\sim 2 \times 10^4$ km to 10^3 km, extending over the disk and illuminated by distinct disk regions. We interpret the evolution of the coronal size in the context

of accompanying radio observations with VLITE and RATAN-600, discussing its implications for the interplay between the corona and the jet.

Indications of magnetic accretion in Swift J0826.2−7033

Poster

Nikita Rawat

South African Astronomical Observatory (SAAO)

Intermediate polars (IPs) represent a subclass of magnetic cataclysmic variables where the low magnetic field strength (B $\sim$1-10 MG) white dwarf (WD) accretes material from a Roche lobe filling secondary star. IPs are asynchronous systems where the spin period of WD differs from the orbital period at least by 10%. We present our findings from the first long X-ray observation of the hard X-ray source Swift J0826.2-7033 with *XMM-Newton*, which has shown characteristics of magnetic accretion. The time variability on diverse timescales and characteristic features in the X-ray spectrum could be easily reconciled with a magnetic CV. Additionally, the presence of suprasolar abundances, with hints of an evolved donor, collectively suggests that Swift J0826.2-7033 likely underwent a thermal timescale mass transfer phase, making it an interesting target for further study.

NEBULA-Xplorer: an X-ray timing small satellite concept for long term x-ray timing monitoring

Talk

Benjamin Ricketts

SRON and University of Amsterdam

As many X-ray telescopes reach the end of their mission lifetime, we have begun planning the next generation of smaller X-ray missions before the launch of larger missions like Athena. While the focus is often still on increasing the effective area and/or spectral resolution, I argue the case for a smaller-scale X-ray timing mission. NEBULA-Xplorer fits a niche that currently remains unfilled by larger, more expensive missions: long term continuous X-ray timing monitoring necessary to reliably observe transient behaviour in X-ray binary outbursts such as jet ejections in the state transition. This is currently unfeasible due to the economic cost of the long exposure times required to reliably capture these phenomena. I will briefly discuss the conceptual instrument and operational design for the mission, before outlining the main science objectives of the mission.

Talk

Sporadic radio pulses from a white dwarf binary at the orbital period

Iris de Ruiter
University of Sydney

Recent observations have revealed rare, previously unknown flashes of cosmic radio waves lasting from milliseconds to minutes, and with periodicity of minutes to an hour. These sources are dubbed long-period transients (LPTs) owing to their unusually long-periods. These transient radio signals must originate from sources in the Milky Way, and from coherent emission processes in astrophysical plasma. They are theorized to be produced in the extreme and highly magnetised environments around white dwarfs or neutron stars. However, the astrophysical origin of these signals remains contested, and multiple progenitor models may be needed to explain their diverse properties. In this talk I will present the discovery of a transient radio source, ILT\{},J1101 + 5521, whose roughly minute-long pulses arrive with a periodicity of 125.5 minutes. We find that ILT\{},J1101 + 5521 is an M dwarf − white dwarf binary system with an orbital period that matches the period of the radio pulses, which are observed when the two stars are in conjunction. The binary nature of ILT\{},J1101 + 5521 establishes that some long-period radio transients originate from orbital motion modulating the observed emission, as opposed to an isolated rotating star. ILT\{},J1101 + 5521 is likely a polar system where magnetic interaction has synchronised the rotational and orbital periods of the white dwarf. I will discuss the possible accretion scenarios for this type of system, and how a potential accretion flow ties in with the observed radio emission.

Talk

Witnessing the onset of a black hole outburst

Dave Russell
New York University Abu Dhabi

X-ray transients have been studied for sixty years, and represent the brightest class of X-ray sources seen from Earth. The cause of these X-ray brightenings is the sudden increase of accretion of matter onto a black hole or neutron star. Models predict a delay between the hydrogen ionization front sweeping through the accretion disc, and the onset of accretion onto the black hole. However, the early stages of outbursts are usually missed altogether, and the process that triggers the onset of an X-ray outburst has remained unconstrained observationally. Here, we report optical and X-ray monitoring of the early rise of the black hole X-ray binary, Swift J1753.5-0127, from the quiescent level. A delay is measured between a thermal instability developing in the accretion disc, causing heating fronts to begin propagating through the disc (seen by an optical brightening), and the onset of accretion onto the black hole (a delayed X-ray brightening). We witness the propagation of the heating wave, as a steady increase in the flux and surface area of the disc, and we constrain the ignition radius and the disc viscosity. We conclude that X-ray transient outbursts are indeed caused by a heating front of ionized hydrogen in the disc,

which propagates to the inner regions. This has implications for the switching on of AGN, and tidal disruption events. I demonstrate the ability of optical monitoring to be able to provide a few days (sometimes weeks) lead time to the rise of X-ray transient outbursts.

The Hunting of Ultra-Compact X-ray Binaries

Poster

Enzo A. Saavedra
Instituto de Astrofísica de Canarias

Ultra-compact low-mass X-ray binaries (UCXBs) are a unique class of X-ray binaries characterized by orbital periods of less than 80 minutes. These extreme systems have Roche lobes so compact that they can only accommodate degenerate, hydrogen-poor donor stars, distinguishing them from the classical low mass X-ray binaries. UCXBs offer unique opportunities to probe accretion physics in hydrogen-poor environments and to constrain critical phases of binary evolution. They are also expected to be primary targets for the detection of low-frequency gravitational waves with the upcoming Laser Interferometer Space Antenna (LISA) mission. We report on efforts to expand the limited population of UCXBs by identifying new candidate systems and, more importantly, confirming their compact nature; an inherently challenging task due to the difficulty of measuring their extremely short orbital periods. To achieve this, we are using a multi-wavelength approach that combines X-ray spectral analysis and optical photometry.

Variability as a tool to investigate ULX nature

Poster

Chiara Salvaggio
INAF-OAB

Ultraluminous X-ray sources (ULXs) are accreting compact objects in binary systems, powered through super-Eddington accretion. The details of the accretion physics and the demography of the ULX population are still unknown. After the discovery of pulsations in the X-ray emission of M82 X-2, it was clear that at least a fraction of ULXs host a neutron star (NS). Only six pulsating ULXs (PULX), with sustained super-Eddington accretion, have been confirmed. Due to the lack of methods for finding a black hole (BH) in a ULX and the difficulty in identifying pulsations, it is important to find alternative methods to determine the ULX demography. PULXs have shown common properties in their spectral-timing behavior, in particular in the long-term evolution. I will show a long-term study of ULXs, aimed at characterizing their long-term variability properties, fundamental to understanding the accretion cycle and to select candidate NSs.

Talk

The ultra-fast outflow in MAXI J1810-222

Melania Del Santo
INAF/IASF Palermo

The X-ray transient MAXI J1810-222 was discovered by MAXI in 2018 and has been active ever since. A long, combined radio and X-ray monitoring campaign was performed with ATCA and Swift, respectively. It has been identified as a black hole candidate, even though the highly unusual outburst behaviour and the absence of information regarding the distance or the donor leaves the nature of the compact object open to ongoing debate. We detected a strong spectral absorption feature at 1 keV with NICER which was described with a physical photoionization model. Through a deep scan of the parameters space, we found evidence for a spectral-state dependent outflow, with mildly relativistic speeds at 0.05-0.15 c. This finding would make MAXI J1810-222 the first X-ray binary where ultra-fast outflows have been detected at such high speeds. This is unlikely from classical thermal winds in Galactic X-ray binary and must involve either strong radiation or (most likely) a magnetically-driven wind.Motivated by these findings, we obtained a high quality XMM-Newton observation which was performed end of 2023, in order to deeply investigate the nature of this absorption feature. I will present the first exciting results of this observation which placed stronger constraints on the UFO thanks to the aid of the high-resolution RGS spectrometer.

Talk

The eROSITA CV X-ray sky

Axel Schwope
AIP

SRG/eROSITA has discovered about 3 million X-ray sources during its X-ray all-sky surveys. The talk will summarize the main eROSITA results on accreting compact white-dwarf binaries, aka CVs. We will give an account on the X-ray properties of known CVs across the 4.4 complete surveys, highlight a few new discoveries and describe elements of the X-ray and optical follow-up program. Details are given in other contributions to this conference. On the long run, the new eROSITA samples will be used to tackle open questions on CV evolution (fraction of magnetic versus non-magnetic objects, frequency of period bouncers, strength of magnetic braking) and to synthesize the Galactic Ridge X-ray Emission.

The Role of Triples on Accreting Binary Populations: A Combined Observational and Theoretical Approach

Talk

Cheyanne Shariat

California Institute of Technology

Accreting compact object binaries – such as cataclysmic variables (CVs) and black hole low-mass X-ray binaries (BH-LMXBs) – are traditionally modeled as isolated binaries. However, many originate in hierarchical triples, where a distant tertiary can fundamentally alter their evolution through the eccentric Kozai-Lidov (EKL) mechanism. By combining Gaia astrometry with detailed three-body simulations, we investigate the role of triple dynamics in shaping these systems.For both BH-LMXBs and CVs, we find that a significant fraction of their progenitors began as wide (10-1000 au) binaries in triples. Secular EKL torques from the tertiary drive the inner binary to high eccentricities until tides shrink the orbit and mass transfer begins, oftentimes avoiding a common envelope stage altogether. In the case of BH-LMXBs, the triple channel can produce a population consistent with Galactic BH-LMXBs and, together with observations, suggests that some black holes receive negligible (¡5 km/s) natal kicks. We also construct a catalog of 50 CVs in hierarchical triples and show that triple evolution enhances their formation efficiency by introducing novel formation routes. Our work highlights the crucial role of triples in shaping accreting binary populations across different mass scales. Moreover, it demonstrates the power of combining Gaia observations with detailed simulations to reshape our understanding of stellar evolution in dynamical environments.

A review on high-mass X-ray binaries: from X-rays to radio wavelengths

Talk

Lara Sidoli

INAF IASF-Milano

I will review the most recent results obtained in the field of high mass X-ray binaries hosting a neutron star in accretion from the wind of an O- or B-type supergiant companion. I will outline some new discoveries performed in X-rays, with new source behaviors and new members of the class, especially for what concerns the population of transient sources (the so-called Supergiant Fast X-ray Transients). Then, I will discuss the recent observations we have obtained for the first time at mm- and radio wavelengths, aimed at measuring the properties of the supergiant companion (i.e. the wind mass loss rate), crucial to calculate the accretion rate onto the compact object.

Talk

Powerful outflows from a mysterious point-like source in NGC 5408

Roberto Soria

INAF-OATo (Turin)

There is a mysterious point-like source in the dwarf galaxy NGC 5408. It is the strongest compact radio source in that galaxy (5-GHz flux density of ≈2 mJy, corresponding to a luminosity of $\approx 3 \times 10^{35}$ erg s^{-1}). Photo-ionized narrow optical lines suggest an intrinsic X-ray luminosity of several times 10^{40} erg s^{-1} (mostly blocked from our view). At the same time, broad Balmer and HeI lines imply a dense, powerful and highly variable outflow with speeds of up to 5,000 km s^{-1}. If it is a stellar-mass accretor in a super-Eddington regime, its multiband properties, and in particular its optical spectra, are unlike any previously known ULX. We speculate that it is going through a short-lived evolutionary phase of its massive donor star, but we cannot yet rule out alternative scenarios such as an intermediate mass black hole.

Talk

Past evolution and final fate of symbiotic binaries

Oscar Straniero

INAF-Osservatorio Astronomico d'Abruzzo

Symbiotic binaries hosting a giant approaching the RGB tip (the donor) and a compact companion (WD or NS, the accretor) may be the result of a common envelope episode occurred when an intermediate-mass star ($3-9M_\odot$), once evolved up to the AGB, fills for the first time its Roche lobe. The observational counterparts of these systems may be recurrent or classical Novae, or low-mass X-ray binaries. It has been also estimated that these binaries may account for the 10% of the SNe Ia progenitors. The cases of IGR J16194 2810 (a X-ray binary) and T CrB (a recurrent Nova) will be discussed. Thanks to the availability of accurate stellar and orbital parameters, we will show how to constrain the past and the future evolution of these systems.

Model atmospheres of hot white dwarfs as a tool for super-soft X-ray sources investigations

Talk

Valery Suleimanov
University of Tuebingen, Germany

We present new sets of LTE model atmospheres of hot white dwarfs (WDs) computed for extended numbers of input parameters, namely effective temperature, surface gravity, and chemical composition.The model atmosphere grids were computed for solar chemical composition, and for chemical compositions corresponding to the Large and Small Magellanic Clouds. The new model spectra were used for investigation of the classical super-soft sources CAL 83 and RX J0513.9-6951 (RX J0513) in the Large Magellanic Cloud by fitting Chandra and XMM-Newton grating spectra of these objects. We found that the obtained parameters of CAL 83 ($T_{\rm eff}$ about 560\{},kK, $\log g$ about 8.6 - 8.7, WD mass in the range 1.1-1.4 solar masses) are almost identical to the parameters obtained using non-LTE model atmospheres by Lanz et al. 2005. During the considered observation CAL 83 was below the stable thermonuclear burning strip in the $T_{\rm eff} - \log g$ plane. Grating observations RX J0513 are more numerous, and we found evolution of this source in accordance with a model track of a WD with 1.05-1.15 solar masses in the $T_{\rm eff} - \log g$ plane. The effective temperature changes within the range $540-62$\{},kK, and $\log g$ within 8.1-8.7. For most observations, RX J0513 is situated in the stable burning strip. We have established that the optical brightness of the source is inversely proportional to its luminosity and the radius of the photosphere and proposed a toy model explaining this fact.

A disc wind origin for optical spectra of outbursting dwarf novae

Talk

Yusuke Tampo
South African Astronomical Observatory / University of Cape Town

Cataclysmic variables (CVs) are close binaries hosting an accreting primary white dwarf. Many high-state CVs exhibit disc wind signatures in their ultraviolet (UV) spectra. However, the impact of these outflows on optical spectra remains poorly understood. We report on our optical spectroscopic observations of so-called WZ Sge-type dwarf novae in outburst. Although many WZ Sge stars show absorption/emission line features consistent with an optically-thick accretion disk, we found that the spectra of V455 And and MASTER OT J030227.28+191754.5 are dominated by notably strong emission lines of Balmer and He II series. Based on their line cores being narrower than expected for lines formed in a Keplerian disk and the lack of detectable radial velocities in these narrow emission components, we propose that vertically-extended disc winds can naturally explain these optical emission lines.We also find that disc wind models similar to those used to describe UV observations can reproduce this type of optical spectrum, but only if the wind is clumpy and/or highly mass-loaded. The spectral evolution throughout their outbursts, with decreasing line equivalent widths and increasing line peak separations, can be described with the same wind models simply by lowering the accretion and mass-loss rates.Overall, since these two systems reached a bright outburst maximum requiring $\geq 10^{19}$ g s^{-1} accretion rate in the standard disk model, intrinsically bright dwarf nova outbursts can be an excellent laboratory to study disk winds even in optical wavelength.

Talk

The highest column disk wind in GX 13+1 by XRISM

Ryota Tomaru
Osaka University

he XRISM satellite observed the neutron star low-mass X-ray binary GX 13+1 in the PV phase, and high-resolution X-ray spectroscopic data by micro calorimeters show numerous blue-shifted absorption lines from He- and H-like ions and an absorption edge structure from He-like iron. The absorber can be described by a high column, high-ionisation, high-velocity (∼600 km/s) component and an even higher column, lower-ionisation, lower-velocity (∼300 km/s) component. This analysis suggests that the column is optically thick, and the intrinsic luminosity of the central source is above the Eddington luminosity. Despite this, the outflow is slow, showing that the gas is launched only from large radii of the disk. This result presents a challenge to our understanding of winds from supercritical accretion flows.

Poster

CSoft X-ray emission from the classical nova AT 2018bej

Andrey Tavleev
Institut fur Astronomie und Astrophysik, (IAAT), Universitat Tubingen

Classical novae are known to demonstrate a supersoft X-ray source (SSS) state following outbursts. This state is associated with residual thermonuclear burning on the white dwarf (WD) surface. We performed a spectral analysis of the supersoft X-ray phase of the classical nova AT 2018bej, which was observed in X-rays by the eROSITA and XMM-Newton telescopes. To describe the spectrum we calculated high-gravity hot LTE model atmospheres of hot WDs with different chemical compositions, assuming equal hydrogen and helium number fractions, and five different values of carbon and nitrogen abundances. The code developed by Suleimanov et al. (2024) was used for this aim. The 0.3-0.6 keV analysis yields a WD temperature Teff 600kK, gravity logg 8.3—8.4, and a WD radius R 8000–8700km, which gives luminosity L 6-6.5e37 erg/s. The derived WD mass is estimated to be 1.1Msun. We traced a minor evolution of the source on a half-year timescale accompanied by a decrease in carbon abundance, decrease in temperature and increase in radius, and concluded that LTE model atmospheres can be used to analyse the available X-ray spectra of classical novae during their SSS state.

Exploring the Evolution of Boundary Layers in Accreting Systems

Talk

Samuel Turner
DAMTP, University of Cambridge

Accretion onto objects such as stars which possess a material surface and are only weakly magnetised, must proceed through a boundary layer (BL) between the disc and the stellar surface, a scenario expected for CVs, FUOrs and accreting giant planets. When passing through this BL, accreting material must rapidly lose angular momentum, transitioning from near Keplerian in the disc to essentially zero in the star. Due to the positive angular velocity gradient, the MRI is unable to operate in the BL, and so a different mechanism must be responsible for driving accretion. Recent work has demonstrated that acoustic modes excited by the supersonic shear can drive accretion in this region. We will present results from a new suite of 2D and 3D simulations, exploring the exact nature and efficiency of this process, and its impact on the long-term evolution of these systems. Wave driven accretion in the BL is known to be bursty, and we will discuss the effect these bursts have on the structure of the BL and the wider system. In contrast to previous work which used a globally isothermal equation of state, including (unphysically) within the star, we will show that the stellar structure affects not only the variety of acoustic modes that are excited, but also the magnitude of accretion and angular momentum transport within the BL. We will conclude by setting these results in a wider context, referencing both the long-term evolution of these systems and interpretation of observations.

Mini-HAWKs: A pilot survey designed to discover new quiescent black holes

Poster

Sara Navarro Umpiérrez
Instituto de Astrofísica de Canarias

In this talk, I present Mini-HAWKs, a pilot photometric survey of 50 sqr deg in the Galactic Plane with 400 h of guaranteed time, being carried out on the JAST80 telescope at the Observatorio de Javalambre. Mini-HAWKs uses 3 interference filters centered on H-alpha with passbands of 35 Å, 150 Å, and 350 Å. Flux ratios measured with these filters allow recovering the FWHM and EWs of H-alpha lines. The survey exploits the FWHM of H-alpha emission as a proxy for gravitational fields around compact objects, allowing us to deduce the mass function of the system. Potential black holes can be identified by the presence of very broad (FWHM¿ 2200 km/s) H-alpha emission, caused by gas acceleration in their deep gravitational fields. The method has been validated in the field of M71, where we were able to estimate the FWHM of two known Cataclysmic Variables using the color-color diagram of our narrow filters: RATS and Do Vul, both with FWHM 1600Km/s. In fact, the Mini-HAWK strategy is promising not only for the detection of new black holes but also for the identification of various interesting stellar populations, such as CVs.

Talk

Understanding Accretion through Optical Variability of Accreting White Dwarfs

Martina Veresvarska
Durham University

Accreting white dwarfs (AWDs) offer a unique opportunity to study accretion physics, exhibiting variability from aperiodic flickering to quasi-periodic oscillations (QPOs). Their rapid variability and evolution make them ideal for exploring the scale-invariant nature of accretion, linking them to systems like X-ray binaries (XRBs) with neutron stars and black holes, as well as active galactic nuclei (AGN).AWDs primarily vary in the optical, making them excellent targets for modern space missions like Kepler and TESS. I will show how optical flickering and broad-band variability reveal accretion geometry, both near the accretor and at the disc's outer edges. Using models such as the propagating accretion rate fluctuations model, which are well established for AGN and XRBs, I will demonstrate how these techniques provide new insights into accretion dynamics. Additionally, I will highlight the fundamental variability plane of accretion, which unifies variability properties across different accreting systems. I will also present the discovery of a new class of strong optical QPOs in AWDs. These QPOs, resemble those in XRBs and are best explained by magnetically driven disc precession. Their detection establishes a direct link between AWDs and X-ray binaries. Broad-band variability and these newly identified QPOs, observed with TESS, offer critical insights into accretion across vastly different scales. As new fast-cadence optical missions like PLATO emerge, AWDs will continue to play a crucial role in understanding accretion physics.

Talk

Multi-wavelength jet variability in Low mass X-ray Binaries

Federico Vincentelli
IAPS-INAF

Jets are powerful, collimated outflows in which matter is accelerated up to fractions of the speed of light. The formation of these outflows is tightly connected to accretion, and play a key role in the evolution of their hosting systems. Galactic binaries, thanks to their high luminosity, their frequent outbursts are ideal laboratories to study this astrophysical component. Recent advancement in time domain astronomy using optical/infrared and radio telescopes, have allowed to study in much more details how jets vary and evolve on very short timescales.In this talk I will review the recent results regarding multi-wavelength variability studies of both black holes and neutron stars. Finally I will discuss what are the future direction of this exciting field in the near future.

MeerKAT radio observations of Cataclysmic Variables and White Dwarf pulsars

Talk

Patrick Woudt

University of Cape Town

The Square Kilometre Array (SKA) is currently under construction in South Africa and Australia. The precursor of the mid-frequency component of the SKA - the MeerKAT radio telescope array - has been in operation in South Africa since 2018 and has been used extensively to study accretion-induced outflows in X-ray binaries and Cataclysmic Variables at unprecedented sensitivity as part of a large survey project on radio transients. In this talk I will present an overview of the main results of the MeerKAT observations of Cataclysmic Variables and closely related objects (including White Dwarf pulsars) and look ahead at how the SKA can further transform our understanding of the radio emission in these compact binaries.

Evidence for enhanced mass transfer in the disc preceding the transition to the soft state in MAXI J1820+070

Talk

Pengcheng Yang

Kapteyn Astronomical Institute, University of Groningen

We investigate the 2018 main outburst and the following mini-outbursts of black hole low-mass X-ray binary MAXI J1820+070 using optical/ultraviolet data from the Las Cumbres Observatory (LCO) and American Association of Variable Star Observers (AAVSO) and Swift/UVOT, as well as X-ray data from HXMT and Swift/XRT. We find a several-day-wide broad dip-like profile in both the optical and X-ray light curves preceding the transition to the soft state, with the X-ray dip lagging the optical dip by 10 days. We discuss the potential mechanisms responsible for the formation of the dips and propose that the dip is caused by a brief decrease followed by an increase in the mass accretion rate as it moves through the disc, consequently leading to the transition to the soft state. We find optical colour $(g' - i')$ bluer and become more stable just before the transition to soft state, preceding a dramatic change in the hardness ratio. This might be a potential tool to predict impending hard-to-soft state transitions, although few sources exhibit such a dip. Additionally, we observe a decline in the low-frequency X-ray variability before entering the hard-to-soft state transition, which indicates that the state transition might be driven by a decrease of the turbulence in the outer thin disc. Finally, we discuss the implications of the complex evolution of optical/X-ray correlation during both outbursts and mini-outbursts.

Talk

Flash: A New Survey and Follow-up Telescope Covering the Southern Sky at 1-second Cadences

Bret Yotti
University of Cape Town

Flash is a new telescope being commissioned at the University of Cape Town to later be permanently installed at the South African Astronomical Observatory's site in Sutherland, Northern Cape. This telescope will have two running modes, both utilizing CMOS technology to image at 1-second cadences. Survey mode will scan the full sky using SDSS filters going as deep as 17.7 magnitudes and covering the visible sky in as little as 1 hour. Staring mode will follow up on transient sources such as fast-radio bursts and gravitational wave events, searching for optical counterparts. The telescope should be commissioned in late 2025, moving to its permanent site in 2026.

Talk

What are the spins of stellar-mass black holes?

Andrzej Zdziarski
N. Copernicus Astronomical Center

In recent years, spins of merging black holes have been relatively accurately measured based on their gravitational-wave signals. Their are generally low, with the estimated average effective spin parameter as low as 0.06. On the other hand, spins of many accreting black-hole binaries have been measured to be high, some close to the maximum spin parameter of 1, e.g. greater than 0.9985 at 3 sigma in Cyg X-1. I will present our recent results regarding this discrepancy. In particular, I will discuss possible systematic effects affecting the spin measurements in accreting systems and whether they can be reconciled with those based on mergers.

Talk

Einstein Probe: a new perspective on the transient X-ray Universe

Francesco Coti Zelati
Institute of Space Sciences (ICE, CSIC)

The launch of the Einstein Probe mission in January 2024 has marked a significant leap forward in our exploration of the transient X-ray Universe. Led by the Chinese Academy of Sciences and in collaboration with the European Space Agency, the Max Planck Institute for Extraterrestrial Physics, and the French space agency, the mission carries two instruments: the Wide-field X-ray Telescope, which employs state-of-the-art lobster-eye Micro-Pore Optics for the discovery of new transient phenomena, and the Follow-up X-ray Telescope, optimized for sensitive follow-up observations of these events. To maximize scientific return, the Einstein Probe consortium has been organized into six independent science topical panels. In this talk, I will detail the main characteristics of Einstein Probe and present a selection of results obtained for accreting compact objects, discussing how these X-ray observations integrate with multi-wavelength studies to provide a comprehensive view of accretion processes. I will also highlight our ongoing and upcoming activities as members of the panel focused on compact objects.

Week 2 – AGN

Testing star-disk collision models in QPE sources with eRO-QPE2

Talk

Riccardo Arcodia
MIT

Several models recently proposed that quasi-periodic eruptions (QPEs) are the electromagnetic counterpart of the gravitational wave emitters called extreme-mass ratio inspirals. While this explanation is tantalizing in relation to the recently-adopted LISA mission, a conclusive and model-independent test is still pending. We designed a multi-mission X-ray campaign on the well-behaved source eRO-QPE2 to test models proposing QPEs to be star-disk interactions by measuring the orbital decay driven by hydrodynamic drag experienced by the star as it collides with the accretion disk surrounding the central massive black hole, or the lack thereof. This test will either pinpoint the type of orbiter in QPEs, or show that current orbital models for QPEs are incomplete or incorrect.

Insights from the optical spectra of X-ray-selected AGN in eFEDS

Poster

Catarina Aydar
Max Planck Institute for Extraterrestrial Physics

Multiwavelength information is crucial for a complete understanding of the observable Universe. In the era of big data, large-number statistics is the ideal tool to characterize the demography of galaxy populations and understand the complex phenomena involved in galaxy evolution. Therefore, SPIDERS (Spectroscopic Identification of ERosita Sources) selected objects identified in X-rays with eROSITA to be observed in the optical domain by SDSS-V. This survey allows us to compare physical properties obtained from optical and X-ray spectra, and I will present the results for 13,000 Active Galactic Nuclei (AGN) observed in the eFEDS field, one of the largest uniformly selected X-ray AGN samples observed in optical. We will study the relation between the black hole growth and the host galaxy by comparing properties such as black hole mass, accretion rate, luminosity, outflow rates, column density, etc. For a subsample of AGN with redshift lower than 1, we will present results of accurate AGN-host spectral decomposition that reveal properties from the host galaxy (such as star formation history, stellar mass, and the age and metallicity of the stellar populations) and their connection with AGN. Some insights about AGN spectra will also come from the challenges of performing the fit of this X-ray-selected sample.

Talk

Towards fast geometrically extended coronal models

Fergus Baker
University of Bristol

Recent X-ray polarisation measurements of NGC 4151 obtained with the X-ray Imaging Polarimetry Explorer (IXPE) disfavour a point-like or vertically extended coronal geometry. This is a particularly remarkable result, as the majority of reflection and reverberation modelling efforts have, for computational simplicity, made use of a point-like corona located on the spin-axis of the black hole. We have been developing new performant methods for spectral and timing models with geometrically extended coronae using a novel time-dependent emissivity function approach. These techniques are sufficiently performant to be used in fitting packages such as XSPEC or SpectralFitting.jl, opening the opportunity to infer the three dimensional geometry of the corona directly from measurements of the X-ray reverberation lag. I will describe our methods and provide illustrative results from our models, detailing the effects that a geometrically extended corona has on the reflection and lag-energy spectra. I will also discuss the challenges that modelling an extended corona brings, including the specification of the coronal velocity and temperature profile, or the coupling between the corona and disc through Compton up-scattering of seed photons.

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A New Bowen Fluorescence Flare and Extreme Coronal Line Emitter discovered by SRG/eROSITA

Talk

Pietro Baldini
Max Planck Insitute For Extraterrestrial Physics

Tidal disruption events (TDEs) can reveal dormant supermassive black holes (SMBH), and allow us to probe the ignition, evolution, and exhaustion of accretion flows. eRASSU J012026-292727 (J012026) is a new X-ray-selected TDE candidate discovered in the second eROSITA all-sky survey. Initially detected as a bright, soft X-ray source, J012026 exhibited unusual X-ray flaring activity on both short (hour-) and long (year-) timescales. We also detected a strong mid-infrared flare, evolving over 2 years, and a weaker optical counterpart, with possible hints of a rise >3 years before discovery. Follow-up optical spectroscopy revealed transient features, including redshifted Balmer lines, FeII, HeII, Bowen fluorescence lines, and high-ionization coronal lines such as [FeX] and [FeXIV]. The spectroscopic features and the slow evolution of the event place J012026 within the class of Bowen fluorescence flares (BFFs) and extreme coronal line emitters (ECLEs). BFFs have been connected to rejuvenated accreting SMBH, although the mechanism triggering the onset of the new accretion flow is yet to be understood. Additionally, ECLEs have been associated with TDEs in gas-rich environments. The association of J012026 to both classes, combined with the multi-wavelength information, supports the idea that the BFF emission could be, at least in some cases, triggered by TDEs perturbing high gas density environments. The observed short- and long-term X-ray variability, uncommon in standard TDEs, adds complexity to these families of nuclear transients. These results highlight the diverse phenomenology of nuclear accretion events, especially in high-density environments, and demonstrate the value of systematic X-ray surveys for uncovering such transients and characterizing their physical origin.

NGC 1068: A XRISM BENCHMARK FOR COMPTON-THICK SEYFERT 2S

Talk

Stefano Bianchi
Università degli Studi Roma Tre

We present preliminary results from the XRISM observation of NGC 1068, a prototypical Compton-thick Seyfert 2 galaxy. NGC 1068 is an ideal laboratory for studying reprocessed AGN emission, as its hard X-ray spectrum is dominated by reflection and scattering from circumnuclear material. The XRISM Resolve instrument provides unprecedented high-resolution spectroscopy of key emission features, such as the Fe Kα line and the Fe XXV triplet, allowing precise measurements of ionization states, chemical abundances, and gas kinematics. These diagnostics are crucial for understanding the structure and dynamics of the circumnuclear matter in AGN.

Talk

The WISSHFUL program: X-ray corona and Ultra-Fast outflows at Cosmic Noon

Laura Borrelli
Bologna University

Ultra-fast outflows (UFOs) are highly ionized ($log\xi = 3-6ergs^{-1}cm$) thickwinds ($log(N_H/cm^2) \sim 23-24$) with characteristic absorption features ($Fe_{XXV}$and Fe_{XXV} at 6.67-6.97 keV rest-frame) in the hard X-ray band, strongly blue-shifted by the extreme velocities of the outflowing material ($v_{out} > 10^4 km/s$).These winds are thought to be the most promising mechanism providing AGNfeedback, influencing the co-evolution between SMBH and their host galaxy,since they can trigger galaxy-scale massive molecular outflows that quench both star-formation and AGN growth. To be relevant to the host galaxy formation history, AGN feedback must have been in place when both the mechanisms were at their peaks, i.e., $z \geq 2-4$, but evidence of UFOs at high redshift remains sparse.We present the WISSHFUL Heritage program, in the process of collecting high-quality X-ray spectra of 15 hyper-luminous, high redshift QSOs with extensive multi-frequency coverage. WISSHFUL represents the first systematic search for UFO features in a large sample of luminous ($L_{Bol} > 10^{47}$ erg/s), high BH mass, and highly accreting QSOs. This project is providing a unique legacy sample for studying the evolution of coronal properties at high redshift/luminosity, estimating the broadband continuum of the accretion disk-corona system at Cosmic Noon, and investigating the link between the nuclear winds and accretion properties in an almost unexplored regime. We will present results from the first year of observations: the first systematic estimate of UFO detection rate and the first robust derivation of typical coronal temperatures in luminous QSOs at Cosmic Noon, and compare these results with literature at lower z and Luminosities.

Talk

The X-ray view of accretion disk winds, from the XMM-Newton and NuSTAR CCD spectra to the XRISM-Resolve data

Valentina Braito
INAF/OAB, CUA

The presence of blue-shifted iron K absorption features in the spectra of nearby AGN was revealed over 2 decades ago with the first XMM-Newton observations of nearby AGN. They indicate the presence of powerful ultra-fast outflows launched from the innermost regions of the accretion disk with velocities up to 0.3c. Recently, a large effort has been devoted in developing physically motivated models that self-consistently describe both the emission and absorption produced by the wind; from these models, a more robust estimate of the energetics of the winds can be inferred. At the same time, large tailored X-ray observational programs on the best examples of these disk winds have been performed and they are shedding more light on their nature. After the successful launch of XRISM observatory, we now are entering a new era, where the superb spectral resolution of the calorimeter will give us an unprecedented view of these disk winds. Here I will report on the new results from recent XMM & NuSTAR observations of the best examples of disk wind, like MCG-03-58-007, PG1211+143 and Mrk231. I will also discuss these results in light of what we are learning from the first XRISM observations of disk winds.

Probing the accretion (in)flow and wind (out)flow in the luminous Seyfert 1 galaxy Mrk 509 with XRISM/Resolve

Talk

Massimo Cappi
INAF-OAS Bologna

We present preliminary results from a 100 ks XRISM observation of the Seyfert 1 galaxy Mrk 509 to assess the origin of its accretion (in)flow and ejection (out)flow. The XRISM high-resolution data is combined to simultaneous and quasi-simultaneous DDT observations from Swift, XMM-Newton, Nustar and NTT/TNG.Authors: M. Cappi, M. Dadina, V. Missaglia, and the Mrk509 XRISM collaboration.

The Most Powerful Quasar Outflows in the Universe

Talk

George Chartas
College of Charleston

Quasars at cosmic noon are expected to have been extremely powerful at a redshift range where AGN feedback is thought to have significantly impacted the evolution of galaxies and groups of galaxies. Most current studies of unlensed AGN have focused on the outflow properties of AGN with redshifts < 1. We present new detections of ultrafast outflows in a sample of 6 quasars with $0.777 < z < 3.77$, and 2-10 keV luminosities in the range between 7e43 erg/s and 3.6e46 erg/s. The outflow velocities detected in this sample range between 0.2c and 0.5c. Including these new detections with existing ones increases the significance of the correlation between v_{wind} and L_{Bol}, and provides further insight into the driving mechanism of ultrafast outflows.We detect a faint partial X-ray Einstein ring in WISEJ0259-1635, one of the lensed quasars in our sample. We interpret this partial X-ray Einstein ring as being produced by the interaction of the quasars winds with the ISM of the host galaxies. Lens modeling of WISEJ0259-1635 indicates that the X-ray Einstein ring of WISEJ0259-1635 can be produced by extended emission with a scale size of about 1 kpc.

Talk

A UV to X-Ray View of Soft Excess in Type 1 Active Galactic Nuclei

Shi-Jiang Chen
University of Science and Technology of China

The physical origin of soft X-ray excess (SE) is a long lasting question, with two prevailing theories – “warm corona” and “ionized reflection” – dominating the discussion. While both models fit the data well, they face persistent challenges: ionized reflection alone sometimes requires extreme physical configurations to fit strong soft excess; while a pure warm corona predicts photoelectric absorption contradicting the smooth soft excess profile typically observed. In this work, we explore the nature of SE from both spectral profiles and broadband correlations, using a sample of 59 unobscured type 1 AGNs with simultaneous \{}textit{XMM-Newton} X-ray and UV observations. We first find that SE exhibits a wide range of spectral profiles, from power-law-like (po-like, 71%) to blackbody-like (bb-like, 29%). Through simulations, we find ionized reflection (\{}texttt{relxilllp}) produces mostly bb-like profiles, while a simple hybrid scenario including both reflection and warm corona (\{}texttt{compTT}) produces both bb-like and po-like soft excesses, matching the data well. Secondly, through extensive correlation analyses among SE, UV, and hard X-ray primary continuum (PC), we find a strong intrinsic correlation between SE and UV that remains robust after controlling for PC ($p_{\rm null} < 10^{-7}$), while a weaker but still significant ($p_{\rm null} < 5 \times 10^{-2}$) correlation between SE and PC. This suggests that SE is intrinsically related to both disk emission (warm corona; major) and the hot corona emission (ionized reflection; minor). Overall, our work highlights the ubiquitous hybrid nature of the SE in AGNs, and the importance of considering both components while fitting the spectra of SE.

Talk

AGN warm absorbers: present status and future prospect

Elisa Costantini
SRON Netherlands Institute for Space Research

In this talk I will review the state-of-the-art, with an outlook to the future, of our understanding of fast winds, outflowing from the innermost parts of accretion disks in Active Galactic Nuclei (AGN). Winds are the likely messengers to explain how the central black hole may influence the host galaxy growth and ultimately explain galaxy evolution across cosmic time. Through high-energy resolution observation by XMM-Newton, Chandra and XRISM, our view of winds evolved enormously. X-rays provide a privileged view of the most energetic and massive multi-phases of the outflowing material. Disk-, ultra-fast winds, episodic massive obscurers and dusty gas components can be all studied in the X-ray band.

Spectral Analysis of NuSTAR-selected AGN in the North Ecliptic Pole Field: First Results and the Compton Thick Fraction

Poster

Samantha Creech
University of Utah

In order to explain the shape of the Cosmic X-ray Background, a sizable fraction of AGN in our universe must be heavily obscured by dust. NuSTAR's hard X-ray capabilities are uniquely suited for resolving and studying these Compton Thick (CT; $\log(N_H) > 24$) AGN. In order to unbury the true fraction of faint, CT AGN in the universe, we must perform deep X-ray surveys, such as the NuSTAR/XMM-Newton survey of the JWST North Ecliptic Pole Time-Domain Field (NEP-TDF). This field has been awarded 3.5 Ms of multi-year hard X-ray (3-24 keV) data from NuSTAR cycles 5, 6, 8, and 9 alongside 250 ks of simultaneous XMM-Newton observations corresponding to NuSTAR cycles 6, 8, and 9, which allows for broad-band analysis of source variability and obscuration. We present the first spectroscopic analysis of hard X-ray-identified sources in the NEP-TDF, as well as our calculation of the Compton Thick fraction.

Black hole masses via spatially resolved broad line regions at low and high redshift

Talk

Ric Davies
MPE

The broad line region and near-infrared hot dust continuum trace two of the key structures on sub-parsec scales around AGN, and understanding them provides insights into how black holes and their host galaxies evolve. In this presentation, I will introduce the interferometric and spectro-astrometric techniques used in our GRAVITY-AGN programme, and summarize the main results of spatially resolving on 10 microarcsec scales the BLR in 7 local AGN and the hot dust continuum in 17 AGN. The upgrades to GRAVITY+ have now enabled us to resolve the BLRs in QSOs at z=2 and beyond, which hold promise for observing a large sample of AGNs across cosmic time. I will describe our observations of rotating versus outflowing BLRs; and report on our first dynamical black hole mass measurements both at this epoch and also at z=4, comparing the masses to those derived from the scaling relations that are being widely applied at high redshifts.

Talk

Unveiling the Dynamic Accretion Disk and Hot Corona in Changing-Look AGN NGC 1566

Gulab Dewangan

IUCAA, Pune (India)

Changing-look active galactic nuclei (CL-AGNs) exhibit dramatic multi-wavelength variability, but the physical mechanisms driving this remain unclear. We analyzed AstroSat UV/X-ray observations of the CL-AGN NGC 1566 in August and October 2018 during the declining phase of its outburst, along with XMM-Newton data from November 2015 (pre-outburst) and June 2018 (peak-outburst). We found that the X-ray power law, soft X-ray excess, and disk emission varied by factors of 25, ¿200, and 30, respectively. The soft X-ray excess was negligible before the outburst, peaked at maximum luminosity, weakened in August 2018, and disappeared thereafter. This behavior is consistent with warm Comptonization in the inner disk, forming during the outburst and vanishing on a timescale comparable to the sound crossing time. To probe UV/X-ray connections, we used broadband spectral data from XMM-Newton, Swift, and NuSTAR during the outburst decline. At high flux levels, both the disk and soft X-ray excess provided seed photons for thermal Comptonization, whereas at low flux levels, only the disk contributed. The X-ray power-law photon index varied weakly ($\Delta\Gamma$ 0.06) but showed no strong flux correlation. However, as the accretion rate declined, the coronal temperature increased from 22 keV to 200 keV, optical depth dropped from 4 to 0.7, and scattering fraction rose from 1% to 10%. These findings suggest coronal expansion and heating, with NGC 1566 evolving into a state analogous to the low/hard state of black-hole X-ray binaries.

Talk

What can we learn about AGN from binaries

Chris Done

durham

I will review what we can learn about AGN by scaling up black hole binary accretion flows.

Impacts of Magnetic Processes on AGN Disk Stabilization and In Situ Object Formation

Talk

Hannalore Gerling-Dunsmore
University of Colorado Boulder

I will present results from a series of Athena++ 3D MHD shearing box simulations investigating the interaction of the magnetorotational instability (MRI) and self-gravity in the outer regions of AGN disks, and the impact of magnetic processes on suppressing catastrophic fragmentation in the outer disk (i.e. cessation of mass transport due to fragmentation). We find that sufficiently strong magnetization successfully suppresses catastrophic fragmentation of the disk, though the disk becomes inhomogeneous. I will present results on how the MRI and related disk properties (e.g. α) are impacted by self-gravity, and how strongly those impacts scale with the strength of self-gravity. Additionally, this study explores the parameter space which permits partial fragmentation of the disk while maintaining mass transport, providing the conditions for in situ formation of embedded objects, some of which may become stellar-mass compact binaries. Mergers of such binaries are expected to be a source for LIGO, and depending on growth of these objects pre-merger, potentially LISA. Disruptions of these objects may also produce tidal disruption events and contribute to enrichment of the disk. These multi-messenger probes would permit more direct observations of disk properties than currently feasible. In turn, constraining disk properties more accurately allows for better constraints on SMBH formation and growth, as well as AGN feedback mechanisms.

AGN Feedback in the Local Universe: Multi-Phase Outflows in the NLSy1 Galaxy NGC 5506

Poster

Federico Esposito
Università di Bologna

Narrow-line Seyfert 1 (NLSy1) galaxies are a fascinating class of active galactic nuclei (AGN) that host rapidly growing supermassive black holes (SMBHs), typically characterized by lower masses and high Eddington ratios. The presence of ultrafast outflows (UFOs), and relativistic jets suggests that feedback may play an important role in their evolution, despite their typically moderate bolometric luminosities. In this context, we present a multi-wavelength study of NGC 5506, a nearby NLSy1 galaxy, based on ALMA sub-mm and GTC/MEGARA optical integral field unit (IFU) observations. We modeled the cold molecular gas kinematics observed by ALMA with 3D-Barolo, identifying a rotating nuclear ring and a molecular outflow with radial velocities around 30 km/s in the central kiloparsec. The high spatial resolution of ALMA allowed us to determine the radial structure of the molecular outflow. Additionally, we analyzed the ionized gas kinematics using [OIII]5007 line observations from GTC/MEGARA, disentangling rotation and outflow components on a spaxel-by-spaxel basis. Interestingly, NGC 5506 also hosts a UFO detected in X-rays and a bent sub-parsec radio jet, both likely associated with recent nuclear

activity. By comparing the properties of molecular, ionized, and highly ionized gas phases, we provide a comprehensive view of the feedback mechanisms at play in this complex AGN. These findings highlight the role of NLSy1 galaxies as prime candidates for studying the interplay between high-accretion-rate SMBHs and multiphase outflows.

Talk

A novel SED fitting module for (not only) low-accreting supermassive black holes

Iván Ezequiel

INAF/OAS - Bologna

While the role of mid- to high-luminosity AGN in galaxy evolution is relatively well understood, the role of low-luminosity AGN (LLAGN) remains unclear. LLAGN are more common in the local Universe than their high-luminosity counterparts, yet studying them is challenging due to their faintness, their different accretion regime, and contamination from host galaxy emission. Even the most widely used AGN censuses struggle to probe populations below a $log\lambda_{\rm Edd} < -2$. However, SED fitting offers a powerful solution by leveraging a multi-wavelength approach to simultaneously estimate AGN and host galaxy.We present a novel SED fitting module tailored for LLAGN and integrated into the CIGALE code. This module effectively recovers black hole properties even in the presence of radiatively inefficient accretion flows (ADAF) alongside standard truncated disks. We test our methodology on a sample of 52 X-ray-detected local LLAGN, demonstrating its ability to estimate AGN parameters despite significant host galaxy contamination. Furthermore, we derive bolometric corrections for X-ray luminosities as low as 10^{38} erg/s yielding results consistent with previous extrapolations. Additionally, our analysis of the $\alpha_{\rm ox}$ index reveals trends distinct from those observed in high-luminosity AGN, with $\alpha_{\rm ox}$ exhibiting a more constant behavior relative to $\lambda_{\rm Edd}$.Future AGN censuses from large surveys could use the enhanced CIGALE code and offer a more comprehensive understanding of the AGN population down to lower accretion rates, shedding light on their feedback effects on host galaxies and their environments.

Probing the Role of X-ray Winds in Driving Large Scale Outflows in Nearby Type 2 Quasars

Poster

Anna Trindade Falcao
CfA/GSFC

AGN feedback has been proposed as the primary driver of the correlation between central black hole mass and galactic bulge mass. Although optical studies have detected AGN winds in the Narrow Line Region, supporting this feedback scenario, their dynamics remain poorly understood. A recent HST study of nearby ($z < 0.1$) type 2 quasars revealed [O III] outflows that often terminate close to the AGN, though disturbed gas is observed to kpc scales. One possible explanation is that the disturbed optical gas, traced by [O III], is being entrained by an X-ray wind. If so, the spatial distribution of X-ray gas may correlate with the extent of the [O III] NLR. To investigate this, we obtained 90 ksec of Chandra observations of two quasars from the HST study with the most extended NLRs: FIRST J120041.4+314745, which shows large-scale disturbed gas, and 2MASX J13003807+5454367, which does not. In this talk, I will present our findings and discuss their implications for the broader picture of AGN feedback.

Investigating the disk-jet coupling in radio-quiet AGN: X-ray and Radio variability of NGC4051

Talk

Matteo Fanelli
Università degli Studi di Roma "La Sapienza"

The origin of low luminosity radio emission in radio-quiet AGN is still unknown. In this class of objects, thanks to the absence of strong relativistic jets, several emission processes can be probed, like star formation, AGN driven winds and low power jets. NGC 4051 is a narrow line Seyfert 1 galaxy, radio-quiet, highly variable in X-rays. Zooming at VLBI scales a small FR-II-like structure was found, with two faint separate components at ≈0.4 arcsecs from the core. I will present the latest results of our X-ray campaign with the Einstein Probe telescope, quasi-simultaneous to radio observations taken with the Very Large Baseline Array and eMERLIN telescopes. I will discuss the radio-X-ray connection to study the role of each different component of the AGN, such as accretion disk, corona and jets.

Poster

Footprints in the Wind: Probing Outflows in NGC 7469 through Infrared Emission Lines

Léa Feuillet
The Catholic University of America

AGN winds play an important role in the co-evolution of supermassive black holes and their host galaxies, yet their driving mechanisms and impact on star formation remain subjects of active investigation. The main dynamic driver of AGN winds is found in X-ray emitting gas. However, the lack of X-ray IFUs currently limits our ability to acquire spatially resolved velocity information in the X-ray regime; instead, this can be achieved using the James Webb Space Telescope. As part of an ongoing investigation of the nuclear feedback processes in NGC 7469, a nearby luminous AGN, we present an analysis of the kinematics of the ionized outflow using infrared footprint lines (e.g. [Ne VI] 7.65 μm, and [Mg V] 5.61 μm). These footprint lines are associated with the same gas detected in soft X-rays and can thus be used to probe the X-ray wind's velocity structure and ionization state. In addition to measuring the gas masses and velocities, we also characterize the dynamics of the wind (energy, momentum, luminosity). Finally, we estimate the mass outflow rates and momentum transfer into the circumnuclear gas to assess the potential impact of the AGN-driven wind on the surrounding ring.

Talk

The Physical Origin of the Ubiquitous Soft Excess in AGN

Javier Garcia
NASA Goddard Space Flight Center

Since its discovery in the 1980's, the physical origin of the soft-excess (SE) emission in the X-ray spectra of active galactic nuclei (AGN) has remained a matter of discussion. This spectral component, ubiquitously observed below 1−2 keV in at least 50% of Seyfert AGN over a wide range of black hole masses, challenges simple thermal-emission scenarios. The lack of correlation between the properties of the SE (emitted flux and peak energy) with black hole mass or accretion rate is suggestive of a very intrinsic property to most accreting systems. In this talk, I will present an overview of both the observational and theoretical challenges we are currently facing to understand the physical mechanisms responsible for the SE. I will discuss the current leading models used to explain this emission, namely, Comptonization of disk photons in a warm, optically thick corona and relativistically blurred reflection from an ionized accretion disk. I will discuss the implications of these findings for black hole spin measurements and AGN accretion physics, and outline key observational tests−both with current facilities and upcoming missions−that are necessary to definitively distinguish between competing scenarios.

Supermassive Black Hole Winds in X-rays – A population study on Ultra-Fast Outflows

Talk

Vittoria Elvezia Gianolli
Clemson University, Clemson, SC - USA

In X-ray the presence of highly ionized outflowing gas with mildly relativistic velocities (0.05 - 0.4c), named Ultra-Fast Outflows (UFOs), has been observed in many Active Galactic Nuclei (AGNs) based on the detection of absorption lines in the Iron K band. Within the SUBWAYS project we characterized these winds in 22 quasars at z $\sim$ 0.2 (Matzeu et al., 2022), and compared the results with those from similar studies on local Seyfert galaxies (i.e., 42 radio-quiet AGNs at z $\leq$ 0.1; Tombesi et al., 2010) and high redshift quasars (i.e., 14 AGNs at z $\geq$ 1.4; Chartas et al., 2021). In this talk, we will present the results of our extensive statistical analysis on the main physical parameters of the sources (e.g. black hole mass, bolometric luminosity, accretion rates, and SEDs) and the UFOs (e.g. column density, ionization parameter, outflow velocity, and energetics), as well as the key correlations found across our sample. We will also explore the implications of our findings for the mechanisms responsible for launching these powerful winds.

Here be LLAGNS: Characterizing Infrared Emission Lines in Nearby Low-Luminosity AGN with JWST NIRSpec and MIRI/MRS Data

Talk

Kameron Goold
University of Utah

Low-Luminosity Active Galactic Nuclei (LLAGN) are the most common AGN in the local Universe, representing a key phase in the evolutionary cycle of supermassive black holes and their host galaxies. Largely unaccessible prior to JWST, the infrared spectra of LLAGN contain numerous emission features that trace distinct physical processes and probe different components of the nuclear environment. As part of the ReveaLLAGN survey we utilize the unprecedented resolution and sensitivity of JWST to study the IR emission properties of LLAGN in detail. Using MIRI and NIRSpec, we extract clean nuclear spectra out to 20 microns for eight nearby LLAGNs, enabling a detailed characterization of their emission features.We find that [Ne V] emission, a clear sign of AGN activity, is systematically weaker at Eddington ratios of 10\{}^{}−3andbelowcomparedtohigheraccretionrates, suggestingsignificantchangesoccuri
diskAGNaccretiontoaradiativelyinefficientaccretionflow(RIAF).Additionally, wefindstrongevi
excess and higher H_2 excitation temperatures compared to both AGN and non-AGN sources. The kinetic energy injected by these outflows plays a critical role in regulating star formation within the host galaxy.

Talk

What drives the fraction of X-ray emission in AGN?

Kriti Kamal Gupta
Univeristies of Liège and Ghent, Belgium

Active galactic nuclei (AGN) grow via mass accretion onto their central supermassive black hole (SMBH) and emit electromagnetic radiation mainly at optical, ultraviolet (UV), and X-ray wavelengths. While the standard disk and corona model can somewhat describe the optical-to-X-ray spectral energy distributions (SEDs) of AGN, it fails to predict certain features observed in the wide variety of AGN SEDs, including soft X-ray excess, short-term optical/UV variability, missing UV excess in low-luminosity AGN, etc. Over the years, bolometric corrections have been used to provide fundamental insights into the accretion and emission mechanisms of AGN, as they quantify the fraction of AGN emission in different bands. In my work, I modeled the simultaneous optical-to-X-ray SEDs of one of the largest, representative samples of hard-X-ray-selected unobscured AGN in the local universe and calculated their bolometric corrections. I studied the dependence of the X-ray bolometric corrections on the physical properties of AGN over a wide range of black hole masses, luminosities, and accretion rates. In this talk, I will present the primary parameter that regulates the fraction of X-ray emission in AGN and discuss the implications of my results on our current understanding of accretion flow in the nearby AGN population.

Talk

The Evolving Accretion Structure in Fairall 9

Scott Hagen
Durham University

Standard accretion disc theory predicts that AGN accretion disc cannot vary on observable time-scales, instead attributing the observed optical/UV variations to the re-processing of X-rays originating from a low-density corona. In recent years the intensive black hole monitoring campaigns (IBRM) have challenged this picture, often showing poor correlations between the optical/UV and X-ray as well as optical/UV variability amplitudes inconsistent with that expected from disc reprocessing. Fairall 9, a local bare Seyfert 1 AGN, was recently subject to a 1000 day IBRM campaign, providing one of the richest current IBRM datasets and a unique window into its accretion structure. These data show a sharp rise after 300 days in the optical/UV, with a corresponding evolution in the spectral energy distribution (SED) suggesting a global change to the system driven by an increase in the mass-accretion rate. Here I will show results indicating a significant departure from standard accretion disc theory, and suggest that even non-changing-look AGN are possibly non-stationary on observable time-scales, impacting how we interpret future monitoring campaigns.

Extremely energetic winds in the luminous quasar PDS 456 revealed by XRISM

Talk

Kouichi Hagino
University of Tokyo

The nearby luminous quasar PDS 456 is well known for its powerful wind. The wind has a very high velocity of $\sim 0.3c$ and has been persistently detected as a blue-shifted Fe-K absorption line in X-ray observations. The high wind velocity suggests a large kinetic power of the wind, emphasizing its importance in the co-evolution of black holes and their host galaxies. However, despite its importance, the kinetic power of the wind has not been well determined due to large uncertainties in the geometry of the wind. In March 2024, we conducted a 260-ks observation of PDS 456 with XRISM, which has an unprecedentedly high spectral resolution in the Fe-K band, allowing us to investigate the complex structures of the wind in detail. Indeed, we have successfully determined geometrical parameters using the emission/absorption features of the wind in PDS 456 detected by XRISM. In particular, complex absorption features and a strong broad emission line provided us with tight constraints on the geometry, and eventually, we found that the wind in PDS 456 has an extremely high kinetic power exceeding the Eddington luminosity limit. In this talk, we present details of the estimation of the wind geometrical parameters, such as the wind solid angle, location, and volume filling factor. We also compare our estimates of the energy and momentum of the X-ray wind with those of galaxy-scale winds, and discuss their differences and the possible implications of their interactions.

AGN jets and wings: unravelling the mystery of cross-shaped X-ray emission

Poster

Thomas Higginson
University of Bristol

Jets from Active Galactic Nuclei have long been observed to interact with the interstellar medium (ISM). Such interactions provide possible mechanisms for star formation quenching, as required by cosmological simulations. The FRII quasar 3CR 14 (z=1.469) has been observed by Chandra to have significant X-ray emission to the southeast of the core, co-aligned with a southeast-northwest LOFAR-observed radio wing. Whilst FRII quasar 3CR 34 (z=0.69) and FRI radio galaxy 3CR 192 (z=0.05) both have significant X-ray emitting wings to the north and south of the core, perpendicular to their jets. Characterised as cross-shaped galaxies, these AGN offer a unique investigation into feedback modes and jet-ISM interactions that can cause large sweeping filaments, jet associated hot spots and X-ray wings. 3CR 34 hosts all three structures with complex hot spot structures from jet-lobe interactions and a bow-shock-like filament cocooning the central galaxy and flowing into diffuse emission wings suggesting a blow-back mechanism. 3CR 14's one-sided X-ray wing could be dominated by displaced gas heating as it falls back into the central galaxy.

Talk

Exploring the disc-wind-jet connection in radio detected quasars with a novel population analysis

Charlotte Jackson
University of Oxford

Outflows in the form of jets and winds are ubiquitous across the zoo of classifications of active galactic nuclei (AGN), and are produced by black holes of all masses. However, the detailed connection between accretion discs and the outflows they drive is still unclear. We explore this disc-wind-jet connection in AGN, utilising LOFAR Two-Metre Sky Survey (LoTSS) radio data and SDSS DR17 spectroscopy for a large sample of quasars at z=2. We probe the demographics of the population, focusing on the relationship between emission lines, colour, and fundamental black hole properties including mass and Eddington fraction.We build upon previous studies (Rankine et al 2021; Temple et al 2023; Petley et al. 2023), using the larger LoTSS DR2 catalogue to examine trends in CIV and HeII emission spaces as well as mass-Eddington fraction space. We produce matched sub-populations in 3000Å luminosity and MgII space, which we use to consider the possible origins of differences between radio-loud and radio-quiet quasars. We also simplify the highly complex nature of the entangled parameter space by applying self-organising map algorithms to the data to identify potential higher dimensional correlations. Our work suggests a fundamental connection between emission line properties and radio loudness, driven by something other than black hole mass and accretion rate, raising tantalising questions about the nature of the radio quasar population.

Talk

Understanding the Intriguing ”Weak-Line” Seyfert Population

Chichuan Jin
National Astronomical Observatories (NAOC), China

Super-Eddington AGNs are the most powerful accretion systems in the Universe. There are super-Eddington NLS1s with masses less than 1.E+7 Msun, which are well-known for exhibiting weak [O III], strong Fe II, and a significant soft X-ray excess. Besides, there are weak-line quasars (WLQs) with masses bigger than 1.E+8 Msun, which are characterized by notably weak high-ionization UV emission lines, such as C IV and N V. Both types of systems also exhibit strong X-ray variability. In this talk, I will present a unique NLS1 that possesses properties similar to both NLS1s and WLQs, including NLS1-like optical emission lines, WLQ-like UV emission lines, and drastic X-ray variability. This source may represent a new population of super-Eddington AGNs, which we termed ”Weak-Line” Seyferts (WLS). I will discuss how the evolution of the super-Eddington accretion flow, in terms of black hole mass and accretion rate, can help us understand these three types of super-Eddington AGNs.

Unexpected fast high-amplitude radio variability in early-stage active galactic nuclei

Talk

Emilia Järvelä
Texas Tech University, TX, USA

I report on the discovery of extreme 37 GHz radio variability originating from early-stage active galactic nuclei (AGN). Most of these AGN are narrow-line Seyfert 1 (NLS1) galaxies, harbouring fast-growing, low-mass supermassive black holes, accreting at high Eddington ratios. These AGN exhibit amplitude variability of three-to-four orders of magnitude over e-folding timescales of a few days. However, despite our relentless attempts, we have not detected relativistic jets in these sources, and thus they might be displaying a new kind of variability phenomenon in AGN. Recently, one of these sources exhibited several 37 GHz flares and was followed up by the Karl G. Jansky Very Large Array, Owens Valley Radio Telescope, Effelsberg Radio Telescope, and Swift XRT/UVOT. Based on these observations, we estimated an e-folding timescale of some hours, leading to variability brightness temperatures and variability Doppler factors that are extremely hard to explain by an incoherent emitter, suggesting a possible detection of coherent emission from an AGN. In this talk, I will present our multiwavelength investigation, including future plans, into this subset of AGN, and discuss the importance of the next-generation astronomical facilities for our efforts to unveil the nature of these extraordinary sources.

Multi-wavelength view of local AGN: Physical (AGN)SED Modeling

Poster

Kristína Kallová
Universidad Diego Portales

Active Galactic Nuclei (AGN) are among the most powerful sources of radiation in the Universe, emitting across many wavebands of the electromagnetic spectrum. While the primary optical/UV radiation originates in the accretion disk, the ubiquitous X-rays are produced by inverse Compton scattering of the seed photons originating in the underlying thermally emitting accretion disk on the hot and relativistic electrons in the corona. Despite extensive studies, the interplay between the corona and the accretion disk is still not well understood across different mass accretion rates.Studying the spectral energy distributions (SED) of AGN can help us better understand the accretion process and the interplay between disk and corona. SEDs can be obtained by the decomposition of the photometric data between the host galaxy and the AGN using tools such as GALFIT. In my work, I apply this approach to study a large sample of 200 local hard X-ray selected AGN spanning across 5 orders of magnitude in mass accretion rate, parametrized by Eddington ratio. For the first time, I apply the physical SED model AGNSED to simultaneous multi-wavelength observations of such a large sample and with the use of Bayesian X-ray Analysis I globally explore the full parameter space. In my talk, I will explore the dependence of important AGN parameters such as bolometric corrections on the Eddington ratio, quantifying the amount of energy output at a specific wavelength contributing to the total bolometric luminosity. I will also compare with previous works using phenomenological SED models, allowing me to address the model-dependency of such results.

Talk

Detection of a highly ionized outflow in the quasi-periodically erupting source GSN 069

Peter Kosec
Smithsonian Astrophysical Observatory

Quasi-periodic eruptions (QPEs) are high-amplitude, recurring soft X-ray bursts associated with supermassive black holes. Many interpretations for QPEs were proposed since their recent discovery in 2019. The most plausible models include extreme mass ratio inspirals or accretion disk instabilities, but as of today, the QPE nature remains to be understood. In this talk I will present the results of the first high-resolution X-ray spectral study of a QPE source. We leverage the nearly 2 Ms of XMM-Newton RGS grating exposure on GSN 069 (the first discovered QPE system) and resolve several absorption and emission lines, among them a strong pair of lines near the N VII rest-frame energy which resemble a P-Cygni line profile (blueshifted absorption and redshifted emission). We apply photoionization spectral models and identify the features detected in absorption as an outflow with a projected velocity of 1700-2900 km/s. Conversely, the emission lines are redshifted by up to 2900 km/s and can be interpreted as originating from the same outflow that imprints the ionized absorption and covers the full 4 sky from the point of view of GSN 069. We find strong evidence that nitrogen is heavily over-abundant in the ionized outflow, consistent with a previous abundance study of GSN 069 using UV data. I will conclude by discussing these findings in the context of QPEs and other nuclear transients.

Talk

Exploring the Magnetic Origins and Properties of Ultra Fast Outflows (UFOs)

Steve Kraemer
Catholic University of America

AGN UFOs are typically identified by the presence of blue-shifted (V ¿ 0.03c) Fe absorption lines from ions such as Fe XXV and Fe XXV, detected in the Fe K band in X-ray spectra. This combination of high velocity and high ionization state suggests that such outflows cannot be radiatively-driven, particularly in sub-Eddington AGN, which points to cold-MHD processes. Also, our earlier force-free cold-MHD analysis predicted velocity structure within UFOs which has been confirmed in new XRISM/resolve observations. In addition to acceleration mechanisms, two other aspects of UFOs suggest a role for magnetic fields. Specifically, these are thermal stability and confinement; in this context, I will discuss the effects of magnetic pressure. The confinement problem is particularly relevant given the possible detection of UFOs in emission 100 pcs from the AGN in Chandra/ACIS observations.

WISSHFUL first results: a super-Eddington QSO at z¿3 showing a very cold corona (kTe 20keV) and a 0.35c Ultra Fast Outflow

Talk

Giorgio Lanzuisi
INAF-OAS

I will present results from the 2.3Ms XMM Heritage Program WISSHFUL aimed at studying accretion/ejection in luminous QSOs at Cosmic Noon. The first observed target, WISSH13 accreting at ~ 3 times the Eddington limit, was observed in October 2024 for 115ks with XMM and 135ks with Nustar, that collected $\sim 10^4$ net counts in the 0.3-10keV band ($\sim 1-40$ keV rest-frame) and 550 net counts in the 2-30 keV band ($\sim 8-130$ keV rest-frame). This represents the highest quality X-ray spectrum for a non-lensed QSO at such high redshift, allowing us to model the broad-band emission with detailed physical models, including reflection and Comptonization. We derived a soft photon index $\Gamma = 2.11 \pm 0.07$), strong reflection ($R = 1.8^{+0.9}_{-0.7}$) and an extremely low high-energy cut-off (Ecut$\sim$ 60 keV)), corresponding to electron temperature of the order of $kT_e \sim$ 20keV, in analogy with highly accreting NLSy1 in the local Universe. We further identify an absorption feature at 9.8 keV rest-frame, compatible with absorption due to FeXXV He\{}alpha and FeXXVI Ly\{}alpha, blueshifted by $v_{out} \sim 0.3c$. When fitted with a photoionization code such as \{}xstar, we find a column density of NH$\sim 10^{24}$ cm^{-2} and ionization parameter $log(\xi) \sim 5.5$ erg*cm*s^{-1}. The energetics of this wind $E_{kin} \sim 5\% L_{bol}$ are consistent with efficient AGN feedback in place in this Cosmic Noon QSO.

A Systematic Search for X-ray Eclipse Events in Active Galactic Nuclei Observed by Swift

Talk

Tianying Lian
National Astronomical Observatories, Chinese Academy of Sciences (NAOC)

The nuclear regions of active galactic nuclei (AGNs) likely host clumpy clouds that occasionally obscure the central X-ray source, causing eclipse events. These events offer a unique opportunity to study the properties and origins of such clouds. However, these transient events are rarely reported due to the need for extensive, long-term X-ray monitoring for years. Here, we conduct a systematic search for eclipse events in 40 AGNs well-monitored by the \{}textit{Swift} X-ray Telescope (XRT) over the past 20 years, comprising a total of ∼11,700 observations. Our selection criteria rely on significant variations in X-ray flux and spectral shape. We identify 3 high-confidence events in 3 AGNs and 8 candidates in 6 AGNs, all in type I AGNs. The observed clouds have column densities of $N_{\rm H} \sim (0.2 - 31.2) \times 10^{22}$ cm^{-2} and ionization degrees of $\log \xi \sim$ (-1.1 − 2.4). For the 5 events with well-constrained duration, their distances from the central black hole range from $(2.4 - 179) \times 10^4$ $R_{\rm g}$, with 2 clouds near the dust sublimation zone, 2 farther out. Interestingly, we find tentative correlations between the cloud properties (e.g. ionization state and column) and the black hole mass and mass accretion rate, implying their

strong connection to the accretion process, potentially via outflows. Our study also demonstrates the potential of the new X-ray all-sky monitor {\{}it Einstein Probe} in providing more detection and physical constraints for such events.

Talk

Fast giant flares in accretion discs around SMBH

Galina Lipunova
Max Planck Institute for Radio Astronomy

We propose a novel scenario for flares in accretion discs surrounding supermassive black holes. Our study builds on the concept of thermally-viscous instability, which isknown to drive outbursts in X-ray novae. It is believed that a criticaldensity must be reached in the disc for a transition from a cold to a hotstate and a subsequent outburst to occur.To investigate this phenomenon in accretion discs around SMBH, we havecalculated the vertical structure of discs, analyzing their thermalequilibria across a broad range of accretion rates. Our findings revealthat, if a cold disc surrounds a central radiatively inefficientflow, the critical surface density in a cold disc can reach such high levelsthat the instability elevates the disc temperature significantly, resultingin a relative thickness approaching unity.The timescale of the subsequent super-Eddington flare, which depends on therelative thickness of the disc in the hot state, is relatively short. Weestimate that approximately 4 to 3000 $M_\odot$ can be accreted, or entrainedin an outflow, during a flare lasting only 1 to 400 years in a discaround a SMBH of 10^7 $M_\odot$. The peak effective temperaturenear the trigger radius reaches about 10^5 K. The optically thick outflowresults in anisotropic emission pattern. We conclude that the observational manifestations of these flares are similar to those resulting from TDEs.

Talk

Unraveling the Quasar Broad-Emission Line Region

Kirk Long
JILA, University of Colorado Boulder

Broad emission lines are an observational hallmark of AGN that imply the presence of a supermassive black hole. This broadening, in conjunction with a radial distance measurement, allow us to measure the masses of supermassive black holes. But to obtain the most precise masses and understand the true nature of the broad-line region requires a degree of modeling. Two popular models of the BLR imagine the emitting gas as either a distribution of puffed up clouds or a thin disk with strong velocity gradients, which could give rise to winds/outflows. In this talk we will first show fits of thin disk-wind models to interferometric GRAVITY data in 3C 273, demonstrating that multiple models can fit real BLR data. We will then discuss modeling of reverberation mapping data obtained via the AGN STORM project in NGC 5548, and how these data products – in particular delay profile measurements – imply that current models of the BLR cannot adequately explain all the observations. In particular, the observed delay and line profiles in NGC 5548 seem

to imply multiple populations of broad line emitting gas with different geometries and kinematics, and we will discuss ongoing efforts to alleviate this tension with multi-component BLR models. We will also briefly show a promising deep learning technique for the deconvolution of reverberation mapping data to obtain 2D velocity-delay maps, which can help in discriminating between which types of models best represent the BLR. The goal of this talk is to demonstrate that through these approaches we can better constrain the true nature of the BLR, what physics can plausibly exist there, and how our choice of model systematically influences our measurements of high level properties such as SMBH mass.

Outflows properties in Narrow Line Seyfert 1 Galaxies

Talk

Anna Lia Longinotti
Instituto de Astronomia UNAM University Mexico

The well-established relations observed between the properties of host galaxies and their nuclear black hole activity suggest that BH activity may have a strong impact at galaxy-scale environment. Multi-band observations of AGN-driven outflows indeed support the idea that energy-conserving outflows may induce AGN feedback via shock processes even in sources at moderate luminosity (few $\times$ 10^{44} erg/s). With their high accretion rate and stratified X-ray Ultra Fast Outflows, Narrow Line Seyfert 1 Galaxies are promising targets where shocked outflows and feedback can be explored. This talk will give an overview of the results from our ongoing study of the host galaxies of NLSy1 selected to have powerful X-ray UFOs that is revealing stunning evidence for galaxy-scale outflows. Particular emphasis will be given to the results from spatially resolved spectroscopy recently obtained by the GTC-MEGARA on IRAS17020+4544, where we observe a biconical, kpc-scale outflow of ionized gas (Hα and [OIII]) coincident with the well-established molecular outflow mapped by NOEMA. This talk might also include preliminary results on the evolution of the X-ray wind properties in IRAS17020+4544 from new XMM-Newton spectroscopic data, scheduled in mid-march.

Precise radial location, density and energetics of the Warm Absorbers in NGC4051 with time-resolved spectroscopy and time-evolving photoionisation

Talk

Alfredo Luminari
INAF - IAPS/OAR

Warm absorbers (WAs) manifest themselves as intervening absorption features in around 50% of the AGNs observed in X-Rays. Notwithstanding their ubiquitous presence, their diagnostic is usually limited to their line-of-sight velocity, column density and ionization parameter. Therefore, it is not possible to firmly determine their radial location and, thus, their energetic and impact on the host environment. Moreover, several formation scenarios (corresponding to different length scales) have been suggested, each one with different implications on the structure of the accretion disc and of the torus, but they can not be effectively tested due to the limited diagnostic power.However a new, promising channel has now been made possible with the advent of time-evolving photoionisation models (such as TPHO, Rogantini+22, TEPID, Luminari+23), which allow to constrain the gas number density by following the temporal evolution of its ionisation.In this talk I'll present the application of TEPID to a time-resolved dataset drawn from a 180 ksec-long XMM observation, complemented by simultaneous NuSTAR coverage. We have been able to firmly constrain the number density and, thus, the radial location of one of the three components, while we obtained upper/lower bounds for the other two. Thanks to this, we derive unambiguously the energy budget of the WAs in NGC 4051 and we spatially locate them at distances comparable to those of the Broad Emission Lines.Such firm measure has never been performed before in an AGN (and only in a handful of compact binaries) and represents a pathfinder of what can be done with the advent of X-ray high-resolution spectroscopy (XRISM and the next NewAthena), as well as with the fast monitoring enabled by Swift and Einstein Probe.

Talk

Characterizing ultra-fast outflows in hyper-luminous quasars at cosmic noon

Alice Deconto-Machado
IASF-INAF, Milano

One of the more effective ways to investigate the AGN feedback effects as major drivers of the galaxy evolution is through the study of quasars at cosmic noon (1 z 3), which corresponds to the peak of the AGN and star formation activity and, therefore, where the outflow parameters are very likely the most extreme. Ultra-fast outflows (UFOs) are believed to play a major role in transferring the immense accretion energy of supermassive black holes (SMBHs) to the gas reservoir of their host galaxies. I will present results from investigations of UV UFOs in hyper-luminous quasars (log Lbol ¿ 47), which typically exhibit velocities of 0.1c. Such extreme velocities are similar to the UFOs typically observed in the X-ray spectra of local AGN. While X-ray UFOs require time-consuming observations, UV UFOs can be studied routinely even at high redshifts. By exploiting their variability, we can derive crucial parameters such as the location and kinematics of the outflow. Specifically, I will present results from the analysis of three WISSH QSOs using VLT/UVES spectra and SDSS archival data, performing a multi-epoch spectroscopic analysis. This analysis aims to characterize the variability of BAL features in the C IVλ1549 emission line, through the study of outflow properties such as maximum and minimum outflow velocity and equivalent width. Our analysis reveals significant changes in the strength and shape of the C IV absorption profiles across the epochs, indicating significant variability in the outflow properties. Additionally, we explore potential drivers of this variability, including changes in the ionization state, geometry, and orientation of the outflow.

The path towards CTAO: a new population of X-ray selected, VHE-emitting blazars

Talk

Stefano Marchesi
Università di Bologna

Jetted accreting supermassive black holes (SMBHs) are among the most luminous and powerful sources in the Universe. They are characterised by a two-peak spectral energy distribution (SED): while the emission mechanisms behind the lower energy one are clearly understood, the processes causing the second peak are still at the centre of an open debate, and could possibly even be linked to neutrino emission.In this presentation, I will give an overview of a recently published catalog of over 1000 radio-selected blazars that have an X-ray counterpart (from XMM-Newton, Chandra, Swift-XRT, or eROSITA) and yet lack a counterpart in the gamma-ray 4FGL catalog. I will show how a portion of these objects, having high synchrotron peak, high X-ray to radio flux ratio, represent a golden sample of rare blazars that, while out of reach for current Cherenkov telescopes, will instead be easily detected by the soon to be available Cherenkov Telescope Array Observatory (CTAO). I will then show how modelling the SED of these VHE-emitting candidates can already allow us to make predictions on how the CTAO will allow us, for the first time, to put strong constraints on the emission processes behind the VHE emission of these rare, extreme targets, in doing so shredding light on what originates the SED second peak.

Unveiling the acceleration mechanism of AGN-driven outflows: a multi-wavelength perspective

Talk

Cosimo Marconcini
University of Florence

Super massive black holes at the centre of galaxies experience an active phase of matter accretion via pc-scale accretion disks. As a consequence of accretion and to conserve angular momentum, energetic multi-phase winds are produced, pushing the ambient gas up to the galaxy outskirt. Models predict the key role of these winds in shaping galaxy evolution, regulate star formation and metals distribution over kpc scales. Nonetheless, it is still unclear what is the mechanism accelerating such outflows and how energy can be exchanged between the wind and the galaxy Inter Stellar Medium. I will present a detailed analysis of the outflow kinematical properties in a sample of nearby active galaxies which finds evidence, for the first time, of the predicted transition from the momentum to the energy driven regime at the critical radius of 1 kpc. In particular, I will show that all these outflows are characterized by constant radial velocities followed by a rapid acceleration starting from 1 kpc from the nucleus, as predicted by theoretical models and hydrodynamical simulations of AGN outflows. I will motivate how these results are crucial to understand the origin of these winds, their powering mechanism and the energy exchange with the ambient medium, exploiting MUSE and JWST observations. Finally, these results confirm and motivate the key role of outflows in shaping the galaxy properties and evolution, as a manifestation of AGN feedback.

Poster

Time delay measurements of NGC 4051 - long term monitoring with LCO

Marcin Marculewicz
Wayne State University, USA

We report the monitoring of a low black hole mass AGN, NGC 4051, with Las Cumbres Observatory. During intensive two years of monitoring, we obtained sub-daily lag. We compare two different methods of lag determination, i.e., pyROA and pyCCF. We found that each year of our two-year campaign produces increasing lag with increasing wavelength. The SED is redder and flatter than other more massive sources reported in the literature. The delay spectrum exhibits u-band excess. The asymmetry in the time delay distribution toward positive lags is also evident, and the removal of the slower component suggests that it may originate from an extended reprocessor. We discuss the physical origin of the extended response and its potential association with a diffuse continuum emission from the BLR. It suggests that smaller masses might influence the SED and that potential differences in the SED between different galaxies are relevant to this study.

Talk

Changing-look AGN and extreme-accretion SMBH events: insights from eROSITA's All-Sky Surveys

Alex Markowitz
Nicolaus Copernicus Astronomical Center of the Polish Academy of Sciences

AGN accretion is likely episodic over timescales of $\sim 10^{5-6}$ years,and the community is still exploring the full range of diversity inaccretion flow behaviors. We are attempting to observationallydistinguish between major changes in accretion rate occurring on"global" scales (global supply of gas turned on/off) versus on "local"scales (events originating within the disk/corona). We are also keento examine how all accretion flow components – X-ray corona, disk,BLR – react and interact during such major changes in accretion.The eROSITA X-ray telescope aboard Spectrum X/Gamma performed multipleall-sky X-ray surveys, and monitored a vast sample of AGN andgalaxies. Our group identified multiple candidate extragalactic transientX-ray ignition/shutdown events, associated with extremes of accretiononto supermassive black holes. For selected events, we triggeredmulti-year, multi-wavelength follow-up monitoring programmes to trackaccretion structures.I will review previous results for campaigns on a few selectedcandidate X-ray-selected transients – including temporary flaringevents and the emergence of a clumpy disk wind– and what new physicsinsights have been gained. I also present our most recent results on achanging-look Seyfert that showed temporary intrinsic accretiondimming followed by a multi-component BLR response.

Magnetic Heating as the Origin of Soft X-ray Excess in Changing Look AGN

Talk

Ryoji Matsumoto

Chiba University

We present the results of global 3D radiation magnetohydrodynamic (MHD) simulations of accretion flows in changing look AGN, in which hard X-ray is dominant in the low-luminosity state, while soft X-ray excess is observed in the bright state (Noda and Done 2018). Machida et al. (2006) showed by 3D MHD simulations that when the accretion rate exceeds the upper limit for radiatively inefficient accretion flow (RIAF), the accretion flow shrinks in the vertical direction by radiative cooling conserving the azimuthal magnetic flux, and that the accretion flow becomes supported by azimuthal magnetic fields. We extended Machida's simulation to AGN by adopting higher accuracy MHD code CANS+ and solved the evolution of the radiation energy density and radiative flux assuming M1 closure. Compton cooling is taken into account. We found that when the accretion rate is the order of 10\{}% of the Eddington accretion rate, hard X-ray emitting hot RIAF near the black hole co-exists with outer soft X-ray emitting magnetically supported, Thomson thick disk. The temperature of the Thomson thick region is $10^6 - 10^7$K. Although the Compton cooling time is less than the dynamical time scale, the temperature of the region is sustained by the dissipation of the magnetic energy transported from the inner region.

X-ray polarimetry of AGN: results from IXPE

Talk

Giorgio Matt

Roma Tre University

The Imaging X-ray Polarimetry Explorer (IXPE) is providing forthe first time X-ray polarization measurements of Active GalacticNuclei. In this talk, the main results are summarized and discussed.

Talk

A newly discovered powerful accretion disk-wind in the quasar LBQS 1338-0038

Gabriele Matzeu

Europen Space Astronomy Centre (ESAC)

We present a detailed XMM-Newton (XMM) and NuSTAR X-ray spectral analysis of the luminous Type I quasar LBQS 1338-0038 (LBQS hereafter) located at z=0.23745 with a bolometric luminosity of log(Lbol) 46 ergs/s together with a black hole mass of log($M_{BH}/M_{/odot}$)=7.77±0.03 indicates that LBQS 1338-0038 accretes almost at the Eddington limit . Such a high accretion rate is a prime ingredient for launching a ultra-fast outflow (UFO). Recently LBQS was observed again with XMM in 2020 for 100 ks as part of the SUBWAYS large program. About a year later, in January 2021, LBQS was observed with NuSTAR for 50 ks as part of the hard X-ray counterpart of the SUBWAYS project. From our optical/UV/X-ray SED modelling of the XMM and NuSTAR, we find that the rest energy of the centroid of the broad emission line is at 6.6 kev with which is consistent with either Fe XXV-FeXXVI transitions or a blend of the two. The centroid energies of two absorption lines are found at 8.00 kev and 11 kev. Analyzing the XMM and NuSTAR data with physically motivated models, we detected a prominent P-Cygni like profile in the Fe K band consistent with a UFO with velocity vout $-$ 0.150c and 2Ω covering factor. We also detected a faster UFO zone with vout $-$ 0.50c which might arise from a wind streamline located closer in to the black hole. Such framework suggests the inhomogeneous a multi-phase nature of UFO already observed with XRISM/Resolve in PDS 456.Finally, we thoroughly investigated whether the XMM and NuSTAR spectra of LBQS and the Fe K profiles arises from an alternative physical modelling such as the blurred relativistic reflection and if we can differentiate between the two scenarios.

Talk

Highlights from the eROSITA all-sky AGN survey

Andrea Merloni

MPE

eROSITA (extended ROentgen Survey with an Imaging Telescope Array), the soft X-ray instrument on the Russian-German Spektrum-Roentgen-Gamma (SRG) mission has expanded the horizon of X-ray astronomy and delivered large legacy samples thanks to its high sensitivity, large field of view, high spatial resolution and survey efficiency. I will present an overview of some of the most important results on growing supermassive black holes, AGN and more exotic nuclear transients.

Radio Emission from radio quiet AGN in the time-domain era

Talk

Eileen Meyer

UMBC

Despite decades of study, radio emission from so-called radio-quiet active galactic nuclei (AGN) is still poorly understood. Several physical processes can contribute to the observed radio emission, including extreme star formation, hot gas associated with the compact X-ray emitting 'corona' very near the black hole engine of the AGN, shocks from relativistic winds, and nascent, small-scale, and/or failed relativistic jets. In this talk, I will describe the new insights we have gained from time-domain radio studies, both for complete samples (the PG Quasars) and unique objects like changing-look AGN 1ES 1927+654. The time domain is a powerful tool to break degeneracies and allow us to determine the physical origin of the radio emission and how it can be used as a probe of the central engine, the accreting super-massive black hole.

Modelling transient relativistic X-ray absorption features in IRAS 13224-3809

Poster

Darius Michienzi

University of Bristol

The narrow line Seyfert 1 galaxy IRAS 13224-3809 exhibits rapid, high amplitude X-ray variability. This provides an excellent opportunity to study how the changing flux state affects the energy spectra of AGN and to conduct reverberation mapping of the inner accretion disc. Using archival XMM-Newton data and custom reduction script we split the observations into three distinct flux states with equal counts producing spectra of the AGN in high, mid, and low states. The spectra are modelled using the SpectralFitting.jl fitting package with the strong relativistic effects calculated by the Gradus.jl ray tracer. The absorption is known to be variable with a highly blue-shifted Fe XXV or Fe XXVI absorption feature appearing in the low flux state around 8.5 keV. This highly blue-shifted feature could be due to an ultrafast outflow or more local ionised absorption in a disc atmosphere. We use Gradus.jl to explore radiative transfer through different disc and corona geometries near the black hole and present our preliminary results for disc absorption models.

Talk

Fingerprints of Black Hole Feedback: the Chandra answer to a Cosmic Mystery

Riccardo Middei
SSDC-ASI/INAF-OAR/Harvard & Smithsonian CfA

The strong correlation between the mass of a galaxy and its central black hole is likely explained by the so-called AGN feedback. The physical mechanisms responsible for the feedback are not yet known but each of the possible proposed processes (photoionization, relativistic jet and wide opening angle winds) imprints distinctive signatures in the X-rays, hence their analysis provides unique clues on the main driver of the feedback. In light of this, we performed a systematic evaluation of the overall X-ray luminosity and properties of a sample of Compton Thick AGN observed with Chandra which is the only instrument sharp enough to separate the active galactic nucleus itself from the surrounding parts of the galaxy where these signatures are found. In this talk, I will report on the X-ray spectral properties and the photoionized and thermal luminosities dominating the different emission components of 20 Compton-Thick AGN and discuss what this implies for the origin of the feedback in these objects.

Talk

An update on X-ray quasi-periodic eruptions from the nuclei of low-mass galaxies

Giovanni Miniutti
Centro de Astrobiología (CAB)

Quasi-Periodic Eruptions (QPEs) are short-lived, high-amplitude soft X-ray burst from SMBHs that typically recur every few hours to few days. Following their first detection in 2018, QPEs have been identified in the nuclei of about ten nearby low-mass galaxies thus far. Despite the lack of any significant X-ray absorption, the spectra of QPE-emitting galactic nuclei do not exhibit optical nor UV broad emission lines, and a rather clear connection between QPEs and Tidal Disruption Events (TDEs) is now emerging. Based on observational evidence and theoretical arguments, QPEs might represent the electromagnetic counterpart of extreme-mass ratio inspirals (EMRIs), one of the most interesting sources of gravitational waves (GWs) that are among the targets of future space-based GW observatories. I will review the current observational status and latest developments in connection with (some of) the proposed interpretations for this extreme-variability phenomenon.

The (resolved) LOFAR view of AGN

Talk

Leah Morabito
Durham University

Recent advances in computing have driven a revolution in new radio surveys at low frequencies. The LOw Frequency ARray (LOFAR) has been particularly successful in driving forward our understanding of AGN with surveys at 150 MHz. With baselines up to 2,000 km, LOFAR can achieve sub-arcsecond resolution, opening the door to spatially resolved studies of AGN including a paradigm-shifting ability to carry out blind statistical studies exploiting this resolving power. In this talk I will review key AGN results from the LOFAR Two-metre Sky Survey, which has an expected final data release this year. I will also introduce new results on AGN using LOFAR's sub-arcsecond resolution imaging, which provides unique information on understanding the radio emission processes in radio-quiet AGN.

The dependence of quasar properties on the Eddington ratio

Talk

Chiara Niccolai
University of Florence

I present a study on the dependence of various quasar properties on their Eddington ratio based on the analysis of multiple observations of the same sources. This approach allows us to isolate the effects of the Eddington ratio from those of black hole mass, which typically dominates when comparing different objects. Specifically, I analyze the relationship between the X-ray spectral slope and the Eddington ratio, as well as how the X-ray to UV correlation varies with the Eddington ratio. These findings provide new insights into the accretion physics of quasars and their radiative properties.

Optical variability characterization of changing-state AGN candidates

Talk

Devika Mukhi-Nilo
Pontificia Universidad Católica de Chile

Changing-state AGN (CSAGN) are a subclass of AGN that show an almost complete appearance or disappearance of broad optical/UV emission lines and disk continuum emission on timescales as short as 6-12 months, presumably due to strong and rapid changes in their accretion rates, directly affecting the luminosity of the source. These extreme changes are argued to be at odds with the viscous timescales of these objects, suggesting a gap in our understanding of accretion. Detecting CSAGN events early and observing their evolution can provide important clues to aid theoretical developments. We present a statistical characterization of the optical and color variability of spectroscopic confirmed CSAGN sources based on 5-yr ZTF light curves, compared to the properties of "standard" SDSS QSOs across several different variability features. We try to identify outlier sources, which may help to better constrain and quantify photometric properties of CSAGN and extremely variable AGN. We investigate potential selection and trigger criteria for candidate CSAGN that could be confirmed by spectroscopic follow-up observations with the 4-metre Multi-Object Spectroscopic Telescope 4MOST in late 2025 as a part of the Chilean AGN/Galaxy Evolution Survey (ChANGES).

Talk

SED Variability as a Key to Changing-Look AGNs

Hirofumi Noda
Tohoku University

Some fraction of active galactic nuclei (AGNs) exhibit dramatic variations luminosity and spectral energy distribution (SED) variations on timescales of several years, causing their optical/UV broad emission lines to appear or disappear. This leads to a type transition between Type 1 and Type 2 AGNs, and such objects are now known as "changing-look AGNs." By investigating their X-ray, UV, and optical spectral variations, changing-look AGNs are thought to result from state transitions of accretion flows onto supermassive black holes, analogous to the transitions between high/soft and low/hard states observed in Galactic black hole binaries. In this presentation, I will discuss how the SED of AGNs changes as a function of key parameters such as black hole mass and mass accretion rate and explain changing-look AGNs by accretion state transitions comparing with those observed in Galactic black hole binaries. Furthermore, understanding the broad-line region is crucial not only for changing-look AGNs but also for AGNs in general, as it serves as a key identifier of their types and activity. I will introduce recent advancements in our understanding of the broad-line region, particularly those achieved through high-resolution X-ray spectroscopy of AGNs with the X-ray microcalorimeter onboard the X-Ray Imaging and Spectroscopy Mission (XRISM).

Talk

Revealing Low-Luminosity AGN with Clean Infrared Spectral Energy Distributions from JWST

David Ohlson
University of Utah

The source of near- and mid-infrared emission from high luminosity AGN is still debated. The structural origin of this IR emission is particularly uncertain in low luminosity (LL) AGN, whose jet and radiatively inefficient accretion flow structures are less well understood than those in higher luminosity AGN. The exceptional resolution and sensitivity of JWST allows us to extract the AGN emission from surrounding stellar contamination using novel methods to measure a unique full spectrum of seven nearby LLAGN. We model the morphology of NIRSpec and MIRI IFUs at each wavelength to isolate the AGN emission through PSF fitting. Our

methods result in the first full-spectrum AGN IR SEDs. The resulting clean AGN flux measurements allow us to probe the empirical relation of IR emission to emission at other wavelengths as a function of Eddington ratio. We compare our results to those expected from jet- or dust-dominated spectra to reveal the primary sources of LLAGN IR flux. Finally, we compare our resulting spectra with existing AGN models and present them as valuable templates of LLAGN for future studies.

Mildly Super-Eddington Accretion onto Slowly Spinning Black Holes Explains the X-Ray Weakness of the Little Red Dots

Talk

Fabio Pacucci
Center for Astrophysics — Harvard & Smithsonian

JWST has revealed a population of low-luminosity active galactic nuclei at z ¿ 4 in compact, red hosts (the "Little Red Dots," or LRDs), which are largely undetected in X-rays. We investigate this phenomenon using General Relativistic Radiation Magnetohydrodynamics simulations of super-Eddington accretion onto a supermassive black hole (SMBH) with M_BH = $10\backslash\{\}^{\{\}}7 solarmassesatz 6, representingthemedianpopulation; thes$
$rayweak. ThehighestlevelsofX-rayweaknessoccurinSMBHsaccretingatmildlysuper-$
$Eddingtonrates (1.4 < f\_Edd < 4) withzerospin, viewedatangles > 30 fromthepole. X-$
$raybolometriccorrectionsintheobserved$ 2-10 $keVbandreach$ $10n\{\}^{\{\}}4atz = 6, 5timeshigherthantheh$
$raystacking. MostSEDsareextraordinarilysteepandsoftintheX-rays (medianphotonindex \Gamma$
$= 3.1$, mode of $\Gamma = 4.4$). SEDs strong in the X-rays have harder spectra with a high-energy bump when viewed near the hot (¿$10\backslash\{\}^{\{\}}8K) andhighlyrelativisticjet, whereasX-$
$rayweakSEDslackthisfeature. ViewinganSMBHwithin 10 ofitspole, wherebeamingenhancestheX$
$rayemission, hasa$ 1.5%$probability, matchingtheLRDX-raydetectionrate. Next-$
$generationobservatorieslikeAXISwilldetectX-ray-weakLRDsatz 6 fromanyviewingangle. Altho$
$Eddingtonrates, ourmodelexplains 50\% oftheirpopulationbyrequiringthattheirmassesareoverestim$
$Eddingtonrates, withlargecoveringfactorsandbroademissionlinesenhancedbystrongwinds, providi$
$consistentexplanationfortheirX-rayweaknessandcomplementingothermodels.$

Dissipative Warm Corona in AGN

Talk

Biswaraj Palit
Nicolaus Copernicus Astronomical Center

The soft X-ray excess in AGN appears as extra emission above a hard X-ray powerlaw at energies below 1 keV. In this talk, I will discuss the X-ray spectroscopic study on a sample of 22 AGNs observed by XMM-Newton in the context of 'dissipative' warm corona computed by TITAN photoionization code. Our general model of the inner disk emission involves the hot corona responsible for hard X-ray emission. And beyond it exists a two-layer accretion flow, where the warm corona covers a cold standard accretion disk. The outgoing emission from warm corona is computed using advanced photoionization radiative transfer code TITAN, which takes into

account all radiative processes, including lines from heavy elements, together with mechanical heating of the plasma. For the first time, we tested this on more than 90 EPIC-pn multi-epoch AGN spectra, which revealed the presence of a dissipative, optically thick warm corona. Apart from being optically thick ($\tau \sim 19$), we found a moderately high value of accretion energy being injected into the warm corona (5×10^{23} ergs cm^3 s^{-1}). Furthermore, a positive trend between accretion rate and warm corona size was observed. It spreads across a large range from $7 - 400$ gravitational radii and is more extended for higher accretion rates, suggesting that the presence of a cold standard accretion disk regulates the size of warm corona.

Talk

Understanding the Active Galactic Nuclei paradigm through variability studies: a path toward LSST

Maurizio Paolillo
Università di Napoli Federico II

Variability studies have been pivotal in building the so-called "unified model" of AGN, trying to explain the complex structure and often contradictory manifestations of accreting Black Holes; however the physical mechanism producing the astonishing changes in luminosity at every wavelength and at all timescales, remains a mystery. I will present the efforts to combine large multi-year surveys, in order to characterise the ensemble optical AGN variability. SDSS lightcurves allow to define a "fundamental plane" where AGN variability properties scale with mass and accretion rate, suggesting the existence of an underlying universal optical PSD. Combining SDSS, Pan-STARSS and ZTF to probe variability on timescales of decades, we find results challenging the predictions of simple DRW models, and pointing to the need to extend monitoring studies even further, as will be done by LSST.

Talk

Multi-wavelength broad-band variability of AGN

Iossif Papadakis
University of Crete

I will review results from recent multi-wavelength campaigns of nearby Seyferts and Quasars. I will discuss the correlation between the variations observed in the various energy bands, the energy dependence of the power spectrum and of variability amplitude, from the X-rays to the UV and optical, and the constraints these observations put on various models.

Properties of the X-ray corona in AGN at intermediate redshifts

Talk

Sara Peluso
INAF

Supermassive black holes (SMBHs), with masses between 10^6 and $10^{10} M_\odot$, are typically found at galaxy centers. When an SMBH is active, it accretes matter, forming a hot accretion disk that emits as a multitemperature blackbody. These galaxies are known as Active Galactic Nuclei (AGN). SMBH accretion is closely linked to galaxy evolution, suggesting a co-evolution scenario. To explore this connection, it is essential to study the innermost regions near the SMBH, including the UV-emitting accretion disk and the X-ray-emitting hot corona. The corona's emission arises from inverse Compton scattering, where UV photons are upscattered by energetic electrons. This study examines the coronae of 25 luminous AGN observed in the SUBWAYs campaign (SUpermassive Black holes Winds in XrAYs), which targets QSOs with $L_{bol} \sim 2 \cdot 10^{44} - 2 \cdot 10^{46}$ at redshifts $< z < 0.40.1 < z < 0.4$. Coronal properties, such as electron temperature, optical depth, and high-energy cut-off, are derived through a NuSTAR program extending their energy range to 40-50 keV. Simultaneous soft (0.3-2 keV) and hard X-ray analysis reveals a median soft excess temperature of 0.30 keV, consistent with a warm corona scenario. A median high-energy cut-off of 61 keV, lower than the typical 100-150 keV in local Seyfert galaxies, suggests that more luminous AGN may host cooler coronae.

Quasar Winds and Radio Emission: Importance of covering fraction and dust

Talk

James Petley
Leiden Observatory

Luminous quasars should host the most powerful forms of AGN feedback, given their high accretion rates and a radiative output that dominates over that of their host galaxy. Two important sub-populations of quasars are the Broad Absorption Line Quasars (BALQSOs), which show fast-moving outflowing gas in their spectra, and Red Quasars, which have increased dust-reddening. Recently, these populations have been found to be over-represented in sensitive radio surveys implying a higher rate of interaction jet or wind interaction with the ISM. This enhancement implies a much larger covering angle for accretion disk winds than estimated through their fraction in optically selected surveys, a feature that simulations and modellers should take note of.In this contribution, I will present my work on the radio properties of BALQSOs and red quasars demonstrating that the preferred interpretation for these sources is as an evolutionary stage in the life of massive galaxies and that the two populations are likely linked. I will begin with results from the LOFAR radio telescope combined with SDSS spectra and finish with my current work utilising Euclid imaging, DESI spectra, and high-resolution, deep radio imaging that exceeds the performance of the SKAO. Through composite spectra and testing of a theoretical wind model, I show that radio emission may be triggered by outflows inducing shocks in the ISM of these galaxies. Given the link between the populations, I demonstrate that dust could play a crucial role in the shielding and launching of quasar winds.

Talk

The Sparkling X-ray Properties of Luminous QSOs at Cosmic Noon

Enrico Piconcelli
Osservatorio Astronomico di Roma - INAF

The most luminous QSOs ($\log(L_{\rm bol}/L_\odot) \gtrsim 14$) at Cosmic Noon ($z \approx 2$–4) provide a unique opportunity to deepen our understanding of the physical processes near the most massive SMBHs and the SMBH-galaxy coevolution at the high-luminosity end. We present the results of an extensive campaign aimed at exploring the X-ray properties of very powerful AGN. Our study focuses on 85 QSOs at $z \gtrsim 2$ selected within a narrow range of bolometric, UV and MIR luminosity, with rich multi-band data, completing their X-ray coverage through Chandra and XMM observations. Despite this homogeneity, we observe a broad dispersion in X-ray luminosity, with about one-third of the sources classified as intrinsically X-ray weak QSOs. This suggests significant heterogeneity in the properties of the X-ray corona and inner accretion flow, both within this population and compared to typical, less powerful AGN. Interestingly, the X-ray continuum slopes are similar to those of lower redshift, lower $L_{\rm Bol}$ AGN, with no dependence on $\lambda_{\rm Edd}$ or X-ray weakness. These findings improve our understanding of the AGN nuclear properties parameter space, emphasizing the need for caution when using $L_{\rm Bol}$, $L_{2500\text{Å}}$, $L_{6\mu\rm m}$, and $\lambda_{\rm Edd}$ to estimate the X-ray properties of luminous QSOs. Furthermore, the blue-shifted velocity of the CIV emission line (indicating nuclear ionized winds) strongly depends on L_{2-10} but not on $L_{2500\text{Å}}$, $L_{6\mu\rm m}$, or $L_{\rm Bol}$. Accordingly, the X-ray corona (or the coupling between the accretion disk and coronal emission) and the kinematics of the inner emission-line region may mutually influence each other in these highly-accreting, powerful AGN.

Talk

Accretion-ejection connection in highly-accreting supermassive black holes

Ciro Pinto
INAF - IASF Palermo

The discovery of fully-grown supermassive black holes (SMBHs) powering active galactic nuclei (AGN) at high redshifts challenges the theories of black hole growth, requiring long periods of high accretion, most likely above the Eddington limit, where powerful outflows are expected to be launched by radiation pressure. These objects are difficult to study in detail but in the nearby Universe there are SMBHs that shine near and above their Eddington limit and can be used as proxy for early SMBHs. Their most extreme winds of ionised plasma can reach relativistic speeds

(ultra-fast outflows, a.k.a. UFOs), as predicted by theory of super-Eddington accretion. However, there are still several open questions on UFOs: 1) What is the mechanism accelerating winds up to relativistic speeds? 2) How much do they affect the overall accretion process and SMBH growth? 3) Are UFOs actually powerful enough to drive AGN feedback (accounting for their solid angle and duty cycle)? Here, I provide some answers showing our recent results obtained with the combination of high-resolution X-ray spectroscopy and spectral-timing studies of an ad-hoc XMM-Newton data sample of highly-accreting SMBHs. In particular, we found correlations between the wind properties and the Eddington ratios and, more importantly, an exciting trend between the presence of UFOs and the disc variability unveiling disturbances of the inner accretion flow.

Decoding M87's emission: A New Physically Consistent Model for Its Active Nucleus

Talk

Sabrina Pizzicato

Doctoral School of Exact and Natural Sciences, University of Łódź

We present a physically consistent model for the active nucleus of the galaxy M87, constructed using general relativistic magnetohydrodynamic (GRMHD) simulations that include the energy balance of electrons. Our model simultaneously reproduces the broad-band spectrum, intensity, and polarimetric images of M87, offering a unified explanation of these observations. We find that the model allows us to explain the observations for a magnetically-arrested solution with a rapidly rotating black hole, and with approximately 10\{}% heating efficiency of electrons. In our solution, most of the radiation observed at frequencies above 100 GHz originates from the inner accretion flow rather than the jet. Our results highlight the critical role of electron energy balance in modeling active galactic nuclei (AGN), demonstrating that commonly used artificial prescriptions for electron temperature tend to overestimate it, leading to discrepancies with observed properties. This work underscores the necessity of physically motivated electron thermodynamics for accurately interpreting high-resolution VLBI images of M87 and other AGN.

Talk

X-ray polarization models: reprocessing in distant components of radio-quiet AGNs

Jakub Podgorny

Astronomical Institute of the Czech Academy of Sciences

Recent advances in X-ray polarimetry (particularly the IXPE mission results since 2022) proved that it is worth simulating the X-ray production and reprocessing in all AGN components in high detail, including those at parsec scales. A series of numerical X-ray spectropolarimetric models, which are applicable to trace the geometry and structure of the dusty tori, of the polar winds, of the outer accretion disc, or of the broad line regions inside radio-quiet AGNs will be presented. We assume a central Comptonized power-law source of X-rays, which is reprocessed in static axially symmetric structures. A Monte Carlo code STOKES is used, in some cases combined with additional calculations, which allows to study parameters related to observer's inclination and components' location, shape, size, density, or ionization up to some degree of consistency. Relevant applications to XRBs will be shown, including X-ray blackbody-like illumination instead of the power-law spectrum of the source. I will clarify the strengths and weaknesses of each model, mention particularly interesting examples in the parameter space with high predictive power with respect to the IXPE mission or compared to X-ray spectroscopy, and highlight those models, which are ready-made for polarimetric fitting in XSPEC between 0.1 and 100 keV.

Poster

Where does AGN activity occur within the cosmic web?

Meredith Powell

Leibniz Institute for Astrophysics Potsdam (AIP)

The large-scale environments of accreting supermassive black holes provide powerful insights on the intertwined histories of structure growth, black hole growth, and galaxy evolution. One way to probe these environments is via the spatial clustering of active galactic nuclei (AGN). Using new data from the BASS and HETDEX surveys, I will present recent AGN clustering measurements as a function of various AGN properties at low (z 0.03) and moderate (z 2.5) redshifts. To interpret these measurements, I forward-model AGN in cosmological simulations to determine the main drivers of AGN clustering and to constrain the relationship between black holes and their host dark matter halos. I will discuss how these results inform the physical mechanisms for how black hole growth is triggered and quenched over cosmic time.

Revisiting High-z Blazars with NuSTAR and Swift-BAT: The Case of SWIFT J0909.0+0358

Poster

Gloria Raharimbolamena
University of Bristol

Blazars are a subclass of radio-loud active galactic nuclei (AGN) with relativistic jets oriented toward the observer. They typically exhibit a flat or rising X-ray spectrum at high redshift, particularly in the hard X-ray band, which, along with their radio loudness, helps confirm their blazar nature. We present a multiwavelength study of SWIFT J0909.0+0358, a blazar candidate at redshift z=3.29. Despite being among the most luminous sources in the 157-Month Swift-BAT survey, it has not been classified as a beamed AGN in the catalog. However, its broadband spectral energy distribution (SED) indicates the presence of a powerful jet and a luminous accretion disk, making it an excellent candidate for probing the jet-disk connection in high redshift blazars. Although the source is a faint gamma-ray emitter, the inclusion of its first-ever NuSTAR data, along with Swift-XRT observation and the 157-Month Swift-BAT spectrum, allows us to better characterize its high energy SED. Our analysis reveals a flat spectrum source and constrains the cut-off energy of the hard X-rays. Using a jet and disk model in the broadband SED, we determine a higher Bulk Lorentz Factor than previous studies, suggesting a fast-moving jet with a jet power ten times the disk luminosity. Though this is model-dependent, our results are consistent with existing literature on blazars z¿3. I will discuss our current progress and how future hard X-ray missions, such as a High Energy X-ray Probe-like concept, could provide deeper insights into the jet properties of high redshift blazars.

The wind properties of the eROSITA-selected SDSS-V quasar sample

Talk

Amy Rankine
University of Edinburgh

Quasar winds are evident in rest-frame UV spectra in the form of blueshifted broad emission lines. How such winds are launched – and how such launching relates to the physical state of the accretion disc system that powers quasars – remains a key open question. SDSS-V follow-up of eROSITA sources is yielding a large quasar sample for which we have access to their wind properties and (via measurements of the X-ray, UV and optical emission) constraints on their accretion state. I will present new measurements for a sample 4000 quasars at redshifts 1.5-3.5 that quantify how the strength of quasar accretion disc-winds (from the CIV emission line) depends on both the strength of the UV ionising continuum (probed via HeII emission) and the X-ray properties derived from the eROSITA spectra (i.e., photon index and column density). We show that quasars with a given X-ray luminosity have a broad range of wind properties that appear to depend most strongly on the strength of the UV-bright inner accretion disc (revealed by the HeII emission line strength). A strong UV component can lead to over-ionisation of the wind such that the outflow

strength is decreased. These results point to radiation-driven winds whose strength and presence are highly sensitive to the physical structure of the accretion system. The X-ray photon index and column density, however, do not appear to impact the strength of the wind. With this information in hand we can gain a new perspective of the wind properties of the X-ray selected quasars.

Talk

New Insights from XRISM Observations of Ultra Fast Outflows

James Reeves
Catholic University of America

Ultra fast outflows (or UFOs) are known to be present in about 40% of AGN, with velocities ranging from 0.03c to greater than 0.3c. Observations, prior to XRISM, which were are mainly based on CCD resolution X-ray spectra, revealed smooth absorption/emission profiles that could be characterized by a single terminal velocity wind component. This picture is now changing with XRISM and thanks to the high resolution (5 eV at Fe K) afforded by the Resolve calorimeter. Here, XRISM observations of the UFOs in the nearby QSO PDS 456 (PV phase) and PG 1211+143 (cycle 1), will be discussed. In PDS 456, at least five velocity components are detected in the iron K band, ranging in velocity from 0.22-0.33c. In PG 1211, multiple velocity components are present in the Fe K band around 0.1c, which may also extend to even higher velocities. Soft X-ray counterparts to the wind components are also observed, e.g. via XMM-Newton RGS observations. The new observations show that, in reality, the accretion disk winds are likely to be far more clumpy and structured than previously envisaged from past observations. The implications for the structure and energetics of the disk winds will be discussed.

Talk

Millimeter continuum emission as a probe of accretion in AGN

Claudio Ricci
University of Geneva

Recent studies suggest that the nuclear millimeter continuum emission observed in nearby AGN could originate from the same population of electrons responsible for the X-ray emission that is ubiquitously observed in accreting black holes. In my talk, I will present the results of several dedicated high-spatial resolution ($\sim 60 - 100$ milliarcsecond) 100\{},GHz ALMA campaigns on a volume-limited, hard X-ray (>10 keV) selected, sample of radio-quiet AGN. I will discuss the spectral, variability and polarimetric properties of this component, and show that nuclear mm emission is ubiquitous in non-jetted AGN. Our high-resolution observations reveal a tight correlation between the nuclear 100\{},GHz and the intrinsic X-ray emission, which highlights the potential of ALMA continuum observations to detect heavily obscured AGN (up to an optical depth of one at 100GHz, i.e. $\sim 10^{27}\,\mathrm{cm}^{-2}$).

Moreover, I will discuss how the spectral properties of the mm continuum emission can provide constraints on fundamental properties of the nuclear plasma and the accretion flow, such as the magnetic field strength and the fraction of non-thermal electrons in the X-ray corona.

The Physical Drivers of Quasar Spectral Properties

Talk

Guido Risaliti
University of Florence

The spectral shape of quasars exhibits a striking and somewhat unexpected uniformity across a wide range of luminosities, redshifts, and spectral bands. I will review the key observational results supporting this nearly “universal” spectral energy distribution (SED) and present new data that further reinforce this finding. I will then propose a revised interpretation based on the standard geometrically thin, thermal accretion disk, incorporating updated black hole mass estimates. Within this framework, I predict that nearly all optically selected quasars in the SDSS survey have an emission peak in the (unobservable) spectral region beyond the Lyman break.

Constraining the X-ray/Optical Transfer Function in AGN Using Long-Term Light Curves and Simulations

Poster

Pablo Saavedra
Universidad de Chile

Active Galactic Nuclei (AGN) are among the most luminous and variable sources in the universe, powered by accretion onto supermassive black holes. AGN exhibit variability across the entire electromagnetic spectrum, from gamma rays to radio wavelengths In particular, the correlation between X-ray and optical variability provides key insights into the structure and reprocessing mechanisms of the accretion disk. By analyzing the variability in these bands, we can investigate how X-ray emission from the corona is reprocessed by the disk into optical light, providing insights into the accretion disk structure.In this work, we analyze the variability of 6 AGN with long-term light curves spanning 10 years, obtained from SWIFT. Using these data, we compute their PSDs using the Mexican hat method (Arévalo+2012) and derive their X-ray/optical transfer functions, which describe the delayed response of the optical emission to variations in the X-ray flux.To interpret our results, we compare the observed transfer functions with simulations based on the ‘KYNXiltr´ model presented on Kammoun+2023, which predicts the expected response of the emission for a given band to X-ray variability on a broad set of AGN parameters, including black hole mass, accretion rate, and disk geometry. This comparison allows us to constrain the disk reprocessing timescales and the reprocessing efficiency assessing the consistency of current disk reverberation models with observations.Our findings provide insights into the connection between X-ray and optical variability in AGNs and the physical mechanisms driving their multi-wavelength emission.

Talk

X-ray-selected AGN in dwarf galaxies: the eRASS1 revolution

Andrea Sacchi
CfA — Harvard & Smithsonian

Supermassive black holes (SMBHs) reside in the heart of virtually every massive galaxy. However, much less is known about whether dwarf galaxies, local analogs of high-redshift environments, commonly host SMBHs. We explored the recently published eROSITA X-ray catalog and built a sample of actively accreting SMBHs in local dwarf galaxies. To date, this uniformly selected sample of 74 AGN is one of the largest compilations of X-ray-selected SMBHs hosted by dwarf galaxies. I will present the sample-building procedure we adopted and the properties of the sources we selected. I will also discuss how, by comparing our sample with semi-analytical models, it is possible to extract precious information about the growth history of SMBHs which could help constrain different seeding mechanisms of the most mysterious building blocks of our Universe.

Talk

Are red quasars in a young, dusty, blow-out phase?

Ciera Sargent
Durham University

Red quasars exhibit a higher incidence of compact (galaxy-scale or smaller) radio emission than blue quasars, arising from systems near the radio-loud/radio-quiet threshold. This result cannot be fully explained by the standard orientation model, instead favouring red quasars as a distinct phase in a quasar's lifecycle, possibly an obscured-to-unobscured transition where low-power jets and/or AGN-driven winds drive away gas and dust. Previous work has focused on classifying radio morphologies of red and blue quasars in one radio frequency band, but radio emission can differ significantly across frequencies, with lower frequencies probing older electron populations.For optically selected red and blue quasars, I compare radio morphologies across 3 surveys (FIRST: 1.4 GHz; VLASS: 3 GHz; LoTSS: 144 MHz) and find further differences not explained by the orientation model. Red quasars are significantly less likely than blue quasars to show extended low-frequency radio emission, suggesting fewer episodes of past activity and a younger evolutionary stage. Red quasars compact in all 3 surveys show the highest radio detection rates and steeper radio spectral slopes than blue quasars, indicative of synchrotron emission. Additionally, there appears to be an intrinsic connection between the amount of dust and the production of radio emission, with the spectral slopes becoming steeper with higher levels of dust extinction. I suggest these compact red quasars represent a young, "dusty blow-out" phase, where a compact jet and/or AGN-driven winds interact with a dusty ISM, causing shocks and thus synchrotron emission, leading to steep spectral slopes and enhanced radio detection rates.

Probing the geometry of soft X-ray ultra-fast outflows through their variability in PDS 456

Talk

Riki Sato
The University of Tokyo

Ultra-fast outflows (UFOs), ejected from accretion disks at speeds of 0.03–0.3 c, are considered the most promising candidates for energy transport mechanisms that drive the coevolution of galaxies and black holes (BHs). However, the estimation of UFO kinetic energy remains highly uncertain, and their acceleration mechanism is not well understood. To address these issues, uncovering the geometry and spatial distribution of UFOs is crucial. In this context, we focused on PDS 456 (z=0.184), the only AGN where UFOs are consistently and significantly detected. We analyzed PDS 456 observations by XRISM and NuSTAR in March 2024, which provided broadband X-ray (0.4–20 keV) spectral coverage and variability information obtained from long-term data (500 ks). We found that the spectrum is heavily absorbed in the soft X-ray band (0.5–5 keV) and well explained by a soft X-ray UFO with partially covered, low-ionization ions outflowing at 0.2–0.3c. Both features are consistent with a scenario in which UFOs are expelled at speeds of 0.2–0.3 c. Furthermore, we found that the covering fraction of soft X-ray UFOs varied by approximately 5\{}% over 500 ks, which can be interpreted as the absorber crossing the line of sight, due to clumpy structures in the outflow. In this talk, we will focus on the soft band variability and present our method for detecting variations in the soft X-ray UFOs. Then, we will show the derivation of the UFO's distance from the BH, inferred from its crossing velocity, and explore the geometry of UFOs.

How to build the early most massive black holes: put jets in your toolbox!

Talk

Tullia Sbarrato
INAF - Osservatorio Astronomico di Brera

The formation and evolution of the first supermassive black holes have been put in the spotlight after the discovery of few hundreds extremely massive quasars at high redshift. An interesting twist in our understanding of the matter was introduced by the discovery of an unusual number of jetted sources: X-ray observations of blazars (i.e. AGN with jets aligned to our LoS) at $z > 4$ prove that the most massive active black holes are preferentially hosted in jetted quasars in the first Gigayear from the Big Bang. Jets might thus play a crucial role in fast assembling and accreting matter onto supermassive black holes. Investigating their occurrence and activity is not straightforward at high z: multi frequencies observations are needed to identify them, especially at high energies where the jet dominates the emission. Swift/XRT proved itself to be very efficient, but lately also eROSITA comes easily into play in this picture: its sensitivity in the soft X-ray energies nicely complements existing and/or new X-ray observations for some sources, gives the much needed multiwavelength view on others, or helps in identifying brand new blazar candidates.I will present our current knowledge about $z > 4$ blazars, a population that provides a comprehensive view on jet, accretion and mass features of the $M > 10^9 M_\odot$ jetted quasars. I will also dive into the inconsistencies that arise from low and high-frequency observations: do jet features change across cosmic time? What is their role in the evolution of the first supermassive black holes of our Universe?

Talk

Do coronal parameters regulate the hard X-ray variability in AGN?

Roberto Serafinelli
Universidad Diego Portales

The origin of X-ray variability in active galactic nuclei (AGN) remains one of the biggest open questions in high-energy astrophysics. In particular, the role of the X-ray-emitting corona, where inverse Compton scattering produces the observed hard X-rays, is still uncertain. Could coronal temperature (kT) and optical depth (τ) be the key regulators of variability?We address this by analyzing 46 NuSTAR observations of 20 AGN, deriving coronal properties from spectral fitting and measuring short-timescale variability through the normalized excess variance on 10 ks timescales. We find no direct correlation between the X-ray variability and either kT or τ. Instead, our results point to two possible scenarios: (i) the X-ray variability is primarily dictated by coronal size, scaling with black hole mass, rather than the intrinsic physical state of the corona; or (ii) fluctuations in kT and τ occuring on timescales shorter than 10 ks, beyond NuSTAR's ability to resolve, play a role in the observed amplitude variability. Disentangling these possibilities requires future high-throughput X-ray observatories capable of probing rapid coronal evolution in unprecedented detail.

Talk

LX – LUV Relation: effects of Optical Variability

Anastasia Shlentsova
UC Chile / UniFi / INAF

Optical variability in Active Galactic Nuclei (AGNs) is closely linked to the properties and dynamics of the accretion disk and the X-ray corona. Modelling optical light curves with stochastic processes has revealed anti-correlations between variability parameters and key physical parameters such as black hole mass, Eddington ratio, and bolometric luminosity, consequently providing insights into the relative size and geometry of the X-ray corona and accretion disk, as well as the reprocessing of X-ray photons. This is potentially valuable information, given that the exact nature of the interaction between the accretion disk and corona, which drives the observed relation between X-ray and UV luminosities (LX-LUV), remains unclear. To better understand the fundamental processes driving the LX-LUV relation, we assess several variability features from the ZTF optical light curves of 2000 blue quasars in the Lusso et al. (2020) sample and investigate the correlations between variability parameters, fundamental AGN properties, and the LX-LUV dispersion.

STORM2 - Variability in the multi-year, multi-wavelength monitoring of Mrk817

Talk

Matilde Signorini
European Space Agency / INAF OAA

Variability is a widespread property of AGN, and its study allows us to gain important knowledge about AGN physical properties and their evolution. In particular, the monitoring of AGN over long times with Reverberation Mapping campaigns has been proven to be a phenomenal tool for characterising the accretion disc, its surroundings and the interactions between different regions of the AGN. The Space Telescope and Optical Reverberation Mapping 2 (STORM 2) campaign is a comprehensive, multi-wavelength monitoring project targeting the Seyfert 1 galaxy Mrk 817. Observations lasted more than 500 days, with coordinated efforts from space-based observatories (HST, Swift, NICER, XMM-Newton, NuSTAR) and ground-based facilities. In this talk, I will review the campaign objectives, methodologies, and key results, which include: (i) the unexpected discovery of an obscurer that simultaneously affects the UV and X-ray emissions, which is consistent with a clumpy disk wind launched from the inner Broad Line Region; (ii) the detailed measurements of wavelength-dependent continuum lags that, across both high- and low-luminosity phases, can be largely explained by a combination of accretion disk reverberation and diffuse continuum emission; (iii) the dynamical modeling of the BLR, which provides insights into its geometry, kinematics, and stratification. Together, these findings underline the power of multi-wavelength reverberation mapping campaigns to understand the interplay between accretion, emission, and wind processes in AGN.

Recurring flares in Active Galactic Nuclei and peculiar optical emission lines

Talk

Marzena Sniegowska
Tel Aviv Univeristy

Active galaxies exhibit stochastic variability across all wavelength bands, but sudden, drastic flux changes over short timescales—sometimes accompanied by the appearance or disappearance of spectral features—challenge current models. These changes suggest that more abrupt alterations to the accretion flow should be investigated. With the rise of astronomical surveys, we are increasingly overwhelmed by transient events in Active Galactic Nuclei (AGN) and need to understand the mechanisms behind extreme variability phenomena. I will discuss recent findings on recurring flares in accreting AGN from both theoretical and observational perspectives. First, I will present mechanisms in AGN accretion disks that may cause recurring flares over a wide range of timescales, including radiation pressure instabilities, and compare them to other suggestions such as magnetic field-driven shocks and ionization instabilities. I will also present a peculiar nuclear transient recently identified in an AGN, exhibiting recurring optical flares over months to years. Photometric observations from SWIFT, ZTF, and ATLAS, along with spectral monitoring from Las Cumbres Observatory, reveal unusual evolution in the emission lines. This source shows strong broad Bowen fluorescence emission features that vary with the recurring continuum flares. This is the first case where we have tracked the simultaneous rebrightening of these Bowen features and the continuum. These rare spectral features provide a unique opportunity to study the innermost accretion flow and test model predictions for recurring instabilities, partial tidal stripping of stars, and the line-emitting regions.

Poster

Double-Peaked Narrow Emission Lines in Radio Galaxies: An Investigation

Agata Szkodzińska
Jagiellonian University

The spectra of active galaxies can be very diverse. Some objects are characterized by the presence of broad emission lines, while in others, primarily narrow lines are visible. The aim of this study was to examine the properties of double-peaked narrow emission lines in compact radio sources from the ROGUE I catalogue (Radio Sources Associated with Optical Galaxies and Having Unresolved or Extended Morphologies). A total of 32,616 objects from the catalogue were investigated. After a multi-stage data selection process, 5,058 objects were chosen for further analysis. The spectra of these objects were analysed for the presence of double peaks in the following lines: [O III]$\lambda\lambda$4959,5007, [N II]$\lambda\lambda$6548,6583, and H_α. The final sample, consisting of 180 sources exhibiting this characteristic, was used to fit functions to the profiles of these lines. The results obtained were then compared with findings from other studies on this topic.

Talk

Confronting AGN outflow and accretion models with SDSS quasar demographics

Matthew Temple
Durham University

One commonly-invoked launching mechanism for AGN outflows is radiation line driving. This mechanism depends on the SED of the ionizing continuum, so is closely linked to the structure of the accretion flow. Theories of line-driven winds therefore provide predictions as a function of SMBH mass and accretion rate. Here I test these predictions using 190,000 quasar spectra from SDSS where we can measure the shape of CIV 1549A and the strength (EW) of HeII 1640A emission. The blueshift of the CIV emission line is commonly interpreted as a tracer of quasar outflows, while the HeII EW traces the strength of the 10-100eV continuum which photoionizes the ultraviolet emission line regions. Above L/LEdd¿0.2, there is a strong mass dependence in both CIV blueshift and HeII EW. Large CIV blueshifts are observed only in regions with both high BH mass and high accretion rate, consistent with predictions for radiation line driven winds. The observed trends in HeII and 2 keV X-ray strength are broadly consistent with theoretical models of AGN SEDs, where the ionizing SED depends on the accretion disc temperature and the strength of the soft excess. At L/LEdd¡0.2, we find a dramatic switch in behaviour: the ultraviolet emission lines show much weaker trends, and no longer agree with SED models, hinting at changes in the structure of the broad line region. Overall the observed emission line properties are generally consistent with the radiation line driving scenario, where quasar winds are governed by the SED, which itself results from the accretion flow and hence depends on both the SMBH mass and accretion rate.

The curious case of NLS1s in radio

Talk

Irene Varglund

Aalto University

Narrow-line Seyfert 1 galaxies (NLS1s) are a peculiar bunch of active galactic nuclei (AGN). Although originally believed to be sources with little to no radio emission, these sources have been proven to be capable of launching and maintaining powerful relativistic jets. These AGN are characterized by their full width at half maximum (FWHM) of the broad Hβ emission line being a maximum of 2000 km s^{-1}, as well as by them having weak [O III] with respect to the broad Hβ (S[O III]/S(Hβ) ¡ 3). Several NLS1 galaxies also present strong Fe II multiplets. As these sources are identified based on their optical properties, from an optical perspective they are quite unified. Nonetheless, a common trait of NLS1s is that they are frequently misclassified. A study was released in 2017 were the authors claimed to have successfully identified 11 001 NLS1s. A follow-up study was made to investigate the sample, resulting in roughly 4000 of the sources considered most likely NLS1s, thus obtaining the cleanest NLS1 sample currently available. This sample has been used to perform an extensive radio study on these peculiar sources in both MHz and low GHz frequencies studying, e.g., detection rate, spectral index, radio luminosity, and other optical spectral properties of the sample. Although NLS1s are quite unified from the optical perspective, their behavior in radio is anything but unified. With this study, it is finally possible to study the population wide characteristic of NLS1s in radio.

Talk

The Millimeter and Xray relation in the most rapidly accreting supermassive black holes at z<0.15

Sophie Venselaar
Universidad Diego Portales

A correlation between the millimeter (mm) and X-ray emission from the nuclear regions of Active Galactic Nuclei (AGN) has been established for nearby and low bolometric luminosity (L_{bol} < 1e45 erg/s) sources, suggesting that both originate from the same region: the X-ray corona. This correlation is an important tool to study highly obscured AGN since mm emission can penetrate higher column densities than the X-rays. A correlation between X-rays and UV has been known to exist as well. However, for more luminous AGN, the UV to X-ray correlation has been shown to break down, but it remained unknown whether the mm would follow the UV or the X-ray emission. Calibrating these relationships is crucial to study AGN at higher redshifts ($z \sim 1-2$) since nearby, luminous AGN probe a similar luminosity range. In my work, we investigated the correlation of nuclear mm emission with X-rays and UV for nearby AGN with high Eddington ratios and high bolometric corrections. For this, we obtained new high-resolution Atacama Large Millimeter/submillimeter Array (ALMA) observations at 100\{},GHz and simultaneous Swift observations, to exclude the possible effects of variability. We found a deviation at high luminosities from the mm to X-ray correlation. However, we did find an extremely tight correlation between mm and UV emission. This suggests that the mm emission is tightly coupled to accretion processes, meaning that, besides synchrotron emission from the corona, additional processes might be at play.

Poster

Broad-band view of the soft X-ray excess in type-1 AGN simultaneously observed by XMM-Newton and NuSTAR

César Iván Victoria Ceballos
Instituto de Astronomía (IA-UNAM)

Active galactic nuclei (AGN) exhibit an excess of X-ray emission below ∼1 keV compared to the 2-10 keV continuum extrapolation. This feature is commonly named soft excess, and its origin is currently debated. In order to investigate the nature of the soft X-ray excess, we performed the first systematic analysis of *XMM*-Newton and *NuSTAR* observations for a sample of 22 type-1 AGN. The detailed spectral analysis in the 0.5-60 keV energy band is based on our previously published solid parameterization of the reflection features from ionized and neutral gas observed in the hard band of this sample. As to the soft band modeling, we tested Comptonization, relativistically blurred reflection, ionized partial-covered absorption, and black-body emission. Our results show that ∼90% of the sources are best fitted with multiple components to account for the soft excess, with contribution of the relativistically blurred reflection at the accretion disk and contribution of a black-body component. We derived the expected radius at which this black-body emission originates, which shows values consistent with originating at the outer parts of the accretion disk or the broad line region. We will also discuss the physical interpretation of the origin of the soft X-ray excess.

Reverberation Mapping of AGN Accretion Flows: Analysing Three Years of Ground-Based Optical Observations for NGC 3783

Poster

Roberta Vieliute

University of St Andrews

The compact inner regions of AGN can be resolved on sub-parsec scales using the powerful technique of Reverberation Mapping (RM). Time delays among correlated flux changes in different UV/Optical wavelength bands hold critical information about the size and structure of the accretion flow, allowing us to put to the test the standard AGN disc and light reprocessing models. We present an RM analysis of the highly variable Seyfert I galaxy NGC 3783, using three years of observations from our intensive broadband reverberation mapping campaign with the Las Cumbres Observatory. Our results are generally consistent with a standard, geometrically thin thermal disc model, with exceptions arising when analysing the variability on long timescales. There is evidence for contamination from an extended reprocessor in both the lag spectrum and the timescale-resolved time delays which may be biasing AGN disc size measurements.

Coronal lines: new clues on winds and inner region geometry

Talk

Martin Ward

Durham University, UK

Based on their velocity width and (often) blue shift, highly ionised species (coronal lines) are thought to arise from a zone between the broad line region, and the lower density extended forbidden line region. A puzzle has been why only a small fraction of type 1 AGN exhibit strong coronal lines. Using composite SDSS spectra combined with ultraviolet (GALEX) and infrared (2MASS and WISE) infrared data to produce SEDs, we look for statistical differences between strong and weak coronal line AGN. The role of winds from the inner torus and lines of sight are explored.

Talk

Are the black hole masses right? Unveiling the central engine of AGN by reverberation-mapping and implications to mass estimation

Jong-Hak Woo
Seoul National University

Black hole (BH) mass is a key parameter for understanding BH growth and AGN physics. The method of determining BH mass has been rapidly evolved over the last 20 years. I will present the latest results of the reverberation mapping (RM) studies based on the 6 year SNU monitoring project, including velocity resolved-lag measurements and BLR kinematical structures. Combining with literature sample, the new calibration of the Hbeta BLR size - luminosity relation shows a slope of 0.4, which is smaller than the popularly used 0.5 slope, along with a systematic trend with Eddington ratios. These results indicate serious limitation and systematic effects on single-epoch BH mass estimation. I will present a new calibration and the updated mass, particularly for high-luminosity AGN, i.e., JWST-based high-z AGN. I will also discuss the relatively new disk-mapping method and the potential of the disk size-luminosity relation for mass estimation in the era of the large photometric surveys, i.e., LSST and SPHEREx.

Talk

Accretion and Multi-scale Ejection Resolved by X-ray Observations from 1999 to 2025

Satoshi Yamada
RIKEN

To make a database of multiphase (e.g., ionized/dusty/neutral/molecular) outflows, we have launched a new project, X-ray Winds In Nearby-to-distant Galaxies (X-WING). As the first study of the X-WING project, we constructed a sample of 132 AGNs in z $\sim$ 0-4 exhibiting blueshifted absorption lines of X-ray winds reported by the end of 2023. With a thorough investigation of the previous works, we created the database of outflow properties of 583 X-ray winds, including outflow velocities (Vout), outflow radii (Rout), and mass/kinetic outflow rates (Mout/Eout). The ultrafast outflows (UFOs) and slower warm absorbers cover the Vout range of $\sim$100 to 100,000 km/s. Interestingly, we found a clear velocity gap around Vout $\sim$ 10,000 km/s. Although the gap can be an artifact due to the confusion of the emission/absorption lines and Fe K edge in the 6-7 keV band, there is another possibility that the UFOs and galactic-scale outflows are physically disconnected. Moreover, we introduce our unprecedented high-energy-resolution spectra with XRISM operated from 2023 and provide new insights into the origin of the Vout gap and the plausible multi-scale structure of X-ray winds (e.g., Yamada+24b, ApJS; XRISM Collaboration+). Finally, we will also report the latest results of the UV-to-radio SED fittings and studies on multiphase outflows for the X-WING AGNs and discuss the accretion and multi-scale ejection in AGNs.

Exploring degeneracies in X-ray models of accretion flows onto the central engine

Poster

Andrew Young
University of Bristol

It is widely accepted that the central engines of bright active galactic nuclei consist of an optically thick accretion disc illuminated by an X-ray corona. The back-scattered disc spectrum is blurred by relativistic effects that are dependent on the spacetime, disc geometry, corona geometry, and disc properties. Careful measurements of emission line properties have been used to infer the properties of the system such as the black hole spin, disc inclination, and emissivity profile. We explore potential model degeneracies by simulating X-ray spectra for a range of different spacetimes, black hole spins, truncated, thick and thin discs, and extended corona models and seeing what parameters simple model fits recover when assuming thin discs, and lamp-post coronae. We will discuss the impact of these degeneracies on the interpretation of real data.

Evidence to the jet powering mechanism in radio quasars from the LOFAR Two-metre Sky Survey

Talk

Bohan Yue
University of Edinburgh/Leiden Observatory

A key component of the AGN feedback is the injection of kinetic energy from radio jets, yet there is still a fundamental lack of understanding of why quasars, otherwise very similar, have such a wide range of radio jet powers, and the impact of radio jets. Using large samples from the LOFAR Two-metre Sky Survey (LoTSS) DR2 coupled with a Bayesian parametric model, we can separate jet from host galaxy radio emission, measure the radio power distribution of quasar jet as a function of properties including bolometric luminosity, redshift, black hole mass, and environment, to investigate the powering mechanism of radio jets. Our results show that all quasars host radio jets across a full range of powers, while their power is mostly governed by local activities. Our model allows us to redefine the radio AGN populations based on the jet dominance rather than single-valued 'radio loudness'; this new physically motivated definition unifies previously divergent results and provides a coherent picture of the black hole mass impact on AGN jets, where a full range of jet powers is seen at all black hole masses, while only quasars hosting the most massive black holes show an enhancement in radio emission due to the higher incidence of powerful jets. We will present new, concrete evidence showing how the production of powerful jets is linked to the large-scale environment and accretion mode of quasars. The combination of these results sets tight observational constraints on the launching mechanism of powerful radio jets in massive quasars.

Talk

Unprecedented X-ray insights on the unique nuclear properties of quasars at the Epoch of Reionization

Luca Zappacosta
INAF-OAR

The first luminous quasars (QSO) discovered at the Epoch of Reionization (EoR; $z > 6$), when the universe was 1 Gyr old, are already powered by $> 10^9\ M_\odot$ supermassive black holes (SMBHs). This implies a rapid and challenging SMBH growth. We aim at shedding light on their nature by probing the innermost QSO regions, very close to the growing SMBH, through X-ray emission.\{}\{}Leveraging our $\sim$ 700 hours XMM-Newton Heritage program, HYPERION, we are conducting an unprecedented systematic X-ray investigation of 18 luminous QSOs at EoR, which experienced the most rapid SMBH growth. Our findings strikingly reveal a new regime for their nuclear properties: their X-ray continuum slopes (Γ) are significantly steeper than those reported at $z < 6$.\{}\{}We present our extensive search for possible correlations between Γ and other key physical parameters. We find:(i) a correlation between Γ and the velocity of AGN-driven ionized winds;(ii) an indication that QSOs with steeper Γ are those that underwent the most rapid SMBH growth.We interpret these findings as evidence that these early QSOs have predominantly accreted at or above the super-Eddington rate throughout their formation history.\{}\{}Finally we will: (i) present results from our recent XMM-Newton Large program, to extend the investigation to sources with a wider SMBH growth range than currently probed; (ii) discuss the implications of our results for the X-ray weakness in JWST-discovered high-z AGN, as well as the prospects of $z > 6$ surveys with future X-ray observatories.

Poster

A New Timescale−Mass Scaling for the Optical Variation of Active Galactic Nuclei across the Intermediate-mass to Supermassive Scales

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The variability of active galactic nuclei (AGNs) has long been an essential avenue for exploring the accretion physics of black holes (BHs). The structure function (SF) method is commonly used to analyze the AGN variability, which can be well described by a damped random walk (DRW) process on timescales longer than $\sim$ weeks, and departures from the DRW process on shorter timescales have been reported. However, such departures have so far been reported primarily in supermassive AGNs, mainly quasars. In this work, we utilize the high-cadence, multiwavelength monitoring of NGC 4395 harboring an intermediate-mass BH, we unveil at the intermediate-mass scale for the first time, prominent departures from the DRW process at timescales shorter than $\sim$ hours in all three nights and bands. Furthermore, by comparing the SFs of NGC 4395 with those of four AGNs at the supermassive scale, we suggest a new scaling relation between the timescale (τ; spanning nearly

three orders of magnitude) and BH mass (M_{BH}): $\tau \propto M_{BH}^{\gamma}$, where the exponent γ is likely between 0.6 and 0.8. This exponent differs from most previous measurements, but confirms a few, and is consistent with a recent theoretical prediction, suggesting a similar accretion process in AGNs across different mass scales.

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