Book of Abstracts

Book of Abstracts of the 15^{th} Italian Meeting on AGN:

Active Galactic Nuclei: from the present-day Universe to the Dark Ages

jointly organized by the Astronomical Observatory of Padua (INAF) and by the Department of Physics and Astronomy of the University of Padova, to be held in Padova on September 23-27, 2024.

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Frontiers in Astronomy and Space Sciences

Scientific Program Overview

Session 1: The Central Engines of AGN, accretion and ejections (including relativistic jets), and analogies with stellar mass black holes

Session 2: The Circum-nuclear Regions of AGN

Session 3: Coevolution of Black Holes and Galaxies and AGN feedback

Session 4: Time domain and variability studies

Session 5: Multi-messenger studies and multi-wavelength surveys, including gravitational wave and neutrino astronomy

Session 6: Perspectives offered by the ground and space based instrumentation under development with Italian participation)

Session 7: Large Scale Environment, High-z AGN and Cosmology

Contents

Welcome address to AGN 15

Welcome address and introductory information to AGN 15 Sept 23 14:00

Paola Marziani, Mauro D'Onofrio, Bianca M. Poggianti

Abstracts: Session 1

Monday, September 23, 2024

Radio-Loud AGN with Hubble and Webb: latest results from low (z∼1) to high (z∼8) redshift

Sept 23
14:15
Invited

Marco Chiaberge

Over the past two decades we have been using HST to study radio-loud AGNs mostly in the nearby universe. Recent results in sources at redshifts between 1 and 2 (what was once thought to represent the "high-z" region of the parameter space) show that these active black holes are closely linked to the properties of their host galaxies. While galaxy mergers do not seem to directly "trigger" the bulk of AGN activity, recent mergers or ongoing mergers are ubiquitously present in association with this specific class of AGNs. One of these objects, 3C 186, is currently thought to be one of the best gravitational wave recoiling black hole candidate, resulting from a relatively recent major galaxy and BH merger. Recently, we extended our analysis at z∼ 1-2 using HST observations of the hosts of RLQSOs, which unveiled spectacular merging galaxies, both confirming and extending previous results. After the launch of JWST, a new region of the parameter space has opened: I will briefly discuss the case of an interesting radio galaxy we recently discovered, that is likely to be located at $z_{\rm phot} \sim 7.7$. If confirmed, this would be the most distant radio loud AGN known to date.

Relativistic Thermodynamics of AGNs' jets

Sept 23
14:45
Contributed

Vincenzo Antonuccio-Delogu

Relativistic Thermodynamics of AGNs' jets. Relativistic jets associated to AGNs have been demonstrated to significantly contribute to the energy budget of their host galaxies' Interstellar medium (hereafter ISM). Their dynamics is usually studied using a large set of (general and special) relativistic tools, but less attention has been paid to apply similar tools to consider their thermodynamics. Unfortunately, Relativistic Thermodynamics still today proves to be a rather elusive field, as witnessed by the circumstance that even the definition of temperature (and relativistic thermodynamic equilibrium), and its covariant transformation between moving frames,

are not assessed without ambiguities. In this short talk I will focus on the applications of Relativistic Thermodynamics to jet-ISM clouds interactions. In a recently submitted paper I have recomputed the relativistic transport coefficients for leptonic jet interacting with cold systems, and their ram pressure. Not surprisingly, the relativistic transformation of temperature turns out to be highly dependent on the Equation of State (EoS) of the combined jet-cloud system. In many astrophysically relevant situations the jet-cloud system does not reach thermodynamic equilibrium ,making thus the definition of temperature problematic.

Revisiting the Fourth Fermi LAT Catalog: the rise of gamma-ray emitting jetted Seyfert-type AGN

Luigi Foschini

Sept 23
15:00
Contributed

We considered the fourth catalog of gamma-ray point sources produced by the Fermi Large Area Telescope (LAT) and selected only jetted active galactic nuclei (AGN) or sources with no specific classification, but with a low-frequency counterpart. Our final list is composed of 2980 gamma-ray point sources. We then searched for optical spectra in all the available literature and publicly available databases, to measure redshifts and to confirm or change the original LAT classification. Our final list of gamma-ray emitting jetted AGN is composed of BL Lac Objects (40%), flat-spectrum radio quasars (23%), misaligned AGN (2.8%), narrow-line Seyfert 1, Seyfert, and low-ionization nuclear emission-line region galaxies (1.9%). We also found a significant number of objects changing from one type to another, and vice versa (changing-look AGN, 1.1%). About 30% of gamma-ray sources still have an ambiguous classification or lack one altogether. Reference: Foschini, L., et al., 2022, Universe 8, 587

A revolutionary view from low-luminosity radio-loud AGN in the local Universe: the FR0 radio galaxies

Ranieri Baldi

Sept 23
15:15
Contributed

A revolutionary view from low-luminosity radio-loud AGN in the local Universe: the FR0 radio galaxies Radio galaxies (RGs) are active galactic nuclei (AGN) able to launch relativistic jets, the most energetic phenomena in the Universe, which can have a large impact on galaxy evolution. Current high-sensitivity and high-resolution surveys have shed new light on properties of RGs, particularly in the local Universe ($z<0.3$) and at low luminosities (<1024 W Hz-1 a 1.4 GHz), where the bulk of the AGN population was not much explored in opposition to the well-studied powerful extended RGs, FRI and FRII. A large population of compact RGs, named FR0s, which differ from classical FRI/IIs, by lacking large-scale (>10 kpc) jet emission, is emerging from recent studies and is revolutionising our idea of an ordinary RG. These sources show host and nuclear characteristics similar to those of FRI radio galaxies. However, in the radio band, while FR0s and FRIs share the

same core properties, the kpc-scale diffuse component dominant in FRIs is missing in FR0s. I will present multi-band observations of FR0s, which provide hints of the ongoing accretion-ejection process in such a common class of RGs . High-resolution radio observations of a sample of FR0s provide evidence that parsec-scale jets in FR0s are mildly relativistic with a bulk velocity on the order of 0.5c or less. A jet structure with a thin inner relativistic spine surrounded by a low-velocity sheath, launched by a low-spinning black hole, could be in agreement with the observed multi-band FR0 properties.

A JVLA view of SUBWAYS quasars: one step closer to the SMBH

Sept 23
15:30
Contributed

Elisa Amenta

Since their discovery, accreting supermassive black holes in the cores of active galaxies have gained progressive importance, especially due to their role in regulating the evolution of their surrounding environment. In the radio band quasars have been historically divided into radio-loud (RL) and radio-quiet (RQ) ones depending on the radio vs optical luminosity ratio. While in RL objects the main source of radio emission is thought to be a relativistic jet, in RQ ones the situation is more complex, and different mechanisms are proposed, including winds, low power jets and the innermost accretion disc coronal activity. The SUBWAYS (Supermassive Black Hole Winds in X-Ray) collaboration aims at performing a detailed multi-wavelength investigation of a sample of $\sim$ 22 AGN at redshift z=0.1-0.5 with luminosity $\log(L_{\rm bol}) = 45 - 45$ to constrain the frequency and properties of Ultra Fast Outflows (UFO), which are formed close to the supermassive black hole, and provide support to QSO feedback models. In this talk I will discuss new radio observations of the sample, taken with the Jansky Very Large Array (JVLA) at 1.5 GHz and 6 GHz, aimed at investigating the properties of the radio emission including luminosity, morphology and spectral index, and thus unveiling its nature. In addition, I will present how these characteristics correlate with X-ray luminosity, wind-outflow velocities, host star formation rate, BH mass, and accretion rate.

Duty cycle and synchrotron ageing of giant radio galaxies

Sept 23
15:45
Contributed

Matteo Fanelli

Radio galaxies are a subclass of active galactic nuclei releasing energy in the environment via relativistic jets and they can undergo several phases of activity and quiescence. Giant Radio Galaxies (radio galaxies exceeding a linear scale of 0.7 Mpc) are one of the largest single entities in the universe and their exceptional size implies also an old age. They were historically very rare, but thanks to nowadays new generation surveys like the Low Frequency Array Two-metre Sky Survey their census raised up by more than two orders of magnitude. However, it is still unclear how they can reach such large sizes. Main hypothesis involve a local low-density environment favouring growth, or particularly powerful and collimated jets. Given their long activity, they are the ideal lab to probe the jets duty cycle as it is often possible to observe different radio phases. In this thesis we have investigated the duty cycle of giant radio galaxies with two different approaches. In the first part of this work we look for restarted radio sources via a spectral study, covering the low frequencies (<1.5 GHz) with surveys and the higher frequencies (>1.5 GHz) with Effelsberg 100-m single-dish observations. We compare the results from two different samples with different accretion regimes, finding no correlation between the accretion regime and the fraction of sources presenting a new radio phase in their core. In the second part of this thesis we present a detailed investigation of the giant radio galaxy B2 1144+35B. In particular, to estimate the age of the large-scale lobes we perform a synchrotron ageing modeling, while for the inner jets we consider dynamical arguments. In this way, we estimate an age of 12.6 Myr for the young radio phase, while 40-45/70-80 Myr for the older one, resulting in a fractional duty cycle of $\sim$ 60%, consistently with what found for other radio sources in previous works. These results suggest that, despite different accretion regimes and sizes, the ratio of the jet active phase over the total life of the radio source, and the fraction of recently restarted jets, have comparable values in the population of radio galaxies. This scenario will be further tested in the future through the study of larger samples of radio galaxies, thanks to the advent of the next-generation radio and high energy telescopes.

The nature of mJy Radio Galaxies: the study of the relation between jet and accretion disk properties

Sept 23
16:30
Contributed

Olena Torbaniuk

The nature of mJy Radio Galaxies: the study of the relation between jet and accretion disk properties Abstract Radio galaxies in the local Universe display diverse extended radio morphologies, optical spectra, and host galaxy properties, which as suggested by studies could arise from intrinsic differences in central SMBH parameters or jet content, or be extrinsically driven by the host galaxy and environmental properties. While research in this field has predominantly focused on the population of the brightest radio galaxies (e.g. 3CR and 2Jy catalogs with flux limits of Jy),

the results remain inconclusive and do not definitively support any of the proposed hypotheses. Moreover, recent studies of less powerful mJy radio galaxies have introduced additional complexity, revealing more compact radio structures compared to their brighter counterparts. In this work, we present the first comprehensive X-ray analysis for a sample of mJy radio galaxies combining optical data from SDSS DR7 and radio observations from NRAO FIRST and NVSS surveys. This extends the study of the radio morphology-accretion mode link, previously examined for Jy radio galaxies, to lower radio powers. We complemented the sample with X-ray data from Chandra, which allows to probe the SMBH accretion properties and processes fueling it at sub-pc/pc scales, and the thermal environments potentially responsible for change of radio morphologies at kpc scales. We analysed the X-ray spectra of 216 galaxies. When available, we collected radio classifications for objects in our sample from existing literature. For the 67 objects lacking such classification, we conducted our own visual classification using VLASS radio images. Using spectroscopic criteria (e.g., BPT diagrams, excitation index), we verified and updated optical classifications (LERG/HERG/SF) for 35 galaxies. Our sample includes 73 galaxies with extended FRI or FRII morphologies (mainly LERG, 8% HERG) and 112 compact galaxies (including FR0 and blazars; 52% LERG, 20% HERG, 29% SF), and 31 objects showing hybrid or uncertain morphologies. As preliminary results, we found that (a) Compact/SF galaxies significantly differ from other AGN-powered classes; (b) extended radio galaxies (FRI/LERGs, FRII/LERGs and FRII/HERGs) host more massive SMBHs than compact ones; (c) LERGs with different morphologies (FR0, FRI and FRII) have similar X-ray luminosity, but FR0/LERGs seem to accrete less efficiently than FRI/LERGs and FRII/LERGs, and all together are less luminous and less efficient than FRII/HERGs; (d) FRII/HERGs galaxies seem to be highly obscured and host slightly more massive SMBHs; (e) about 50% of FRI/LERGs (and nearly all FR0/LERGs) are in denser environments, while FRII/HERGs (and blazars) seem to avoid them, supporting the hypothesis that radio galaxies in clusters exhibit more inefficient accretion.

The Jet Mechanisms and Accretion Properties for Low-Excitation Radio Galaxies

Sept 23 16:45 Contributed

Xuhong Ye

Radio galaxies are a subclass of active galactic nuclei, which are suggested to be the parent populations of blazars. According to the accretion/ejection paragram, RGs can be classified into low-excitation or high-excitation radio galaxies. In this talk, we compiled a distance-limit (redshift $z<0.15$) sample of 434 low-excitation radio galaxies (Fanaroff-Riley type 0, I, and II radio galaxies) to discuss their jet formation mechanism with the ADAF (advection-dominated accretion flow) scenario surrounding the Kerr black hole, and compare their accretion/ejection properties with Fermi BL Lacertae objects. The maximum kinetic jet power for FR 0s and FR Is can be, respectively, explained by the pure Blandford-Znajek jet mechanism and hybrid jet mechanism, whereas about one third of FR IIs exhibit kinetic jet power that cannot be explained by the hybrid jet mechanism. The centre of the high

synchrotron peaked BL Lacs is dominated by ADAF, which is similar to the centre of both FR 0 and FR I radio galaxies. Eleven nearby BL Lacs, showing similar environments with FR 0s in Massaro et al., are cross-checked as high synchrotron peak blazars, strongly supporting that the high-frequency peak BL Lacs could be the reasonably beamed counterparts of FR 0s.

Radioastronomical Safari: Exploring the AGN Zoo with SHORES

Sept 23
17:00
Contributed

Meriem Behiri

In this presentation, we explore the advantages of integrating data from the radio to the far-infrared (FIR) spectrum for characterizing dusty star-forming galaxies (DSFGs). These galaxies are believed to be the star-forming progenitors of local massive quiescent galaxies and are pivotal in reconstructing the cosmic star formation rate density up to high redshifts (Talia+21,Enia+22,Behiri+23). Due to their heavily obscured nature by dust, DSFGs are often invisible in near-infrared/optical/UV bands, necessitating observations at longer wavelengths, primarily in the FIR band where dust emission occurs, and in the radio band, unaffected by dust absorption. By combining data from these spectral regions, even the most dust-obscured objects can be characterized, providing insights into their age, dust temperature, and star-formation activity, and enabling differentiation between various galaxy populations evolving throughout cosmic history (Behiri+24). In this context, we introduce the Serendipitous H-ATLAS fields Observations of Radio Extragalactic Sources (SHORES) survey. SHORES is a newly conducted survey at 2.1 GHz performed with the Australia Telescope Compact Array, comprising 27 shallow fields and 2 deep fields centered around a candidate lensed galaxy. These fields are complemented by Herschel observations (H-ATLAS sgp) and data from various surveys (KIDS, VIKING, Euclid, DES, eRosita..), as well as SKAO pathfinders surveys (e.g., RACS). The extensive 200+ hours of observations with the ATCA interferometer have enabled us to achieve a 33 uJy rms for the shallow fields and 5 uJy rms for the deep fields, resulting in a collection of more than 3200 sources. To fully characterize the radio spectra, the SHORES deep field is observed at 5.5, 9, and 20 GHz, providing crucial insights into various radio populations, including Active Galactic Nuclei (AGN) and Star-Forming Galaxies (SFGs) (Behiri+, in prep.). Additionally, all SHORES observations incorporate polarization measurements, offering a unique opportunity to explore the polarization nature across a substantial sample of AGN and SFGs (Galluzzi+, in prep.). This comprehensive, panchromatic approach provides a crucial perspective for unraveling the mysteries of the radio sky. The broad multi-wavelength coverage of the SHORES survey positions it as an ideal candidate for studying the diverse array of objects in the radio zoo, thereby preparing us for forthcoming SKAO observations.

Discovery of an unprecedented jet-galaxy interaction in Abell 160S

Alessandro Ignesti

Sept 23
17:15
Contributed

Galaxy clusters host a variety of galaxy types ranging from massive ellipticals at their centers to blue, star-forming spirals that enter the cluster following the large-scale cosmic structure. Low-frequency, radio-continuum observations provided by the LoTSS survey led to the discovery of an unprecedented interaction between the central, radio galaxy of the the galaxy cluster Abell 160 (z=0.04317) , GIN 049, and the infalling spiral galaxy JO36 (z=0.0407). The new low-frequency observation revealed that one of the radio jets ejected from GIN 049 encompasses the spiral galaxy JO36. Previous studies carried out with MUSE revealed that the hot, ionized plasma atmosphere of JO36, traced by Hα emission, is severely truncated with respect to its stellar disk. We further explore this unique system by including new uGMRT observations to map the spectral index all over the radio source. I will showcase the results of this multi-wavelength analysis. The emerging scenario is that the evolution of JO36 has been strongly driven by a combination of environmental processing, via the ram pressure stripping, and the encounter with the radio lobe. In turn, the galaxy passage left a trace in the radio-old lobe by re-accelerating the old relativistic electrons. This system represents a new, unique laboratory to study the astrophysics of relativistic plasmas in the jets of radio galaxies, and the effect of AGN feedback on galaxy evolution, thus it will be the object of future studies.

Jet reorientation in cluster-central radio galaxies: insights from VLBA and Chandra data

Francesco Ubertosi

Sept 23
17:30
Contributed

The imprints of feedback from cluster and group-central AGN, in the form of X-ray cavities, highlight the transitory, repetitive, and directional nature of jet activity. Recently, observations of misalignments between jets and X-ray cavities, or of misaligned jets and radio lobes, have raised concerns about the jet – bubble connection in cooling cores, and the processes responsible for jet realignment. In this talk, I will present our investigation of the frequency and causes of such misalignments in a sample of 16 cluster and group-central AGN. Using VLBA radio data we measured the parsec-scale position angle of the jets, and compared it with the position angle of the X-ray cavities detected in Chandra data. We measured a 30% – 38% chance to find a misalignment larger than $\Delta\Psi = 45$ when observing a cluster/group with a detected jet and at least one cavity. We determined that projection may account for an apparently large $\Delta\Psi$ only in a fraction of objects ($\sim$35%), and given that gas dynamical disturbances (as sloshing) are found in both aligned and misaligned systems, we excluded environmental perturbation as the main driver of misalignments. Moreover, we found that large misalignments (up to $\sim$90) are favored over smaller ones ($45 \leq \Delta\Psi \leq 70$). Overall, misalignments seem more likely related to actual reorientation of the jet axis, which may be caused by several engine-based mechanisms.

The curious case of the missing FeII bump in JWST low-luminosity AGN

Sept 23 17:45 Contributed

Bartolomeo Trefoloni

Observations of the James Webb Telescope (JWST) kept revolutionising our understanding of the early Universe in the last few years. One of the most intriguing class of objects discovered so far is arguably the hidden population of low-luminosity active galactic nuclei (AGN) at high redshift (z≥4), which exhibit significantly different characteristics with respect to their local counterparts. Examples of these features are their peculiar photometric colours, the lack of large scale ionised winds often observed even in low-luminosity local AGN and their remarkable X-ray weakness. I will present recent results based on a sample of 18 intermediate-to-high redshift sources, with JWST observations, which add a new peculiarity to this class of high-redshift sources, that is the weakness of the optical FeII ∼4570 Å bump. In particular, I will show that these objects significantly detach from the main observational trends observed locally (e.g. the 4D eigenvector 1). I will also compare these new findings to the X-ray properties of the sample, where we observe a clear correlation between X-ray detection and strength of the FeII bump. Lastly, I will discuss whether low-luminosity AGN in dwarf metal poor galaxies can be regarded as intriguing local counterparts of this elusive high-redshift population.

Phenomenology of super-Eddington accretion in AGN

Sept 23 18:00 Contributed

Sara Peluso

I will present the first systematic estimate of the coronal properties (electron temperature, optical depth, amount of reflection) in a sample of 23 luminous AGN (43.5< $\log L_X$ (erg/s) <44.8) beyond the local Universe ($0.1 < z < 0.4$), which are the targets of the Supermassive Black Hole Winds in Xrays (SUBWAYS) campaign, an XMM Large Program devoted to the systematic search for Ultra Fast Outflows in QSOs at $z > 0$. (Matzeu et al. 2023). The coronal properties are obtained through the novel analysis of a Nustar LP acquired to follow up the targets in the SUBWAYS program since it extends the energy coverage up to 40-50 keV. These results allow us to investigate, for the first time in a systematic way, the coronal properties of luminous QSOs at intermediate redshift, and together with literature results (Bertola et al 2022,Tortosa et al. 2018), possible correlations with luminosity, BH mass,Eddington ratio and redshift, also in relation to the presence of ultra fast outflows.

AGN Ultra Fast Outflows across Cosmic time

Sept 24
18:15
Contributed

Giorgio Lanzuisi

AGN-driven multi-phase and multi-scale winds are thought to be fundamental in shaping the SMBH/galaxy co-evolution process. In particular, Ultra Fast Outflows (UFOs), launched from the inner regions (tens of Rg) of the BH accretion disk, are thought to be the first engine powering the ionized, atomic, and molecular outflows seen at larger scales. They have been studied so far, mainly in local Seyferts. Investigating the prevalence of UFOs in QSOs beyond the local Universe, and possibly at Cosmic Noon (z=1-4) when both BH growth and star-formation rates were at their peaks, is critical to understanding the impact of AGN feedback on galaxy evolution. I will review recent results obtained from SUBWAYS, an XMM 1.6Ms Large Program devoted to the study of UFOs in a statistical sample of QSOs up to z=0.5 (based on Matzeu et al. 2023) and briefly introduce the recently approved 2.2Ms XMM multi-year Heritage program WISSHFUL, aimed at studying a statistical sample of QSOs at Cosmic Noon drawn from the WISSH sample.

Exploring AGN coronae through X-ray polarimetry: insights from IXPE observations

Sept 24
18:30
Contributed

Daniele Tagliacozzo

The Imaging X-ray Polarimetry Explorer (IXPE) observed three unobscured radio-quiet AGN during its initial years of operation (NGC4151, IC 4329A and MCG-05-23-16, for a total of 5 independent observations), retrieving two clear detections, one marginal detection and two tight upper limits. Here we present the results of the X-ray polarimetric analyses of these sources, together with simultaneous XMM-Newton, NuSTAR and NICER data. The synergy between these instruments has been fundamental to constrain the physical properties of the hot corona and to assess its geometry, which may hold clues to its physical origin. The outcomes of extensive Monte Carlo simulations will also be presented, exploring insights gained through comparison with real data. Present and future polarimetric observations remain pivotal for understanding the nature of AGN coronae.

Tuesday, September 24, 2024

The central engine of AGN:shedding light on powerful disk winds

Sept 24
08:30
Invited

Valentina Braito

Over 20 years ago, with the launch of XMM-Newton and Chandra, we entered the modern era of X-ray observation of AGN. Now, after the successful launch of IXPE and XRISM observatories, we are entering a new era. The new window offered by the superb spectral resolution of the calorimeter on board XIRSM will give us an unprecedented view of the central engine of the AGN. Here I will review the most recent results obtained with these observatories, with particular focus on the ultra-fast outflows. Their existence was first revealed over 20 years ago, thanks to the X-ray observations with Chandra and XMM of bright nearby AGN. These outflows appeared to be powerful, reaching velocities up to 0.3c, and launched from the innermost regions of the accretion disks. Recently, a large effort has been devoted to 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 are shedding more light on their nature and driving mechanisms. Here I will review the most recent results obtained thanks to these efforts and the future prospects with the X-ray calorimeter observations.

The X-ray properties of the most luminous quasars with strong outflows

Sept 24
09:00
Contributed

Anastasia Shlentsova

The details of the interaction between the X-ray corona and the accretion disk in Active Galactic Nuclei (AGNs), as well as the underlying physical processes that dictate the relationship between UV and X-ray luminosities, are not fully understood. Moreover, despite the presence of winds driven by the accretion in both the UV and X-ray spectra, the relationship between the presence of outflows and the UV and X-ray emission properties remains unclear. In order to gain insight into the physical processes powering the dispersion of the X-ray to UV emission relation and to better understand the mechanisms in AGN engines, we investigate the correlation between X-ray emission and strong winds in extremely luminous quasars (QSOs). We study the most luminous QSOs showing extreme outflows in the C IV line. Using targeted Chandra observations of these QSOs, we determine the slope of the $L_X - L_UV$ relationship with high precision and explore the correlation of the C IV blueshift with the steepness of the UV to X-ray spectral energy distribution.

PDS456: a new look at the archetypal AGN-feedback laboratory with the XRISM X-ray microcalorimeter

Sept 24
09:15
Contributed

Alfredo Luminari

PDS456, the brightest Quasar in the local Universe, represents one of the earliest and clearest-cut evidence of X-ray mildly relativistic outflow at nuclear scales. Since the discovery of its broad P-Cygni profile in the Fe K band in 2015, many works explored the multi-phase feedback taking place from accretion disc up to the host galaxy scale, and from the X-ray up to the millimetric regime. The energetic of such feedback is more than enough to drive feedback effects onto its host galaxy, which indeed appears fairly perturbed. In this talk, I will illustrate the new data taken with the XRISM telescope, operating since autumn 2023. For the first time, XRISM successfully carried a high-resolution X-ray microcalorimeter on orbit, increasing the resolution in the hard band ($E > 5$ keV) from typical CCD-like widths of around 100 eV up to 5 eV. Such unprecedented resolution reveals multiple Fe XXV, XXVI absorption lines with velocity widths of hundreds of km/s and outflow speed between 0.2 and 0.3 c , which were spectroscopically unresolved with previous instruments. The same outflow is also responsible for a broad emission profile with a width of around 2 keV, consistent with being fully-covering the ionising source. Such detailed picture of both the wind absorption and the emission features opens an unprecedented discovery space for the innermost region of PDS456, and gives new and deep insights onto the wind clumpiness, geometry, location and acceleration. In turn, this will allow to precisely derive the outflow energetic and, then, to assess the coupling with larger-scale outflows and the impact on the host galaxy evolution.

Unraveling the Complexity of Ultra-Fast Outflows: X-ray Spectroscopy Insights from IRAS 13224-3809 and PDS 456

Sept 24
09:30
Contributed

Pierpaolo Condò

Ultra-fast outflows (UFOs), detected in X-rays and originating from the innermost regions of the accretion disk in AGNs, play a crucial role in regulating the growth of both the central black hole and the galaxy's stellar component. X-ray observations are indispensable for probing these winds, which carry significant kinetic energy. A comprehensive flux- and time-resolved X-ray spectral analysis of the narrow-line Seyfert 1 galaxy IRAS 13224-3809, based on a 1.5 Ms XMM-Newton campaign in 2016, reveals a dynamic UFO with a velocity greater than 20% of the speed of light. This extensive campaign allowed us to re-analyze broad-band CCD-resolution spectra (from 0.3 to 10 keV) and characterize a massive outflow, focusing for the first time on its rapid and extreme spectral evolution. Additionally, we discovered a soft spectrum component, correlated with the outflow, which hints at a complex multi-phase wind structure. Our capabilities in these tasks are significantly enhanced by the recent JAXA/NASA XRISM mission, equipped with a high-resolution X-ray microcalorimeter. The new observation of PDS 456, the brightest local quasar, provides an unprecedented view of UFOs with fine detail. What appeared as broad

absorption features in CCD spectra, as seen in IRAS 13224-3809, is now resolved into a forest of Fe XXV and Fe XXVI lines with velocities between 0.2 and 0.3 c. This newfound evidence allows for a detailed understanding of the wind's clumpiness, geometry, and acceleration mechanisms. Together, these studies highlight the transformative power of long-term monitoring and high-resolution X-ray spectroscopy in unraveling the complexities of AGN winds. By examining these phenomena, we gain critical insights into the mechanisms driving these outflows and their broader impact on SMBH and galaxy evolution.

HYPERION XMM-Newton Heritage Program. The X-rays Strike Back: unique relations between X-ray continuum and disk winds and SMBH mass growth revealed in luminous QSOs at $z > 6$

Sept 24
10:00
Contributed

Alessia Tortosa/Luca Zappacosta

The rapid formation of supermassive black holes (SMBHs) with masses $> 10^9$ M sun, powering luminous quasars (QSOs) at $z > 6$ is a fundamental question and to this end, shedding light on their nuclear properties is crucial. We tackled this challenge using our ∼700 hours XMM-Newton Heritage program on the HYPERION sample of 18 luminous QSOs at z>6 powered by SMBH which experienced the fastest SMBH growth. Our systematic investigation of these unprecedented-quality X-ray spectra revealed steeper X-ray spectral slopes compared to similar QSOs at $z > 6$. In this talk we present the discovery of a highly-significant (>3 sigma) correlation between the steepness of the X-ray continuum and the velocity of ionized disk winds, traced by the shift of the broad CIV emission line. This relation, not reported for other AGN samples so far, unveils a connection between the properties of the accretion inflow and the outflowing gas in the innermost part of the accretion disk, likely triggered by changes in its physical and geometrical properties. Then, we report a dependence of the X-ray continuum slope on the SMBH growth rate experienced by the SMBHs powering them. We discuss the implications of our results for the origin and evolution of $z > 6$ QSOs and their SMBHs. Our findings, after 3 years of the HYPERION XMM-Newton Heritage program, stress the importance of investigating AGNs at early cosmic epochs on a sub-parsec scale in the X-rays to understand their evolution and feedback processes.

Homologous structures in AGN and X-ray binaries

Sept 24
10:00
Invited

Roberto Soria

The physical structure and observational appearance of accretion inflows and outflows in AGN is often modelled within a framework originally developed for stellar-mass black holes. Accretion disk, corona, jet, winds represent homologous rather than analogous structures between the two species. I will outline current efforts to classify supermassive black hole activity in terms of the "canonical" set of accretion states initially defined for stellar-mass systems (eg, low/hard, high/soft and super-Eddington states). One of the advantages of such a classification scheme is that it makes it easier to predict the expected behaviour and appearance of the still-elusive class of intermediate-mass black holes. On the other hand, the comparison between stellar-mass and supermassive black holes can be misleading if we do not take into account for example the different role of black hole spin for jet launching, the different importance of magnetic pressure for disk support, and the different definition of Eddington limit in the presence of dust. I will also summarize a few types of systems for which a direct AGN/X-ray binary symmetry remains unclear: for example, changing-look AGN, and ultraluminous supersoft sources.

Session 2:

Stars, Explosions, and Gravitational Waves in AGN Disks

Sept 24
11:00
Invited

Matteo Cantiello

I will introduce the exotic evolution of stars embedded in AGN disks, which can experience rapid accretion and lead to the formation of massive and very massive objects. These stars undergo core-collapse, leave behind compact remnants and contribute to polluting the disk with heavy elements. I will show that AGN stars can have a profound impact on the evolution of AGN metallicities, as well as the production of gravitational waves sources observed by LIGO-Virgo. AGN stars can lead to the formation of short and Long GRBs, and I will discuss the electromagnetic signature produced by relativistic explosions in AGN disks.

X-ray polarimetry of the torus in Compton-thick AGN

Sept 24
11:30
Contributed

Francesco Ursini

We present the first X-ray polarimetric observations of Compton-thick AGN, namely the Circinus galaxy and NGC 1068, with the Imaging X-ray Polarimetry Explorer (IXPE). Both sources are found to be significantly polarized in the X-rays, with a polarization angle roughly perpendicular to the radio jet. The X-ray spectrum is known to be dominated by reflection components, both neutral (torus) and ionized (outflow cone). Combining the spectropolarimetric analysis of IXPE and Chandra data with ad-hoc Monte Carlo simulations, we show that the neutral reflector is consistent with being an equatorial torus with a half-opening angle of 45-55 deg. We conclude that the first X-ray polarization measurements in Compton-thick AGN confirm the basic predictions of the Unification Model.

The spatially resolved star formation law in nearby AGN host galaxiesi

Sept 24
11:45
Contributed

Maria Vittoria Zanchettin

In this talk I will discuss the correlation between gas content and star formation activity in nearby active galactic nuclei (AGN) host galaxies. This relation plays a pivotal role in galaxy evolution and determines the efficiency with which galaxies convert their gas reservoirs into stars. This study aims at investigating how the gas and star formation properties change across the galaxy and understanding whether the activity of the central super massive black hole (SMBH) plays a role. I will provide a detailed spatially resolved analysis of the interstellar medium properties by combining JWST/MIRI imaging with the F770W filter, with CO(2-1) and the underlying 1.3 mm dust continuum data from ALMA, along with VLA radio continuum observations. I will focus on the correlation between the 7.7 μm polycyclic aromatic hydrocarbon emission, the star formation rate and the cold molecular gas. I will show the correlation between the star formation rate and the cold molecular gas mass surface densities, commonly referred to as the Kennicutt-Schmidt star formation law, and the depletion time, which is the time needed to exhaust the molecular gas reservoir. I will illustrate the application of this approach to a sample of local hard-X-ray selected Seyfert galaxies, including NGC 7469. Furthermore, I will compare these results with spatially resolved studies on non active galaxies.

AGN-Host decomposition with the SDSS-V

Sept 24
12:00
Contributed

Hector Javier Ibarra Medel

We will introduce a new set of methodologies for decomposing AGN-Host spectra for studying the stellar populations of host galaxies (HG) using the forthcoming SDSS-V DR-19 data release. Our analysis will assess the feasibility of recovering stellar masses, star formation rates, ages, synthetic colours, and other properties for AGN-hosting galaxies observed during the SDSS-V Black Hole Mapper. To achieve this goal, we will utilize the full-epoch coadded optical AGN spectra within a redshift range of 0.1 to 0.8. The data was collected from October 2020 up to date. We employ a set of stellar population synthesis models to separate the non-thermal component of the active nucleus from that of the host galaxy using STARLIGHT and PyQSOFIT. This work will produce data products, including stellar masses, star formation rates, star formation histories, and deblended HG and ANG spectra.

Insights of the AGN circum-nuclear region from a spectroscopic point of view

Sept 24
14:30
Invited

Giustina Vietri

The analysis of optical and UV spectra in QSOs provides the opportunity to shed light on the kinematic properties of the ionized gas in the circumnuclear emitting and absorbing regions. Low-ionization emission lines, such as Hβ and Mg II, exhibit more symmetric profiles and are typically reliable indicators of redshift and BH mass estimates. In contrast, high-ionization emission lines such as C IV tend to be asymmetric in emission, can exhibit a large range of outflow velocities, and can be affected by strong absorption, revealing outflows with velocities up to $\sim$0.2c. Moreover, the high-ionization weak He II emission line can be considered a proxy for the ionizing radiation in a QSO and an indirect indicator of the strength of the corona, strongly linked with the observed properties of the C IV line. I will review the diversity of the nuclear spectral signatures and their properties as a function of AGN characteristics, such as bolometric luminosity, BH mass, Eddington ratio, and optical-to-X-ray spectral slope.

The ever elusive blazar host galaxies: a guide to their characterisation

Sept 24
15:00
Contributed

Gaia Delucchi

One of the fundamental characteristics of blazars is their central black hole mass. In absence of broad emission lines, which is the case for the majority of blazars (i.e. BL Lacs), the black holes mass is estimated by analysing the luminosity of the host galaxies. To date, these galaxies are thought to be massive and luminous ellipticals, but the data sample supporting this conclusion is limited. While the most recent studies date back to the early 2000s, it is crucial to provide a detailed characterization of the host galaxies in order to build realistic models exploiting the large number of sources whose photometric and spectral properties are measured with greater precision. In this contribution I will show preliminary results of the adaptation of the QSFit software to the study of blazars. This is of interest for the creation of a criterion for discriminating (and quantifying) the host from the blazar jet, and also for the generation of a repeatable and reusable classification algorithm for more general purposes. This work provides for the first time a study of the host galaxies of blazars on a theoretical level using analytical and coherent spectra, and can be applied to large new-generation surveys such as JWST and Euclid to characterise blazars at various redshifts and contribute to understand better the relation between the black hole activity and the host galaxy.

The Influence of the HG in the Quasar Main Sequence

Sept 23 15:15 Contributed

Alenka Negrete

We present an analysis of the Eigenvector 1 or quasar main sequence (QMS, FWHM(Hb) vs RFeII) dependent on the contribution from the host galaxy. We used the forthcoming SDSS-V DR19 spectra for AGN at $z < 0.8$ and $S/N > 20$ to have a good-quality spectral decomposition. This work uses a novel tool to catalog the sample into three groups according to the stellar and AGN contribution: AGN-dominated, HG-dominated, and intermediate. We then used Starlight to isolate and subtract the stellar component and the PyQSOfit tool to obtain the QMS parameters. This work helps us to see the behavior of the MS along the AGN power in terms of AGN-HG contribution and redshift.

The disturbed broad line region of the SMBH binary candidate PG 1302-102

Sept 24 15:30 Contributed

Fabio Rigamonti

Constraining the merger rate of supermassive black hole binaries (SMBHB), for example through electromagnetic detections, is crucial for a better understanding of galaxy evolution, as these systems are expected to be natural outcome of galaxy mergers. However, these measurements are highly challenging, mainly due to the absence of binary-specific observable features. Indeed no bona fide SMBHB has been detected so far. PG 1302-102, identified through a quasi-periodic modulation of its light curve, is among the strongest SMBHB candidates; however, it is still uncertain whether the modulation in PG 1302-102 is a random red noise realization (Vaughan et al. 2015) or caused by the Doppler boosting effect of a SMBHB (D'Orazio et al. 2015). In this talk, I will present a study of this particularly interesting target based on the, so far, highest resolution optical spectrum (collected with ESPRESSO) and its analysis through a fully Bayesian approach. To obtain an accurate model of the spectrum, we included multiple Gaussian components (for the Hβ , Hγ , Iron, and [OIII] lines) on top of a power law continuum only if motivated by Bayesian model selection. Through this method, we identified multiple narrow emission lines (NELs) at the expected redshift of the source and confirmed the clear presence of redshifted broad components in the Hβ and Hγ for which we provided accurate measurements of their properties. Moreover, we detected for the first time, the presence of outflows in, at least some, of the NELs (i.e. [OIII] doublet). Our analysis, combined with previous literature results, provides new insights into the nature of PG 1302-102 and its broad line region (BLR). If the observed periodicity of the light curve traces the orbital motion of a putative binary, our spectral measurement, coupled with simple estimates of the BLR sizes, suggests a scenario where the individual BLRs of the black holes have either already merged or are truncated and highly disturbed. Given the high resolution of the data, we constrained a BLR model in favor of a disk-like geometry characterized by a strong, although azimuthally thin, spiral perturbation. While disturbances in BLRs are not uncommon, in the case of PG 1302-102, we

cannot yet determine whether these perturbations are caused by SMBHB or by self-gravitating instabilities. Future spectroscopic monitoring will help in clarifying the nature of this source and its BLR.

Exploring the AGN-Ram pressure stripping connection in local clusters

Sept 24
15:45
Contributed

Giorgia Peluso

A plethora of processes have been advocated to light up Active Galactic Nuclei (AGN) at the centers of galaxies in the past decades. Growing evidence, both observationally and theoretically, has shown that the Ram Pressure Striping (RPS) phenomenon acting in the cluster environment is one of them. The link between RPS and AGN activity has roots in the fact that the presence of an AGN is regulated by the gas content in a galaxy, which in turn is strongly affected by RPS. More than that, hydrodynamical simulations have shown that the interplay between AGN activity and RPS can drive the metal evolution of a galaxy. Particularly, the synergy between these two phenomena would result in a more efficient removal of the gas from the galaxy disk and in a way more rapid quenching of the star formation, which in turn means an earlier halting of the metal production and gas pollution thought SN explosions. A hypothesis is that this happens because the AGN feedback can re-distribute the gas surrounding the supermassive black hole (SMBH) towards regions where the RP is strong enough to strip it. Under these assumptions, we expect to observe lower oxygen abundances (or, equivalently, metallicity) in stripped AGNs with respect to a control sample of AGNs not affected by RP. To look for such a footprint, we investigate the spatially resolved gas-phase metallicity (with a spatial resolution of $\sim$ 1 kpc) in a sample of 48 RPS galaxies and a control sample of 77 field galaxies with log M*/Msol $>$ 10.5 and at redshift $z < 0.07$. To measure oxygen abundances, we compute and exploit metallicity calibrators to be applied in case of ionization from stars, AGN or a mixing of both. This is the first tool kit of calibrators generated coherently between each others for different kinds of ionization sources. In this way, we were able to draw a considerable number of conclusions not only on the AGN-RPS interplay, but also on the role of the AGN activity in affecting the metal content in nearby galaxies. First of all, observationally, we did not see the sings of the effect of RPS on the metal content in galaxies, meaning that larger samples of RPS galaxies are required. In both the RPS and control samples, oxygen abundances in the nuclei of AGN hosts are enhanced by a factor $\sim$ 0.07 dex with respect to SF galaxies, and the enchantment is induced by the AGN activity on the surrounding ISM, as the metal enhancement is limited to the very inner regions of the galaxy. Finally, AGN hosts do not follow a tight relation in the stellar mass versus nuclear metallicity diagram, as opposed to the well-known mass-metallicity relation in SF galaxies. In my talk, I will give more details on the analysis performed and the conclusions drawn from it.

Session 3

Early galaxy growth and how it is shaped by black hole feedback

Sept 24
16:30
Invited

Manuela Bischetti

I will present a smart strategy to hunt for evidence of black hole feedback on galaxy growth in the first Gyr of the Universe. A massive observational effort has been put put in the last decade with ALMA and recently with JWST into searching for black hole winds and assessing their impact on early galaxy growth. Nevertheless, a few detections and contradicting results about the strength of these winds were reported. I will show that the large abundance of broad absorption line quasars at $z > 6$ can be exploited to systematically detect black hole winds and, more importantly, to design follow up studies of black hole feedback on galactic and circumgalactic scales with ALMA and JWST. To support this, I will present results for the first $z \sim 7$ quasar with multi-phase detection of a black-hole wind and, crucially, with a robust measurement of the wind energetics both on nuclear and kpc scales. This quasar is surrounded by a bright and extended [CII] halo, much larger than what has been observed so far around quasars without strong winds and star forming galaxies at similar redshift. I will show that these large halos are common around $z > 6$ quasars, providing evidence that strong feedback can occur at $z > 6$ and leave an imprint on the gas morphology and physical conditions up to circumgalactic scales. I will discuss how MUSE and JWST observations with IFU spectroscopy may complement the above picture by providing key insights on the warm ionized gas phase.

Deriving improved black hole masses in quasars

Sept 24
17:00
Contributed

Elena Dalla Bontà

At the heart of understanding the growth of black holes is the necessity for an observationally constrained black hole mass function over cosmic timescales. While stellar and gas dynamics and reverberation mapping have allowed us to determine black hole masses locally, and in some cases out to a redshift of a few, these methods are fundamentally resource-constrained and will not in the foreseeable future be able to provide the statistics required for meaningful determination of the mass function, particularly at high redshift. Fortunately, the masses of black holes in quasars can be estimated from empirical scaling relationships based on reverberation studies. These mass estimates require measurements of luminosity and broad-line width from only

a single spectrum. We present new results on single epoch masses providing a state-of-the-art empirical formula to determine black hole masses through the Halpha emission line and compare the results with the masses based on Hbeta and CIV line-width characterization.

The formation and evolution of quasar-host galaxies across cosmic time

Sept 24 17:15 Contributed

Francesco Salvestrini

The coexistence between the outstanding mass growth of the Supermassive Black Holes (SMBHs; MBH$\sim 10^{8-10}$Msun) powering luminous quasars, and the concurrent growth of their host galaxies, still challenges theoretical models aimed at explaining how these systems formed and evolve. While the characterisation of quasars up to $z > 7$ has been achieved thanks to large surveys in the rest-frame UV-optical bands, the knowledge of how quasar host-galaxies build up and evolve can only be achieved with far-IR/sub-mm observations. Furthermore, sub-mm observation have proved to be a reliable probe of the obscured star formation, which constitutes a significant, or even dominant, fraction of star formation at early epochs. In this context, I will present new and archival mm observations used to characterise the molecular gas reservoirs, star formation rates, and dust properties in a sample of $\sim$40 quasars, equally distributed in two key eras: the Epoch of Reionization (EoR; $z > 6$) and Cosmic Noon (CN; $z \sim 2-4$). Copious amounts of dust (up to few 10^8 Msun) and gas (up to 10^{11} Msun) trace the assembly of the host of luminous quasars in both subsamples, with rates of star formation (SFRs) up to 1000-3000 Msun/yr. The resulting star formation efficiencies are among the highest observed among massive galaxies, exceeding that of galaxies without active nuclei at similar epochs by a factor of 10 or more. There are evidence for the accreting SMBH to heat/remove the cold molecular gas from the host galaxy, halting the formation of stars in few tens of Myr. Thanks to ALMA fine sensitivity, we will also reveal the presence of several companion galaxies surrounding the massive quasar, invisible at rest-frame UV/optical bands, suggesting that mergers may play a crucial role in sustaining the star formation in high-density sites like this hosting quasars. I will present a comparative study of the properties of the luminous quasars in our samples with a rich collection of quasars, AGN and star forming galaxies at different epochs, down to the local Universe, focusing on the properties of the interstellar medium and SF in the hosts.

Sustained super-Eddington accretion and outflow properties in high-redshift quasars

Sept 24 17:30 Contributed

Giada Quadri

Sustained super-Eddington accretion and outflow properties in high-redshift quasars Observations of quasars at cosmic dawn (age of the Universe $<$ 1Gyr) show that these objects are powered by massive black holes (MBHs), which are already in place at their centre with masses up to $\sim 10^{10}$ Msun. This evidence challenges the BH formation scenario within the standard Eddington-limited accretion of gas, thus posing severe constraints on the initial mass of the seeds from which they have grown. Through very high-resolution cosmological zoom-in simulations of a $z \sim 7$ quasar that implement different accretion regimes with associated radiative and kinetic feedback, we investigate the origin of these massive compact objects. In my talk, I will show that despite the current strong assumptions (relatively high spin for the MBH with a strong jet feedback), MBHs embedded in gas-rich environments at high redshift can sustain long-lasting super-Eddington accretion phases and grow rapidly in mass within their host galaxies. As a result, these MBHs can potentially move above the local correlations before they begin to regulate themselves, providing a plausible explanation for the formation of overmassive systems. I will also discuss the interplay between this rapid MBH growth and the evolution of the MBH galaxy host, in particular regarding the physical properties of the outflows coming from the MBH feedback, to establish a link between our numerical results and potential observables for current and future observations.

Tracing Quenching and AGN Activity throughout Cosmic Epochs

Sept 24 17:45 Contributed

Fabio Fontanot

I will introduce the latest version of the GAlaxy Evolution and Assembly (GAEA) semi-analytic model of galaxy formation, that combines (i) an updated treatment of cold gas accretion on super-massive BHs (including AGN feedback); (ii) an explicit partition of the cold gas content in atomic and molecular components; and (iii) an improved modelling of cold and hot gas stripping from satellite galaxies. These improved treatments are critical to correctly reproduce the redshift evolution of key properties of galaxy populations up to z$\sim$ 5 such as the galaxy stellar mass function; the mass-metallicity relations both in the stellar and gaseous phase; the QSO/AGN bolometric luminosity function. In particular, I will highlight the impact of AGN feedback, in the form of AGN-driven outflows, on the SF properties of model galaxies, by showing that GAEA recovers quenched galaxy fractions in remarkable agreement with observational constraints up to z$\sim$ 3-4, while predicting number densities of massive quiescent galaxies at z$\sim$ 3 that are the largest among recently published models. At low stellar masses, these successes are connected with the updated treatment of satellite galaxies; at intermediate to large stellar masses, AGN-driven winds are the main responsible for quenching, although the better treatment for star formation, based on the partitioning of cold gas into atomic and molecular phases,

also play a role. Nonetheless, the large number of quiescent galaxies discovered in the Early Universe by JWST raise fundamental questions on when and how these galaxies became and stayed quenched. Irrespective of their stellar mass, quiescent z$\sim$ 7 model galaxies in GAEA are connected with AGN feedback and quasar winds, while they remain quenched for more than 1 Gyr. In order to get a better understanding of the quenching mechanism at high-z we study the environment of the more luminous QSOs at z$\sim$ 7 selected from a GAEA run in a $\sim$ (800 Mpc)^3 box. These mock fields are directly comparable with the highest redshift QSOs observed by JWST programs. I will then show that using GAEA to study the redshift evolution of these model galaxies (and their environments) is then possible to trace the quenching journey of these galaxies across cosmic epochs and define the properties of their descendant population.

A tale of emission and absorption: ISM, CGM and outflows in z$\sim$ 5 quasars

Sept 24 18:00 Contributed

Matilde Brazzini

The co-evolution of supermassive black holes (SMBHs) and their host galaxies is probably regulated by complex feedback mechanisms involving multi-phase and multi-scale outflows. In luminous quasars, black hole-driven outflows are thought to make a major contribution by significantly impacting the host galaxy interstellar (ISM) and circumgalactic (CGM) media. Here, we investigate the gaseous environment and outflow properties of a sample of 40 luminous quasars bridging the Epoch of Reionization and Cosmic Noon ($z \sim 5$). Our study combines an analysis of both absorption and emission line systems from X-Shooter@VLT and ALMA. In particular, X-Shooter enables us to study CIV and NV intrinsic absorbers against the quasar rest-frame UV continuum, likely associated with AGN-driven ionized outflows. ALMA, on the other hand, allows us to study the distribution of the mildly ionized gas through the [CII]158μm emission line arising from the CGM and host galaxy ISM. By combining these probes, we aim to achieve a multi-phase characterization of outflow properties in the high-redshift Universe. This comprehensive analysis is essential for understanding the first feedback mechanisms occurring in the Post-Reionization Universe.

The unprecedented NIRSpec/JWST view of the nuclear region in the prototypical merging galaxy NGC 6240

Sept 24 18:15 Contributed

Matteo Ceci

Merger events are considered an important phase in the assembly of massive galaxies. At the same time, Active Galactic Nuclei (AGN) play a fundamental role in the evolution of their star formation histories. Both phenomena can be observed at work in the active merging galaxy NGC 6240, the prototypical merging galaxy in the local Universe, and the subject of this work. Having an elevated infrared luminosity, NGC 6240 is classified as an UltraLuminous InfraRed Galaxy (ULIRG). It hosts two AGN, separated by 1.5" ($\sim$ 735 pc), observed in X-ray and radio bands. Taking advantage of the unrivalled sensitivity and wavelength coverage provided by the Integral Field Unit (IFU) of the NIRSpec instrument onboard JWST, we observed the nuclear region of NGC 6240, in a field of view of $3.7"x3.7"(1.9x1.9$ kpc^2), to reveal the gas kinematics and InterStellar Medium (ISM) properties with an unprecedented spatial resolution ($\sim$ 0.1"). We decoupled the different kinematic components through multi-Gaussian fitting and studied the ISM properties using state-of-the-art NIR diagnostic methods. We isolated the ionization cones of the two nuclei and found that the molecular hydrogen gas is excited mostly by thermal processes. We computed a hot molecular gas mass of 1.3 x $10^5 M_\odot$ and an ionized gas mass in a range of $10^5 - 10^7 M_\odot$, depending on assumptions. We resolved coronal lines emission in the nuclear regions. We discovered that the molecular hydrogen has different kinematics from the ionized gas. In particular, we observed a complex morphology of the warm molecular gas, including previously unknown kinematic features such as a blue outflow near the Southern nucleus, and filaments connecting a highly redshifted H2 cloud with the two nuclei. We focus our discussion on this cloud and propose two possible scenarios for its nature: either outflowing gas or a tidal cloud falling onto the nuclei.

Fast & Furious at $z \sim 2$: faster ionised winds in type-2 AGN than in type-1 systems

Sept 24 18:30 Contributed

Giulia Tozzi

Although AGN-driven outflows are widely accepted as a crucial ingredient of galaxy evolution, we still miss definitive observational proof of their real impact on their host galaxy. To shed light on this, spatially resolved observations at cosmic noon ($z \sim 2$) are fundamental, this being the epoch where AGN feedback is expected to be more effective. In this talk, I will present the latest results for type-2 AGN from SUPER (Survey for Unveiling the Physics and Effect of Radiative feedback), a completed SINFONI program using adaptive optics to target X-ray AGN at $z \sim 2$. We found large evidence of spatially resolved ionised outflows on kpc scales, traced via [OIII]λ5007 line emission. Interestingly, SUPER type-2 AGN are all obscured systems and host faster ionised outflows than their type-1 counterparts in the same range of bolometric luminosity. Moreover, the ionised outflows detected in SUPER

overall have velocities high enough to reach 30-50 kpc distances from the centre, where they can reduce and possibly quench star formation. I will hence discuss the main implications of these results, in particular highlighting the major role played by obscuration in driving the type-1/type-2 AGN dichotomy at high redshift, and favouring wind acceleration in obscured type-2 systems.

The effects of AGN winds and radioloudness in high-redshift type I Quasars

Sept 24 18:45 Contributed

Alice Deconto-Machado

At high and intermediate redshifts ($z > 1$), galaxies are in a critical phase of their evolution, often undergoing significant growth and star formation. During these epochs, many galaxies exhibit powerful nuclear activity These active galactic nuclei (AGN) can drive strong jets of relativistic particles observable at radio wavelengths and winds detectable in the optical and UV spectra. Through the detailed analysis of the broad emission line profiles, we can find some insights of the relevance of jets for the structure and dynamics of the broad line emitting regions, including the winds. Estimating the feedback contribution involves the decomposition of the broad emission line profiles from quasar spectra, with particular focus on high-ionization lines such as CIV λ 1549 and [OIII] λ 4959,5007. High-ionization lines usually present a significant asymmetry towards the blue especially in radio-quiet (RQ) sources, which is strong evidence of outflow motions. At variance, radio-loud (RL) quasars tend to feature modest blueshifted components, suggesting a potential role of radioloudness in mitigating outflow effects. The strongest radio emitters are also found with more symmetric emission line profiles in both UV and optical ranges. In this study, we present a remarkable sample of 32 high-luminosity and high-redshift quasars ($z = 1.5\check{}3.7$) observed with ESO-VLT and combine it with previous data at both high and low redshift, aiming to evaluate the role of the feedback in RL and RQ sources. Measurements are shown and contextualized taking advantage of a set of correlations associated with the quasar Main Sequence (MS), which consists of a parameter space that allows to connect observed UV, optical, and X-ray properties to the relative relevance of radiative and gravitational forces. We discuss the main differences found in accretion and feedback properties and highlight the effects of the radio-loudness on the emission line properties.

Wednesday, September 25, 2024

The properties of progenitors of the merging SMBH

Sept 25 08:30 Contributed

Filippo Mannucci

Dual AGN represent a crucial phase in the life cycle SMBH. Studying these systems is of great importance to: 1) understand the contribution of BH merging to the grow of the SMBH population; 2) predict the gravitational wave (GW) background detected by pulsar timing array (PTA) experiments and the event rate in the LISA mission; 3) provide an astrophysical interpretation of the GW data; 4) test many assumptions of the galaxy/black hole formation and co-evolution models by comparing their predictions with the observed properties of dual AGN, such as the mass function of primary and secondary black holes, distribution of separations, fraction of dual AGN, etc. Despite their critical significance, knowledge about dual AGN within the same host galaxies is extremely limited. We will present the properties of the first sample ever of dual AGN in the same host galaxies (separations between 0.2" and 0.8", corresponding to 1-6 kpc). These systems have been selected using Gaia and Euclid, and have been classified as dual (or lensed) AGN by spatially resolved spectroscopy from AO-assisted observations from the ground (VLT, LBT, Keck) or from space (HST). Follow-ups in X-ray (Chandra) and radio bands (VLBA and LOFAR) are also on-going. We will present the first physical properties of these systems (dual fraction, mass functions, separation etc.) and how they compare with the predictions of current models of galaxy formation and galaxy/SMBH co-evolution. Finally, will also present the strategy of a ESO large program recently approved with MUSE-NFM to greatly enlarge this sample.

Deciphering dual AGN in merging galaxies

Sept 25 08:45 Contributed

Manali Parvatikar

In this talk, I will present our multiwavelength study on a sample of optically selected Dual-AGN candidates with separations ranging from 3-100 kpc, which appear as X-ray single and double sources. To study the role of mergers in triggering dual AGN, we performed optical and X-ray spectral analysis using SDSS, XMM-Newton, and Chandra and investigated their absorption properties using mid-IR diagnostics with WISE. Our studies on both the samples revealed that (i) X-ray dual and single AGN systems exhibit higher nuclear obscuration compared to isolated systems and (ii) X-ray dual AGN show increasing luminosity with decreasing projected separation, but trends for X-ray single AGN are uncertain (iii) The infrared classification of the X-ray single AGN counterpart poses questions about their true nature, the role of X-ray absorption, and optical classification. We also determine the fraction of dual AGN in our sample and the X-ray detection efficiency, giving insights into the role of mergers in dual SMBH activation.

X-ray view of dual AGN candidates

Sept 25 09:00 Contributed

Lorenzo Battistini

Dual Active Galactic Nuclei (DAGN, projected spatial separation $rp < 100$ kpc) are sources of great interest in astrophysics, since they are crucial to understand how AGN are triggered. However, DAGN are rare, identify and characterize such sources is challenging and multi-waveband observations and analysis are needed. At early stage of separation ($rp > 30$ kpc), we can exploit X-ray data available so far to identify DAGN, while at the closest separations (rp < 30 kpc) most of the sources are not resolved in the X-ray band and indirect methods must be used (such as a Double- Peaked [OIII]λ5007Å line profile). Here, I present X-ray and optical analysis of a sample of 22 optically selected Double-Peaked AGN and derive their intrinsic emission properties (such as luminosity and nuclear absorption) to be compared with those observed in isolated AGN. I will also present a preliminary study of a sample of ~ 300 DAGN candidates detected and spatially resolved with XMM-Newton (z $\sim 0.001 - 0.137$, rp ~ 1 — 100 kpc) to derive the dual rate in a homogeneous sample up to z < 0.137.

A new benchmark for the local and high-z scaling relations of supermassive black holes: dissecting the roles of AGN feedback and black hole mergers

Sept 25 09:15 Contributed

Francesco Shankar

The correlations between Supermassive Black Hole (SMBH) mass and host galaxy properties can reveal the processes shaping the co-evolution of SMBHs and galaxies, from mergers to Active Galactic Nuclei (AGN) feedback. However, a clear knowledge of the exact shape and evolution of these relations is still missing, and which of the galaxy properties is most fundamentally related to SMBH mass. In this talk, I will present the latest results on the SMBH scaling relations, their residuals, and their time evolution. I will first show that stellar velocity dispersion is, according to the latest available data, the key galactic property linked to SMBH mass in the local Universe. The correlation with galactic bulge or total stellar mass at fixed stellar velocity dispersion disappears, whilst the one with stellar velocity dispersion at fixed stellar mass is steep and strong, implying that interpreting the co-evolution between SMBHs and their host galaxies uniquely on the Mbh-Mgal plane may lead to inaccurate conclusions. These behaviours in the residuals of the SMBH-galaxy scaling relations are NOT reproduced by several of the current state-of-the-art models. In many galaxy evolution models, in fact, the apparently steep Mbh-sigma relation, is mostly a conspiracy induced by the underlying combination between the Mbh-Mgal and Mgal-sigma relation, which can be unveiled when analysing the residuals. I will also show that current high-z data in terms of (integrated) X-ray luminosities and star formation histories, all suggest a weak evolution of the SMBH-galaxy scaling relations up to at least z$\sim$2-3, providing a robust benchmark for interpreting the new high-z data. I will conclude by including these findings in a comprehensive

semi-empirical model for the supermassive black hole evolution in a cosmological context, starting from the high-z conditions imposed by luminous red dots, to the local Universe, with new determinations of the local supermassive black hole mass function down to very small masses.

The complex (negative and positive) AGN feedback from outflows and jets in the Teacup

Sept 25 09:30 Contributed

Giacomo Venturi

Understanding the effect of active SMBHs (AGN) on their host galaxies requires constraining the properties of outflows and jets, considered key actors in this process, and how exactly these interact with their host gas reservoir. The massive, star-forming, post-merger z∼0.1 Teacup QSO is a great laboratory to study in detail the complex interplay between SMBH, outflows, jets, ISM and CGM. It hosts a compact (∼1 kpc) jet, ∼10 kpc radio and optical AGN-driven bubbles, a giant (∼100 kpc) ionised nebula, and ionised and molecular outflows. By exploiting VLT/MUSE observations, we find that the compact radio jet strongly perturbs the host ISM, by driving large gas velocity dispersions perpendicular to its motion, as recently found in other jetted sources and in line with simulations. We find an exceptionally powerful galactic ionised outflow relative to the molecular one, and dissect its properties (mass, kinematics, energetics) from ∼1 to 10s kpc scales. We explore its driving mechanism among jet and AGN radiation by comparing its energetics with model predictions. While the outflow efficiently depletes the gas reservoir for star formation ("negative" feedback), little material can eventually escape the massive dark matter halo. The expelled gas might thus be re-accreted on the galaxy at later times, but could also progressively heat the halo gas and hamper its (re-)accretion. Finally, we find evidence for stars formed around the 10 kpc-size expanding bubble due to the compression by jet and outflow ("positive" feedback), as predicted by theory. All in all, the Teacup constitutes a rich system in which AGN feedback from outflows and jets, in both its negative and positive flavours, co-exist.

The merging system BR1202-0725: a close pair of AGN at z ∼4.7 from NIRSpec observations

Sept 25 09:45 Contributed

Sandra Zamora

The models predict that massive objects as quasars (QSOs) are located in overdensities of the "cosmic web", a large structure formed by filaments of neutral gas. Along this structure, the gas can be directed onto the nodes, formed by massive dark matter halos with QSOs or other massive objects, powering star formation processes in these environments. Then, the study of gas-rich major mergers at high redshift is the key to our understanding of galaxy evolution. In this work, I will present JWST observations of the merging system BR1202-0725: one of the best laboratories at z∼4.7 to study. It is formed by a quasar located about 24 kpc from a submillimetre

galaxy (SMG) with evidence of heavily dusty BH at its center. Thus, they form one of the most distant close pairs of AGN known so far. Additionally, this merger is one of the most overdense fields known in the early universe, also formed by the three known optical companion Lyα emitters. Through observations of emission nebular lines, I will discuss the evidence and properties of the heavily dusty BH at the center of the SMG and the kinematics of the gas in this galaxy, which shows slightly turbulent yet rotation-dominated disks despite the extreme star formation activity of 1000 $M_{\odot}$/year. Furthermore, we have estimated the QSO black hole properties, and we have characterised the interstellar medium of the host system to understand the physical and ionizing mechanisms and the kinematics of the merger.

Expanding the Parameter Space of Circumnuclear Obscuration: Ultra-Thick, Highly-Variable Warm Absorbers

Sept 25
10:00 Contributed

Riccardo Middei

The X-ray continuum of AGN can be absorbed by circumnuclear matter intercepting our line of sight. This process imprints characteristic features in the emerging spectrum that vary as a function of the physical properties of the intervening matter. Shallow and sharp troughs in the soft and hard X-rays, respectively, are commonly observed in AGN and are attributed to the presence of so-called warm absorbers (low column density and low ionization) or disc winds (high column density and high ionization). In this context, we present the discovery of ultra-thick warm absorbers observed in a sample of nearby AGN, whose X-ray SEDs exhibit extraordinary absorption variability on the sampled timescales. The very large column densities ($\sim$1e22-23 cm-2) of the warm absorbers measured in our sample significantly exceeds by a factor of $\sim$10-100 the values commonly detected for the bulk of the AGN population. This finding reveals a much larger parameter space of warm absorber properties, which deserve future high resolution spectroscopic investigations to shed light on their kinematics and, in turn, their kinetic power. I will discuss a possible scenario that links the detection of these rarely-observed ultra thick, highly variable WAs with a specific inclination of our line of sight to the nucleus.

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GA-NIFS: Resolving AGN outflow properties at z∼3-6 with JWST NIRSpec

Sept 25 10:45 Contributed

Elena Bertola

A key phase of galaxy evolution is the rapid transition (<2Gyr) from early galaxy assembly at 'cosmic dawn' (i.e., z>6) to the so-called 'cosmic noon' (z∼1-3), where the cosmic density of both star formation rate (SFR) and SMBH accretion rate peak. Galaxy growth is thus closely tied to AGN activity, yet little is known about the impact of AGN feedback beyond z∼3, especially in the ionized gas phase. This is rapidly changing thanks to the advent of JWST. The GA-NIFS JWST/NIRSpec GTO program includes the largest sample of AGN at z∼3-6 with available rest-frame optical spatially-resolved spectroscopy collected with JWST/NIRSpec/IFU. I will present our study to characterize AGN outflows in such a sample of z∼3-6 AGN selected from COSMOS and GOODS-S to have log(Lx/erg/s)>44. We mapped the ionized emission of AGN (Halpha, [OIII], Hbeta, ...) at sub-kpc scales and spectrally isolated the broad components tracing outflows from the gas at rest with the galaxy. We derived outflow properties from spatially-resolved and integrated spectra (e.g., velocity, outflow mass rate) and compared them with those of the galaxy (e.g., Mstar, SFR) and of the AGN (Lbol), retrieved from dedicated SED fitting. Finally, we compared our results with literature AGN from the local Universe to earlier cosmic epochs, spanning a very broad range of AGN luminosity.

Effect of stellar wind and AGN feedback on the statistics of metal absorbers in hydrodynamical simulations

Sept 25 11:00 Contributed

Sukanya Mallik

One of the key questions in modeling the formation and evolution of galaxies is the impact and relative importance of the stellar and AGN feedback. We study the statistical properties of OVI, CIV, and NeVIII absorbers at low-z (i.e.,z <0.5) using Sherwood simulations with "WIND" only and "WIND+AGN" feedback and Massive black-II simulation that incorporates both "WIND" i.e. outflows driven by stellar feedback and AGN feedbacks. We find simulations with AGN feedback show metal enrichment in media of a wide range of densities. Hence, the inclusion of the AGN feedback helps in the metal enrichment in lower-density gas which is farther away metal production site. By generating simulated metal line spectra along the sightlines shoot in these simulations, we show the statistical properties such as distribution functions of column density (N), b-parameter and velocity spread, the relationship between N and b-parameter, and the fraction of Ly α absorbers showing detectable metal lines as a function of N(HI) are influenced by the feedback models implemented and the UVB used. The difference in some of the predicted distributions between different simulations (with and without AGN feedback) is similar to the one obtained by varying the UVB for a given simulation. Most of the observed properties of O VI absorbers are roughly matched by simulations incorporating WIND+AGN feedback when using the softer UVB. However, this simulation

fails to produce observed distributions of C IV and the fraction of HI absorbers with detectable metals. All these simulations show a positive metal absorber clustering signal upto a scale of 3 Mpc, with amplitudes affected by the feedback models. We find that the effect of feedback is restricted to small scales (i.e.$\leq$2 Mpc at z$\sim$0.3), while the effect of the UVB is confined to even smaller scales (i.e.$<$ 1 Mpc at z$\sim$0.3). Hence redshift clustering can provide a good discriminator between effects of variation in the feedback models and UVB as they affect clustering amplitudes at different length scales.

From momentum to energy driven: the first proof of accelerating AGN outflows

Sept 25 11:15 Contributed

Cosimo Marconcini

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 wind kinematical properties in a sample of nearby active galaxies observed which finds evidence, for the first time, of the predicted transition from the momentum to the energy driven regime at the critical radius of $\sim$1 kpc. In particular, I will show that all these outflows are characterized by constant radial velocities followed by a rapid acceleration starting from $\sim$ 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. 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 session

Abstracts of posters are at the end of the book.

Spectroscopic analysis of quasars in the distant Universe through a main sequence

Nancy Jenaro

Sept 23—27 Poster# 1

AGN contribution to the infrared luminosity function up to $z = 6$

Alberto Traina

Sept 23—27 Poster# 2

Tracing the origin of giant Black Holes at high redshifts: a Cosmic Archaeology Tool

Nazanin Davari

Sept 23—27 Poster# 3

Powerful radio sources in the southern hemisphere: the G4Jy-3CRE catalog

Ana Jimenez-Gallardo

Sept 23—27 Poster# 4

The MUSE view of galactic-scale Lyman Alpha outflows at cosmic noon

Miguel Coloma Puga

Sept 23—27 Poster# 5

Optical follow-up of a sample of gamma-ray emitting jetted AGN

Benedetta Dalla Barba

Sept 23—27 Poster# 6

Exploring Low-Luminosity AGN Feedback at the center of M58

Iván López

Sept 23—27 Poster# 7

Accretion disk and wind emission in the Population B, jetted quasar 3C 47

Paola Marziani

Sept 23—27 Poster# 8

Deciphering dual AGN in merging galaxies

Manali Parvatikar

Sept 23—27 Poster# 9

The jet and core of 4C 71.07, and the first detection of an outflow in blazars

Claudia M. Raiteri

Sept 23—27 Poster# 10

Combining HST and SDSS spectroscopy to reach the peak of the accretion disc

Bartolomeo Trefoloni

Sept 23—27 Poster# 11

Star formation processes in the circumnuclear environment of galaxies

Sandra Zamora

Sept 23—27 Poster# 12

Session 4

Understanding AGN through variability: pleasures and pains

Sept 25
14:30
Invited

Maurizio Paolillo

I will review the current knowledge of (radio-quiet) AGN continuum variability in terms of methodologies and application to local and high redshift sources, and it's ability to constrain the physics of the accretion process and the size of the AGN components. I will finally highlight the results and expectations from timing studies in large sky surveys.

Time-Resolved Diagnostics of the Ionized Absorbers in NGC 4051

Sept 25
15:00 Contributed

Roberto Serafinelli / Speaker: Fabrizio Nicastro

We present detailed X-ray spectroscopy of the Narrow-Line Seyfert 1 galaxy NGC 4051, using the EPIC and RGS cameras aboard XMM-Newton and NuSTAR. We find evidence of a multiple-layer ionized absorbers for which past observations established non-equilibrium conditions (e.g. Krongold et al 2007). Particularly, the average X-ray spectra during the two relatively long ($\sim$100 ks) XMM observations analyzed here, are characterized by at least three distinct ionized components, with i) low-to-moderate ionization and low outflow velocity (v$\sim$500 km/s) and (ii) high ionization and relatively high-velocity (v$\sim$5000 km/s). We also perform time-resolved spectroscopy of the low-velocity variable ionized absorbers, and through the study of the variability of the ionized absorbers we are able to constrain their density and distance from the ionizing source, which in turn allows us to estimate the energetics of these outflows and their impact on the host galaxy.

Optical spectral variability in a relativistic jetted AGN: the case of PMN J0948+0022

Sept 25 15:15 Contributed

Benedetta Dalla Barba

Narrow-line Seyfert 1 (NLS1) are a subset of AGN that accrete mat- ter near or above the Eddington limit. Some of these galaxies can generate relativistic jets and emit gamma rays, as demonstrated by PMN J0948+0022, the first identified gamma-ray NLS1. In the early 2000s, its optical spectrum showed weak forbidden lines and a narrow Hβ line with a Lorentzian profile, indicating turbulent motion in the nuclear gas. However, recent observations with X-Shooter and MUSE revealed a composite line profile, with a broad component and a nar- row peak, typical of Intermediate Seyfert (IS), a poorly understood class of AGN whose nature is still unclear. The analysis of optical spectra from SDSS, X-Shooter, and MUSE taken at different epochs suggests a change of the physical conditions, not only around the su- permassive black hole. These observations offer new insights into the changing-look AGN phenomena, and, particularly, about the transient nature of IS and NLS1 galaxies within the AGN lifecycle, showing how these two classes of gamma-ray emitting sources can be linked, and enriching our understanding of AGN evolution.

The Luminosity-variability relation in BASS type-1 AGN, its connection with physical properties and cosmological implementations

Sept 25 15:30 Contributed

Matilde Signorini

Variability is observed in AGN across all wavelengths, yet the physical mechanisms driving this phenomenon remain not fully understood. It has long been established that variability correlates with certain physical properties of AGN. Specifically, more massive black holes, and thus more luminous AGN, exhibit lower variability. However, the underlying cause of this correlation is still debated, with uncertainty about whether black hole mass, the accretion rate, or a combination of both is the primary driver. In this presentation, I will share results from the luminosity-variability analysis of the BASS sample, which includes type-1 AGN with X-ray excess variance measurements and optical/NIR spectroscopy. I will show the relation between variability and various physical properties of AGN, discussing how these correlations can deepen our understanding of AGN physics and variability mechanisms. Additionally, the correlation between luminosity and variability offers potential for estimating absolute luminosities and thus absolute distances of AGN, enabling their use as standard candles. I will discuss the implications of this approach for cosmology, addressing current limitations and exploring how future surveys like LSST may allow for the estimation of absolute distances through variability.

'Would you follow me?' X-ray and optical variations of the changing-look AGN J0413-0050

Sept 25 15:45 Contributed

Amelia Vietri

Active galactic nuclei (AGN) are characterised by flux variability at diverse timescales and wavelengths. Recently, optical/UV and X-ray observations have identified a new class of AGN showing much more drastic flux and spectral changes: the changing-look (CL) AGN. This peculiar behaviour may be attributed to changes in the accretion rate of the SMBH (changing-state CS-AGN), inducing variability in the continuum emission, or changes in the line-of-sight column density (changing-obscuration CO-AGN), possibly due to a passing cloud or nuclear outflows, obstructing our view of the central engine. Here, I present one of these objects, 2MASX J04130-0050, which has undergone a transition from a Type 1 AGN (6dF Galaxy Survey, 2004) to a Type 2 AGN (Nordic Optical Telescope, 2021). This transformation is marked by the complete disappearance of the Hβ line and the absence of the Hα broad component. Meanwhile, the X-ray flux increased between the Chandra observations in 2014 and the Swift/XRT observations in 2022 and 2023, with a particularly notable spike (2 dex higher) in the recent Swift/XRT observation in September 2023. Ten days after the latest Swift/XRT observation, an optical spectrum of the source was taken with FORS2@UT1 revealing a re-emerging of the Hβ narrow component and an increase in the flux of Hα, although its broad component was still absent. The results of this follow-up campaign, which I coordinated using Chandra, NOT, VLT and Swift, revealed that this source is a CS-AGN. Its behaviour is attributed to changes in the activity of the accretion disk rather than changes in the obscuration state. Upcoming coordinated observations with XMM and VLT will tell us more about the nature of this fascinating source.

Testing close massive black hole binary candidates through multi-epoch spectroscopy

Sept 25 16:00 Contributed

Lorenzo Bertassi

Emission from two massive black holes bound in a close binary is expected to be modulated by different processes such as Doppler boost due to the orbital motion, accretion rate variability generated by the interaction with a circumbinary disc and binary gravitational self-lensing. When the binary is close enough the two black holes are thought to be surrounded by a common broad line region that reprocesses the impinging periodically varying ionizing flux creating broad emission lines whose observed shape will change in time. The study of broad lines through multi-epoch spectroscopic campaigns will enable the search for smoking guns of the presence of a binary. We study the response of a disc-like broad line region to the Doppler-boosted ionizing flux emitted by sub - mpc circular massive black hole binaries, and compare it with the response of a broad line region illuminated by a single massive black hole with a periodically varying intrinsic luminosity. Through the study of the delay between the continuum and the broad emission line light curves, we identify a new

binary signature that cannot be produced by single massive black hole surrounded by asymmetric broad line regions.

Probing Black Holes in Distant Quasars with Photometric Reverberation Mapping: A smarter, faster (150x) way to measure BLR sizes (and black hole masses) in active galaxies

Sept 25 16:45 Contributed

Swayamtrupta Panda

Probing Black Holes in Distant Quasars with Photometric Reverberation Mapping: A smarter, faster (150x) way to measure BLR sizes (and black hole masses) in active galaxies Reverberation mapping accurately determines virial black hole masses for redshifts $z < 0.2$ using the relationship between the Hbeta broad-line region (BLR) size and the 5100 Angstrom continuum luminosity established with ∼200 AGNs. For quasars at $z \sim$ 2-3, determining the BLR size is time-consuming and limited by seasonal gaps, requiring ∼10-20 years of monitoring CIV emission lines. In this work, we demonstrate that an efficient alternative is to use a continuum size-luminosity relation, which can be obtained up to 150 times faster using photometric reverberation mapping (PRM). We outline the method and its feasibility based on simulations and propose an observational strategy that can be carried out with ground-based meter-class telescopes equipped with narrow and medium-band filters. As a case study, we focus on the ESO La Silla 2.2 meter telescope observations with a well-defined sampling rate which recovers our predictions - a testament to the validity of our scaling relation. These observations provide the scaling factor between the accretion disk and the CIV-based BLR sizes, which is (1) crucial for estimating the masses of black holes at higher redshifts extending beyond the cosmic noon, (2) evaluating the contribution of the diffused continuum emission and assessing the standard accretion disk theory, and, (3) validating quasars as cosmological distance indicators and bridge the gap between the local and early Universe.

Unprecedented extreme radio variability in high-Eddington AGN

Sept 25 17:00 Contributed

Marco Berton

In this talk I will report on the discovery of one of the most extreme cases of high-frequency radio variability ever measured in active galactic nuclei (AGN), with observed variability on timescales of days or less, and amplitudes reaching three to four orders of magnitude. These sources, identified as radio-weak narrow-line Seyfert 1 (NLS1) galaxies, were initially discovered at the Metsähovi Radio Observatory (MRO) through recurring flaring at 37 GHz, strongly suggesting the presence of relativistic jets. To investigate further, we conducted observations with the Karl G. Jansky Very Large Array (JVLA) at 1.6, 5.2, and 9.0 GHz, which revealed no signs of jets. Subsequent observations at higher frequencies (10, 15, 22, 33, and 45

GHz) using the JVLA, and at 15 GHz using the Very Long Baseline Array (VLBA), were complemented by single-dish monitoring at 37 GHz from MRO and at 15 GHz from Owens Valley Radio Observatory (OVRO). These observations revealed that, intriguingly, all but one source exhibited a steep radio spectrum up to 45 GHz or were not detected at all. The 37 GHz data indicate that the timescales of the radio flares can go down to a few days, with derived variability brightness temperatures and Doppler factors comparable to those observed in blazars. Despite exploring various explanations for their extreme behavior, no definitive conclusions can yet be drawn. These extraordinary sources exhibit radio variability at a level rarely, if ever, seen in AGN, suggesting they may represent a new type of jetted AGN or a novel variability phenomenon.

An optical perspective on early-stage AGN with extreme radio flares

Sept 25 17:15 Contributed

Luca Crepaldi

A few decades have passed since the identification of narrow-line Seyfert 1 (NLS1) galaxies as a subclass of active galactic nuclei (AGN). NLS1s show a Seyfert 1-like spectrum, but with emission line widths similar to those of Seyfert 2 spectra. These peculiar traits suggest a combination of factors: high accretion rates near the Eddington limit and low-mass black holes. Although few, jetted NLS1s have been discovered. Recently, seven sources with an inverted radio spectrum and extreme radio variability were identified, among a sample of radio-quiet and radio-silent jetted NLS1s. They show rapid high-frequency flares at 37 GHz that increase their flux density up to 9000-fold (Jy level) with an e-folding timescale of less than 10 hours. During quiescence and at lower frequencies, they achieve only mJy levels. Until now, their radio spectra are the only common feature. I will present the results of a multi-epoch analysis, devoted to search optical variability and periodicities using publicly available data. For this purpose I performed Fourier analyses, to find any similarity between such extreme flaring objects. Moreover, a long-term variability comparison between radio and optical light curves, and an optical spectra analysis have been carried out, showing a complete different scenario compared to that in radio band. Such strong radio variability had never been observed before in any AGN, making this work an important key to understanding the phenomenon. Furthermore, understanding the physics behind these peculiar objects may ultimately help us reveal a new and unexplored population of jetted AGN.

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eROSITA-detected X-ray flaring event in a Seyfert galaxy: a multi-wavelength analysis and interpretation of the physical processes

Sept 25 17:30 Contributed

Saikruba Krishnan

Active Galactic Nuclei (AGN) are powered by accretion of gas onto supermassive black holes. There are open questions regarding how the X-ray corona, disk, and BLR evolve in response to changes in the global accretion supply. We are using eROSITA's all-sky X-ray surveys to identify extragalactic X-ray transients. I present multi-wavelength observations of a candidate AGN transient event detected with eROSITA. Its X-ray flux increased by ~ 5 over six months; concurrent optical photometric monitoring data with ATLAS showed a simultaneous increase. We triggered a multi-wavelength follow-up monitoring program (XMM-Newton, NICER; optical spectroscopy) to study the evolution of the accretion disk, broad-line region, and X-ray corona. We witnessed a likely sudden strong increase in local accretion rate, which manifested itself via an increase in accretion disk emission and thermal Comptonization emission in the soft X-rays, followed by a decrease in accretion and Comptonized luminosity. The physical processes (e.g., disk instabilities) leading to such substantial variations are still an open question, and future continuous monitoring along with multi-wavelength studies will shed some light on it.

Mapping of molecular gas in radio-loud AGN at z=0.4 hosted by cool-core brightest cluster galaxies

Sept 25 17:45 Contributed

Gianluca Castignani

Brightest cluster galaxies (BCG) are today passive and very massive galaxies at the center of their clusters, still accreting mass through swallowing companions, and flows of cold gas, regulated by radio-mode AGN feedback. However, their formation history is still a matter of debate. I will present new results based on NOEMA millimeter interferometric observations (24 hr in total), mapping the cold molecular gas (CO) that feeds the star formation of distant BCGs. We selected three among strongest cool-core BCGs at intermediate redshifts (z=$\sim$0.4), all associated with powerful radio-loud AGN, namely RX 1532, MACS 1447, and CHIPS 1911. Previous unresolved millimeter observations and multi-wavelength analysis showed that they are among the most star forming (SFR$\sim$100 Msun/yr) and gas rich (MH2$\sim$1e+11 Msun) BCGs at intermediate redshifts. The selected BCGs are thus caught in a phase of rapid mass assembly, which makes them ideal targets for high-resolution observations of their molecular gas. We find that all three BCGs show point-like and steep-spectrum (alpha=0.8) continuum emission at mm wavelengths, interpreted as optically-thin synchrotron emission from the AGN. By combining our NOEMA intensity and velocity maps with archival deep optical / IR images from HST, we unambiguously detect in-situ star formation, filaments of accreting cold gas likely regulated by AGN feedback, disturbed morphology associated with tidal tails of molecular gas, as well as gas compression and tails originated from ram pressure

stripping. Altogether, despite the underlying homogeneous selection, the BCGs exhibit a broad variety of environment-driven mechanisms responsible for the processing of their cold gas: cooling flows, galactic tides, and ram pressure stripping. This study thus sheds new insights on the physical mechanisms responsible for the mass assembly of galaxies hosting AGN at the center of clusters.

Accretion properties of X-ray AGN: Evidence for radiation-regulated obscuration with redshift-dependent host galaxy contribution

Sept 25 18:00 Contributed

Brivael Laloux

Accreting supermassive black holes, or active galactic nuclei (AGN), are known to grow behind clouds of gas and dust, obscuring their view. In orientation unification models, unobscured ($20 < \log(N_{\rm H}/{\rm cm}^{-2} < 22$) and obscured ($22 < \log(N_{\rm H}/{\rm cm}^{-2} < 24$) AGN differ only by their viewing angle, while evolutionary models suggest that obscuration correspond to a specific phase in the AGN life-cycle. Consequently, the former predicts similar accretion properties while the latter expect discernible differences. To investigate this dichotomy, I analysed 3882 X-ray-selected AGN from three different *Chandra* deep extragalactic fields (COSMOS Legacy, CDFS, AEGIS) and constrained their stellar masses, $M_\star$, intrinsic X-ray luminosities, $L_{\rm X}$, obscuring column densities, $N_{\rm H}$, and specific accretion rates $\lambda \propto L_{\rm X}/M_\star$. By combining these observables within a Bayesian non-parametric approach, I infered, for the first time, the specific accretion rate distribution (SARD) of obscured and unobscured AGN to $z \approx 3$, i.e. the probability of a galaxy with mass $M_\star$ at redshift z hosting an AGN with column density $N_{\rm H}$ and specific accretion rate λ. I will present my findings showing: (1) both obscured and unobscured SARDs share similar shapes, shifting towards higher accretion rates with redshift, (2) unobscured SARDs exhibit a systematic offset towards higher λ compared to obscured ones, (3) the obscured AGN fraction declines sharply at $\log \lambda_{\rm break} \sim -2$ for $z < 0.5$, but shifts to higher λ values with increasing redshift, (4) the incidence of AGN within the blow-out region of the $\lambda - N_{\rm H}$ plane increases with redshift. These observations provide compelling evidence for AGN "downsizing" and for radiation-regulated nuclear-scale obscuration with an increasing host galaxy contribution towards higher redshifts.

Session 5

Thursday, September 26, 2024

Perspectives offered by the ground and space based instrumentation under development with Italian participation

Sept 26
08:30
Invited

Roberto Ragazzoni

Italy, and INAF in particular, is involved in a number of ground based and space based instrumentation that could have some relevance for the study of Active Galactic Nuclei. I will briefly review these with some emphasys on the offered opportunities that have chance to be unique under some aspects.

New opportunities in AGN high energy astrophysics from space and from the ground

Sept 26
09:00 Contributed

Massimo Cappi

Nowadays, high and very high energy astrophysics are at a cross-road: X-ray Space Observatories such as e.g. Chandra, XMM-Newton, Integral, Swift and Fermi are "workhorses" slowly exhausting their power for new discoveries, after decades of vigorous and successful services. Similarly, at very high energies, MAGIC and HESS are slowing down their pace of unique publications and identifications of new VHE sources. However new scientific questions have also just turned up, often (but not exclusively) pointing to transient and multi-messenger science, that require new facilities/observatories to become operational as soon as possible. Given this context, I will review current and future high energy observatories accessible from space and from the ground, and will summarise the broad opportunities they will offer to the AGN community, with particular focus on the space missions XRISM/NewAthena/Theseus and on the ground Observatories ASTRI-MA and CTAO North & South.

The greatest hits of the Whole Earth Blazar Telescope in understanding blazars

Sept 26 09:15 Contributed

Claudia M. Raiteri

The Whole Earth Blazar Telescope (WEBT; https://www.oato.inaf.it/blazars/webt) was born in 1997 with the aim of providing dense and high-precision optical monitoring of gamma-loud blazars observed by the Compton Gamma-Ray Observatory (CGRO). Since 2000, the leadership has been maintained by researchers of the INAF-Osservatorio Astrofisico di Torino, who have expanded the collaboration to also include observers in the near-infrared and radio bands. The WEBT has carried out many multiwavelength campaigns, usually in conjunction with observations by satellites like AGILE, Fermi, XMM-Newton, Swift and TESS, and of Cherenkov telescopes like MAGIC. The goal is to follow the behaviour of selected blazars at all accessible frequencies to understand the emission and variability mechanisms in extragalactic jets, as well as the structure of the jet itself, and to shed light on the central engine of active galactic nuclei. In the WEBT campaigns managed by the Torino team, a geometrical interpretation of the long-term blazar variability has been proposed, according to which flares are observed in the multiwavelength light curves when the emitting regions of a inhomogeneous, curved and twisting jet better align with the line of sight, with consequent increase of the Doppler beaming. In this contribution I will present the WEBT and some of its most remarkable results.

Overview of active galactic nuclei in Euclid

Sept 26 09:30 Contributed

Federica Ricci

Euclid is a medium-class mission in the Cosmic Vision 2015–2025 program of the European Space Agency (ESA), launched on the 1st July 2023. It has already started providing high-resolution optical as well as near-infrared imaging, showcasing its amazing capabilities with the Early Release Observations (EROs) data. Euclid will also acquire NIR slit-less spectroscopy. Euclid mission will have a transformative impact on astronomy, not only for understanding cosmology, which is its main goal, but also for a wide range of legacy science. We will have more than 1/3 of the sky imaged with Euclid's exquisite cameras, we will detect billions of galaxies, and millions will harbour accreting supermassive black holes or AGN, which are the focus of my research. Euclid will be pivotal to understand how AGN evolve, whether they influence the cosmological environment and hosts galaxies where they live. The unique combination of spatial resolution, depth, and wide-area coverage of Euclid will allow us to explore the AGN population like never before using both photometric and spectroscopic selection criteria. The depth of the NIR observations will enable the detailed study of Type 1 and Type 2 AGN sub-populations and their co-evolution with galaxies during the so-called 'Cosmic Noon' ($1 < z < 3$) and beyond. The most luminous Type 1 AGN, i.e. quasars, can be identified using Euclid photometry alone or in combination with multi-band coverage from optical surveys such as LSST. I

will provide an overview of the work done so far within the Euclid collaboration, particularly focusing on the efforts by the work package on Type 1 and Type 2 AGN, which I co-lead with Prof. Sotiria Fotopoulou. I will present our forecasts for AGN selection and detection using Euclid photometry in combination with ground-based coverage like LSST. The identification of AGN in Euclid will also rely on spectroscopic data, as Euclid will measure spectroscopic redshifts for millions of AGN. Finally, I will discuss prospects for the future.

Selection and Characterization of AGN with Gaia

Sept 26 09:45 Contributed

Maria Isabel Carnerero Martin

Gaia, a space observatory launched by the European Space Agency, has revolutionized our understanding of the cosmos by providing unprecedented precision in astrometric, photometric, and spectroscopic data for over a billion stars. In June 2022, the highly anticipated Gaia data release (DR3) was unveiled, marking a significant milestone with the introduction of the first-ever AGN catalog, specifically tailored to capture variability patterns. Leveraging insights from the established Gaia-CRF3 AGN catalog and employing key parameters indicative of object variability (such as Fractional Variability and Slope of the Structure Function), this new catalog, known as GLEAN, was meticulously curated through a series of rigorous selection criteria, resulting in an impressive compilation of approximately 872,000 sources. Looking ahead to 2026, the forthcoming fourth data release of Gaia (DR4) promises an array of exciting advancements. With an extended data span of 66 months, researchers will gain access to photometric light curves, offering deeper insights into AGN variability. Furthermore, the updated AGN catalog accompanying DR4 will introduce additional parameters related to variability, enriching classification and characterization endeavors within the scientific community. Notably, DR4 opens avenues for more detailed investigations into temporal delays in lens quasars, potentially facilitating estimations of H0, albeit within the complexities of this endeavor. Additionally, DR4 will facilitate access to low-resolution spectroscopic time series, presenting valuable opportunities for reverberation mapping studies. By observing the temporal delay between line and continuum measurements, researchers can glean insights into the structural dynamics of Broad Line Regions (BLR), particularly for the brightest objects. Another notable enhancement in DR4 is the inclusion of astrometric time series, enabling investigations into both Radio-loud and Radio-quiet AGN. For instance, researchers may explore the detection of motion within extragalactic jets, as exemplified by studies such as Blinov et al. (2021) on Blazar 3C 279. Additionally, studies related to AGN suggest that large-scale modifications in the accretion disk and surrounding dusty torus can induce shifts in the photocentre, as evidenced by works such as Souchay et al. (2022), highlighting 41 sources with significant proper motion. While challenging, these endeavors underscore the transformative potential of Gaia data in advancing our understanding of AGN dynamics and morphology.

Empirical AGN mock catalogues for the exploitation of future surveys

Xavier Lopez Lopez

Sept 26
10:00 Contributed

Realistic simulations have become essential for the design and development of future large surveys, which will produce unprecedented amounts of data. In this context, we present MAMBO, a flexible and efficient workflow to build empirical galaxy and AGN mock catalogues that reproduce these sources' observed physical properties and statistical distributions. Following an empirical methodology, we populate simulated dark matter halos with galaxies and AGN, and we use observed distribution functions such as stellar mass functions (SMF), host galaxy AGN mass functions (HGMF) and AGN accretion rate distribution functions studied at different redshifts to assign different physical parameters to our mock AGN, such as stellar mass, multiwavelength (X-ray and NIR to UV) luminosity, multiwavelength obscuration, spectral features, etc. In this talk, we will present the methodology, its validation against different observational data, and provide an example of its application using Euclid as a case study.

Session 6

Are AGN neutrino emitters?

Sept 26
10:45
Invited

Paolo Padovani

After the 2017 association between the blazar TXS 0506+056 and high-energy IceCube neutrinos, there has been a surge of research exploring the potential link between blazars and neutrinos. In 2022, somewhat surprising evidence emerged for neutrino emission from the nearby prototype Seyfert II galaxy, NGC 1068. This raises the question: which, if any, AGN are neutrino emitters, and why? I will attempt to answer these questions based on the current state of the field, focusing primarily on the observational side but trying to give also a theoretical perspective.

Simulating the evolution of dual and binary SMBHs/AGNs and their implications for gravitational wave astronomy

Sept 26
11:15 Contributed

Jasbir Singh

A natural outcome of the hierarchical structural evolution is that multiple supermassive black holes (SMBHs), which formed in separate dark matter halos, end up in the same halo, and eventually in the same galaxy. Although black hole pairs emitting as Active Galactic Nuclei (AGN) at a few kpc separations have already been reported, observations are often mired in known and unknown selection effects, and are unable to resolve separations of parsec scales or lower. In this talk, I will give a brief overview of various types of simulations used to predict the dual AGN fraction at different separation scales based on different assumptions. Then, I will focus on one particular model of formation of SMBH using cosmological simulations from PINOCCHIO code and will present simplistic estimates of the dual AGN fraction based on timescales for galaxy mergers obtained from the semi-analytical model PinGAEA. To conclude, I will present the implications of this model for the expected merger rate of SMBHs relevant for different gravitational wave experiments, such as LISA and the Pulsar Timing Arrays.

Connecting Gamma-Ray Absorption Features and Neutrinos to investigate the presence of Large-Scale Environments in BL Lac objects

Luca Foffano

Sept 26 11:305 Contributed

Investigating large-scale environments in active galactic nuclei (AGNs) typically relies on analyzing absorption and emission lines in their optical spectra. However, in BL Lac objects - a class of AGNs with a relativistic jet pointing directly at the observer - the dominant non-thermal emission from the jet obscures any optical thermal emission. Consequently, the identification of photon fields produced by large-scale structures turns out to be challenging. However, these environmental photon fields can still interact with gamma rays from the blazar jet via gamma-gamma pair production, reducing the original gamma-ray flux and creating observable absorption features in the spectral energy distribution. Interestingly, the same photon fields can trigger proton-photon interactions, acting as targets for the production of high-energy neutrinos. In this contribution, we discuss the crucial role of gamma-ray observations in unveiling absorption features in the spectra of BL Lac objects and demonstrate how these features are connected to high-energy neutrino production. Furthermore, we present simulations exploring the optimal physical conditions for producing neutrino fluxes compatible with the sensitivities of current and upcoming neutrino detectors.

JASSIE: A Customizable Interface for Simulating SEDs in simulated Jetted AGNs

Marco Sortino

Sept 26 11:45 Contributed

I present JASSIE (Jetted AGN Simulated Spectrum InterfacE), an advanced interface designed to compute the Spectral Energy Density (SED) of magnetohydrodynamic simulated jetted Active Galactic Nuclei (AGNs). This tool, constructed using the agnpy library (made by Nigro et al. 2022), offers a high degree of customization. Users can select the distance to the source and the angle of view, and choose which radiation processes (Non-Thermal Bremmstrahlung, Synchrotron, Synchrotron Self-Compton, External Compton) and structural components to consider in their simulations. Unlike traditional models that treat the jet as a single large blob, JASSIE defines a distinct blob for each cell in the computational grid. It calculates the emission from each individual blob and models the interactions of photons between these blobs along the observer's line of sight. JASSIE is compatible with outputs from the Adaptive Mesh Refinement (AMR) code FLASH, and it leverages data parallelism to enable efficient parallel processing. This capability makes it a powerful tool for detailed and accurate modeling of the complex emissions from jetted AGNs.

A new look at the extragalactic Very High Energy sky: searching for TeV-emitting candidates among the X-ray bright non-Fermi detected blazar population

Sept 26 12:00 Contributed

Stefano Marchesi

A new look at the extragalactic Very High Energy sky: searching for TeV-emitting candidates among the X-ray bright, non-Fermi detected blazar population In this talk, I will present the results of a multi-wavelength study of blazars selected from the 5th ROMABZCAT catalog, aimed at determining how effectively the blazars X-ray emission can be used to trace their Very High Energy (VHE, i.e., above 20 GeV) emission. To do so, we selected a subsample of 1007 objects that are not detected in the Fermi-LAT 14-year source catalog (4FGL) while at the same time having at least one counterpart in one of the three main archival X-ray catalogs, which is, the fourth release of the XMM-Newton Survey Science Catalogue, the second release of the Chandra Source Catalog, and the second Swift-XRT X-ray Point Source catalog of detections by XRT, or in the recently released eROSITA-DE Data Release 1 catalog. We find that a large number of sources, mostly BL Lacs or BL Lacs with host-galaxy contribution to the spectral energy distribution, have large synchrotron peak frequency and X-ray to radio flux ratio, two properties that characterize the vast majority of known TeV emitters. With respect to these known TeV emitters, our targets have X-ray fluxes $\sim$1 order of magnitude fainter. We then computed the 0.2-12 keV and 20 GeV - 300 TeV fluxes for the known 5BZCAT TeV emitters, and determined the existence of a direct correlation between X-ray and TeV fluxes in the BL Lacs population. We used this trend to estimate the VHE flux of our targets, and found a promising sample of sources for follow-up observations with current or future, more sensitive, Cherenkov telescopes, first and foremost the Cherenkov Telescope Array Observatory.

The spectral energy distribution of extreme population A sources

Sept 26 12:15 Contributed

Karla Garnica Luna

Knowledge of the broad-band active galactic nuclei (AGN) spectral energy distribution (SED) that ionizes the gas-rich broad emission line region (BLR) is key to understanding the several radiative processes at play. The SED involves a ionizing continuum that is producing the rich emission line spectrum observed in all type 1 AGN. We modelled a SED for highly accreting quasars, also known as xA sources or extreme Population A, based mainly on observational data available at astronomical databases. Our main selection criteria is the Rfe parameter, the ratio of the optical FeII emission between 4434 A and 4684 A to the HB intensity, Rfe$\geq$1. This criterion is satisfied by highly-accreting black holes (Pop. A3 and A4 following Sulentic et al. 2002). We started with near 900 xA sources previously reported on the literature to create a median xA SEDs spanning from radio to X-ray and subdividing it into radio loud, radio intermediate and radio quiet. We found that

the radio quiet SED for Rfe$\geq$ 1 is consistent with the one of Mathews & Ferland (1987), from IR to hard X-ray, which was thought to be appropriate with all AGN at high Eddington ratios. One of the most interesting results is the difference of radio loud and radio intermediate SED, where the radio intermediate ones show IR excess in differences of the rest of the sample. Also, we identify 6 sources as radio loud in our 900 sources strong database. This is a much lower prevalence than the typical one among optically selected samples, usually around 10-15%.

Chandra-to-MeerKAT: A complete multi-λ characterisation of obscured AGN at $0.6 < z < 3$

Sept 26 14:30 Contributed

Luigi Barchiesi

A fundamental phase of most AGN-galaxy co-evolution models is the obscured accretion phase, where a significant fraction of the SMBH mass is assembled in gas-rich conditions. Despite its importance, this phase is one of the least studied, mostly due to the challenges in selecting and identifying such obscured sources. UV lines from the NLR (such as [Ne V] and C IV) can be powerful tools to select type 2 AGN, as they are not obscured from the AGN torus. I will present the properties of $\sim$200 obscured AGN, the first sample of UV-line selected AGN at 0.6<z<3.1 with complete coverage from the X-rays to the Radio band, exploiting multi-wavelength spectro-photometric data ranging from Chandra to MeerKAT and VLA observations. This extraordinary multi-wavelength coverage of the COSMOS field allows us to create a coherent picture of the AGN and host-galaxy properties. I will show how we are able to properly characterise a large number of very obscured and CT-AGN that would not be recognised as such via single-band selection techniques. We will also investigate the AGN and SF interplay, as well as the importance of having both Radio and X-ray coverage when characterising the source properties via SED-fitting.

Spectral Energy Distribution Modeling of Broad Emission Line Quasars: From X-ray to Radio Wavelengths

Sept 26 14:45 Contributed

Avinanda Chakraborty

While it is known that, based on radio emission, quasars can be classified into two categories - radio-loud (RL) and radio-quiet (RQ), the underlying mechanism for this dichotomy has long been a matter of debate. In addition to their intrinsic differences, the presence of a strong radio jet in RL quasars may distinguish them from RQ quasars in how they affect the dynamics of their host galaxies. While previous studies involved modeling the spectral energy distributions (SED) of normal and active galaxies, the modeling of quasar-host galaxy SEDs, particularly classified by their radio emission, remains relatively unexplored. In this work, we study the differences in physical properties of quasar-host galaxies using an optically selected (SDSS; Shen et al. 2011) sample of RL and RQ quasars which we have further

cross-matched with the VLA-FIRST survey catalog. The sources in our sample have broad Hβ and MgII emission lines and include broad emission line quasars (1000 km/s<FWHM<15000 km/s) with a subsample of extremely high broad line quasars (FWHM > 15000 km/s). We construct the broadband SED of our broad line quasars using multi-wavelength archival data and targeted observations with the AstroSat telescope. We are introducing the AstroSat sources to CIGALE code for the very first time. We then perform the SED analysis of our RL and RQ quasars. We use the state-of-the-art SED modeling code X-CIGALE (Yang et al. 2022) to model the SEDs and determine the best-fit physical parameters of the quasar host galaxies namely their star formation rate (SFR), main sequence stellar mass, luminosity absorbed by dust, e-folding time and stellar population age. We find the stellar masses, dust luminosities and SFR to be similar for both RL and RQ populations whereas RQ has a higher e-folding time and stellar population age than RL. We find that the emission from the host galaxy for our sources are between 20%-35% as they are mostly dominated by the central quasars. Using our best-fit estimates for the SED modeling we reconstruct the optical spectra of our quasars which show remarkable agreement in reproducing multiple features in the observed SDSS spectra of the same sources. Our analysis, thus, provides a completely independent route in studying the host galaxy correlations of quasars and addressing the radio dichotomy problem from the host galaxy perspective.

X-ray VS multiband nuclear properties of luminous quasars at the Cosmic Noon: surprises and confirmation

Sept 26 15:00 Contributed

Cecilia Degli Agosti

We investigate the X-ray emission of the complete sample of 85 WISE/SDSS selected Type 1 Hyper-luminous (WISSH) quasars at the Cosmic Noon. Our aim is to explore the accretion disk – corona coupling and the nuclear environment, and possible changes occurring in hyper-luminous sources compared to lower-luminosity AGN. We derive continuum spectral properties, as photon index Γ, intrinsic column density NH and luminosity. About 27% of the sources for which NH is estimated exhibits significant obscuration. Even once NH is taken into account, $\sim 1/3$ of our sample is X-ray weak. WISSH sources follow literature correlations between X-ray and bolometric, UV and mid-infrared luminosities, despite exhibiting broader dispersion around them. Conversely, our results do not support the dependence previously found in the λEdd – Γ plane. Finally, we find blue and non-BAL QSOs to occupy a region in the λEdd – NH plane typically associated with intense feedback processes during heavily-reddened evolutionary phases. Our analysis suggests additional phenomena occurring in the accretion disk – corona system may cause the spread around literature relations. These might be linked to the large amount of radiated energy and high accretion rates which characterize the most luminous QSOs.

A tailored SED fitting module for Low-luminosity AGN

Sept 26 15:15 Contributed

Iván López

AGN are essential for understanding galaxy evolution, primarily due to the significant impact of AGN feedback. While mid to high-luminosity AGN are relatively well understood, the role of low-luminosity AGN (LLAGN) in galaxy evolution remains unclear. LLAGN are more common in the local Universe compared to their high-luminosity counterparts, yet their study is challenging due to their faintness and the contaminating emission from their host galaxies. Even the most popular AGN censuses struggle to cover the population below a log λEDD of -2. However, SED fitting is a tool that can overcome this problem by using a multi-wavelength approach to estimate both the host galaxy and AGN emissions simultaneously. In this work, we introduce a novel SED fitting module designed specifically for LLAGN and integrated into the CIGALE code. This module effectively recovers black hole properties even in the presence of radiatively inefficient accretion disks (ADAF) along with regular truncated disks. Our methodology, tested on a sample of 52 X-ray-detected local LLAGN, demonstrates the module's efficacy in estimating AGN parameters despite significant contamination from the host galaxy. Furthermore, we derive bolometric corrections for X-ray luminosities as low as 10^{38} erg/s, extending beyond traditional luminosity regimes ($> 10^{42}$ erg/s) and yielding results consistent with previous extrapolations. Additionally, our investigation into the αox index reveals trends that differ from the high-luminosity regime, with αsox displaying a more constant behavior relative to λEdd. The enhanced CIGALE code provides the community with a valuable tool for SED fitting across a broader range of AGN luminosities. Future AGN censuses through large surveys promise to offer a comprehensive understanding of the LLAGN population and its feedback effects on host galaxies and their environments.

The AGN content in EROSITA DR1

Sept 26 15:30 Contributed

Mara Salvato

Galaxy evolution can only be understood if their AGN phases are accounted for. For that, a complete and pure census of AGN is needed. Hunting for AGN in X-ray is the most obvious way to go, given the low emission from galaxies at this frequency. In the last 20 years, XMM and Chandra have provided us mostly with pencil-beam surveys, thus sampling the faint and high-redshift regime. Finally, with eROSITA, we can also sample the rare (local and z>5.5) and faint Universe. In my talk, I will review the multi-wavelength properties (including redshifts) of the first eROSITA AGN sample, also in comparison with AGN selected from other surveys.

Session 7

High-z AGNs at the end of the Dark Ages

Sept 26 16:45 Invited

Andrea Grazian

Astonishing results have been recently obtained for the population of high-z AGNs from deep JWST observations and wide ground based surveys, well within the Reionization epoch and close to the end of the Dark Ages. The most relevant novelties are the large space density of faint AGNs at z>4, their extreme weakness in X-ray luminosities, their over-massive SMBHs with respect to the expectation from local scaling relations, the coevolution with their host galaxies, and the unexpectedly emergence of the previously unknown population of Little Red Dots. In this talk, I will discuss the implications of these unexpected results on the nature of the sources driving the Reionization process and on the seeding of early SMBHs. Final perspective will be dedicated to the possible expectations from ongoing and future observational facilities like Euclid, Vera Rubin LSST, and ELT on the statistical and physical properties of the high-z AGNs, that will reserve us many other surprises in the near future.

The formation of supermassive black holes from Population III.1 seeds. III. Galaxy evolution and black hole growth from semi-analytic modelling

Sept 26 17:15 Contributed

Vieri Cammelli

We present an implementation of Pop III.1 seeding of supermassive black holes (SMBHs) in a theoretical model of galaxy formation and evolution to assess the growth the SMBH population and the properties of the host galaxies. The model of Pop III.1 seeding involves SMBH formation at redshifts $z \geq 20$ 20 in dark matter minihalos that are isolated from external radiative feedback, parameterized by isolation distance d iso. Within a standard ΛCDM cosmology, we generate dark matter halos using the code pinocchio and seed them according to the Pop III.1 scenario, exploring values of d iso from 50 to 100 kpc (proper distance). We consider two alternative cases of SMBH seeding: a Halo Mass Threshold (HMT) model in which all halos $> 7 \times 10^{10} M_{\odot}$ are seeded with $\sim 10^{5} M_{\odot}$ black holes; an All Light Seed (ALS) model in which all halos are seeded with low, stellar-mass black holes. We follow the redshift evolution of the halos, populating them with galaxies using the GAlaxy Evolution and Assembly theoretical model of galaxy formation, including

accretion on SMBHs and related feedback processes. Here we present predictions for the properties of galaxy populations, focusing on stellar masses, star formation rates, and black hole masses. The local, $z \sim 0$ metrics of occupation fraction as a function of the galaxy stellar mass, galaxy stellar mass function (GSMF), and black hole mass function (BHMF) all suggest a constraint of d iso < 75 kpc. We discuss the implications of this result for the Pop III.1 seeding mechanism. We also present estimates of the UV luminosity functions and BH accretion history.

The radio properties of z>3.5 quasars: Are most high-redshift radio-loud active galactic nuclei obscured?

Sept 26 17:30 Contributed

Alessandro Capetti

We present the results of an analysis of the radio properties of powerful (rest-frame luminosity >10E28 W/Hz at 500 MHz) high-redshift (z > 3.5) quasars. The aim of this study is to gain a better understanding of radio-loud sources at the epoch when they reach the highest space density. We selected 29 radio-loud quasars at low radio frequencies (76 MHz). Their radio spectra, covering the range from 76 MHz to 5 GHz, are generally well reproduced by a single power law. We created samples that were matched in radio luminosity at lower redshift (from z∼1.3 to z∼2.8) to investigate any spectral evolution. We find that the fraction of flat-spectrum radio quasars (FSRQs) strongly increases with redshift (from ∼8% at z=1.2 to ∼45% at $z > 3.5$). This effect is also observed in quasars with lower luminosities (down to ∼10E27 W/Hz. The increase in the fraction of FSRQs with redshift corresponds to a decrease in the steep-spectrum radio quasars. This result can be explained, assuming that the beaming factor and the slope of the luminosity function do not change with redshift, if high-redshift radio-loud sources can be recognized as quasars only when they are seen at a small viewing angle (<25 degrees), while most of them, about 90%, are obscured in the UV and optical bands. We also found a trend for the size of radio sources to decrease with increasing redshift. Because projection effects are insufficient to cause this trend, we suggest that the large amount of gas causing the nuclear obscuration also hampers the growth of the more distant sources.

Quasar feedback at z=6 traced by JWST

Sept 26 17:15 Contributed

Stefano Carniani

High-redshift quasars are some of the most extreme systems in the Universe, with intense accretion at or even above the Eddington limit, forming black holes with masses of 1e8– 1e9 Msun in less than a billion years. In the last decades, more than 200 quasars have been discovered at z $\sim$ 6 and beyond, raising questions about the nature of the first black hole seeds, their extreme growth mechanisms, and their feedback effect on the host galaxy. I present the JWST NIRSpec GTO observations targeting a sample of z>6 quasars, allowing us to access the first for the first time to near-infrared spectral range with unprecedented sensitivity and cover key rest-frame optical emission lines that have been previously unobservable. Thanks to the observations carried out with NIRSpec in IFS we derive the most accurate measurements of the black hole mass, Eddigton ratio, galaxy properties, and small-scale environments of the selected quasars. Comparing the black hole mass with the host galaxy mass obtained from spatially resolved emission, we find that our quasars lie above the local black hole–stellar mass relation. The rest-frame optical lines clearly reveal ionized outflows with a mass loss rate much larger than the star-formation rate of the host galaxies, implying that if this is prolonged, the quasar-driven outflows may be the main driver for gas depletion within the galaxies. Finally, we discover companion galaxies undergoing mergers with the host galaxy and, likely, triggering quasar activity. In summary, such analysis shows JWST/NIRSpec observations are significantly improving our understanding of the first quasars.

Unveiling dark matter with the smallest known quadruple lensed Quasar

Sept 26 17:30 Contributed

Quirino D'Amato

Strong gravitational lensing is key to address many open challenges of current cosmological models (such as the "missing satellite" and the "cusp-core" problems), by modeling the inner mass density profile and the level of dark matter substructure within the lensing galaxy. High resolution observations of these systems are needed to put strong constraints on the lensing mass modeling. I will present the first ERIS/NIX IFU observations of a subarcsecond quadruple lensed Quasar at z=2.85, which is the smallest detected so far (separation 0.2"-0.4"), comparable to the smallest known strong lensing system (CLASS B0218+357, separation $\sim$ 0.3"). The image also displays significant emission of the lensing galaxy. Thanks to spectroscopic follow-up we measured a spectroscopic lens z=1.055, which makes this system one of the farthest lensing galaxy ever detected. Thanks to the secure spectroscopic redshift and high resolution observations of the lens and the quasar, we disentangled the lens emission and measured its size, luminosity and mass for different IMF. In addition, from the lens reconstruction we also derived the gravitational mass and Einstein radius, allowing us to compare the total mass to the stellar mass and so derive the dark matter fraction at different radii from the lens center.

The most extreme radio QSOs at $z > 5$

Sept 26 17:45 Contributed

Luca Ighina

How the supermassive black holes (SMBHs) we detect in the early Universe formed and grew to the observed sizes in such a short period of time is still not clear. One possible explanation could be given by the presence of relativistic jets that may significantly increase the growth efficiency. However, the actual number and the properties of "jetted QSOs" (usually dubbed as radio-loud, RL) at high redshift is still poorly constrained, due to low statistics. In this talk I will describe our efforts in characterising the evolution of the high-z RL QSO population. In particular, I will present the selection of the largest well-defined sample of RL QSOs at $z > 5$ currently available, containing 30 objects, built from the combination of some of the deepest wide-area surveys currently available: RACS, in the radio, and DES/PanSTARRS, in the optical/NIR. This sample can now be used in order to firmly constrain the redshift evolution of this population (in terms of emission and obscuration) and of their space density. At the same time, I will also describe how dedicated multi-wavelength (radio, NIR and X-ray) observations of these sources are essential in order to help constrain the properties of the SMBHs and jets hosted in these extreme systems. Finally, I will show how future surveys (EMU, LSST, EUCLID) will allow us to push these studies to unprecedented redshifts.

A NIRSpec/IFU view of a quasar-galaxy merger at cosmic dawn

Sept 26 18:00 Contributed

Federica Loiacono

Quasars are among the most active sources emerging in the early universe (z > 6). Their host galaxies have stellar masses and star formation rates orders of magnitude higher than what is observed in typical galaxies at the same redshifts. Investigating these sources is thus necessary if we want to unveil how the first massive galaxies formed. Here we present the rest-frame optical spectrum of a z = 6.23 quasar obtained with JWST/NIRSpec IFU. The spectrum shows the quasar emission with exquisite quality (S/N $\sim$ 100 - 400 per spectral element). As shown by previous ALMA and HST data, the quasar presents two companion galaxies and lies within a prominent Lyman-alpha halo. This makes this source a perfect target to investigate several aspects, such as, the black hole properties, the quasar-host and companion galaxies, and the environment. Specifically, the NIRSpec data provide us with: 1) Accurate estimates of the black hole mass and the Eddington ratio; study of AGN feedback via ionized outflows. 2) A map of the ionized gas in the host galaxy and companion sources, showing a complex velocity structure, which enables a detailed study of the dynamics within this system; 3) A chart of the photoionization conditions in the gas, which enables shedding light on the physics of the interstellar medium (metallicity, hardness of the ionization field, powering source, etc); 4) A map of the halo seen in Halpha, which reveals resonance scattering as the main mechanism powering the Lyman-alpha halo. These data offer a deep insight into the assembly and early growth of the first massive galaxies and black holes.

Thursday, September 27, 2024

AGN under the eye of JWST: new selection techniques and physical properties

Sept 27
08:30 Contributed

Giovanni Mazzolari

The transformative era opened by JWST on the high-z Universe allows us to investigate the early stages of the Supermassive Black Holes (SMBH) evolution. In this talk, I will present some key results regarding the selection of high-z AGN and their peculiar properties. In particular, I will present three new narrow-line AGN (NLAGN) diagnostic diagrams, leveraging the [OIII]4363 auroral line, which has been detected in several JWST spectra. These diagnostics are able to separate much of the AGN population from Star Forming Galaxies (SFGs), and proved to be able to select AGN up to z>6, where the traditional NLAGN diagnostic diagrams fail, due to the different conditions of the AGN environments. I applied for the first time these new AGN diagnostic diagrams in the spectroscopic selection of NLAGN among the $\sim$ 300 publicly available medium-resolution spectra of the CEERS survey, identifying 52 NLAGN at $2 < z < 9$. I performed a detailed multiwavelength analysis of these sources, of which I will show the main results. In particular, given the presence of a deep X-ray observations on the field of the CEERS survey (AEGIS-XD, 800ks of Chandra), I investigated the X-ray properties of the selected NLAGN. We find that all but 4 NLAGN are undetected in the deep X-ray image, as well as all the high-z BLAGN that were previously selected in the literature from the same survey. We do not find a detection even by stacking the undetected sources, resulting in an X-ray weakness of 1-2 dex from what is expected based on their bolometric luminosities. Finally, I will present the latest result, namely the radio analysis used to discriminate between the heavily obscured AGN scenario or the intrinsic X-ray weakness as the origin of the observed X-ray weakness.

Phenomenology of super-Eddington accretion in AGN

Sept 23
08:45
Contributed

Paola Marziani

Super-Eddington accretion in active galactic nuclei (AGN) represents a phenomenon that is at the frontiers of our understanding of black hole growth and the dynamics of accretion processes in extreme environments. The phenomenology of super-Eddington accretion is fundamental for comprehending the rapid growth of supermassive black holes, the evolution of quasars, and their impact on their host galaxies. I'll consider multi-wavelength observations of quasars, highlighting key spectral features that indicate super-Eddington accretion rates. These include a characteristic emission line spectrum, extreme Eddington ratio, and powerful accretion disk winds. Additionally, the interplay between radiation pressure and gravitational forces can lead to distinctive observational phenomena, such as anisotropic emission and the potential for beaming effects. The available observational constraints allow for a structural and dynamical scheme connecting accretion mode to the broad line emitting regions that accounts for the most compelling observations.

LBT IR observations of candidate super-Eddington quasars

Sept 27 09:00 Contributed

Tania Buendia-Rios

High accreting quasars are characterized by extreme radiative and mechanical output, and are explored for their crucial role in galactic evolution. They are known for nuclear outflows, contributing to feedback effects on host galaxies. We present new observations at the Large Binocular Telescope (LBT, z $\sim$ 2) covering a sample of 6 high accreting quasars in the Hβ region. The analysis covered the data reduction of the observed quasars and redshift estimation of the IR/LBT sample and its UV counterpart, multi-component fitting at the quasar RF of the most prominent emission lines in the UV-optical ranges, estimation of the physical parameters (black hole mass and Eddington ratio) using Civ, Siiv, Aliii, Mgii, Hβ, as well as the computations of the outflows/winds properties using Civ and [Oiii]. The Hubble diagram was estimated for the LBT sample, and it was observed to be in agreement with current cosmological models.

First systematic investigation of broad-band X-ray-to-NIR SED of z$\sim$6-7.5 quasars

Sept 27 09:15 Contributed

Ivano Saccheo

Luminous QSOs shining at the Epoch of Reionization are essential to uncover the formation and growth history of the SMBHs powering them, a process that remains not fully understood. In this talk, I will present the results of a systematic investigation into the X-ray-to-NIR broadband emission of 54 QSOs at z = 6-7.5. Our goal is to gain insights into their intrinsic physical properties, including accretion rates, energy budgets, and the prominence of their primary continuum emission components. Remarkably, the optical-UV SED of these early QSOs closely resemble those of luminous QSOs at Cosmic Noon (z=2-3), despite significant differences in their X-ray spectral properties and extreme accretion histories. In contrast, the NIR emissions show a broad range of hot dust emission strengths, with some objects exhibiting low levels of emission and others displaying enhanced contributions. Additionally, I will discuss UV and optical bolometric corrections for z $>$ 6 QSOs and compare them with those derived for the broader QSO population. Accurate bolometric corrections are crucial for robustly estimating the bolometric luminosities of the thousands of high-redshift QSOs expected to be observed by the upcoming Rubin-LSST survey.

Too many or just right? Massive jetted quasars in the early Universe

Sept 27 09:30 Contributed

Tullia Sbarrato

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. eROSITA comes easily into play in this picture: its sensitivity in the soft X-ray energies nicely complements existing 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 $M > 10^9$Msun 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?

Shedding X-ray light on the formation sites of high-z

Sept 27 10:15 Contributed

Ilaria Villani

Hot Dust Obscured luminous quasars: the case of W0410-09 at z$\sim$ 3.6 Hot Dust Obscured Galaxies (Hot DOGs) represent a transitional, heavily dust-enshrouded phase in the merger-driven, feedback-dominated evolutionary sequence of luminous (Lbol $>$ 1e47 erg/s) QSOs. Due to the presence of large amount of dust, this phase is thought to be a key stage of BH growth and AGN evolution. Galaxy formation models predict these systems to grow via mergers, that can deliver large amounts of gas toward their centers, induce intense bursts of star formation and feed their supermassive black holes. The Hot DOG W0410-09 (z $\sim$ 3.6) is one of the brightest ($L_{IR} >$ 1e14 Lsun) and most gas-rich (>1e11 Msun) star-forming ($>$ 1000 Msun/yr) galaxies discovered so far. MUSE revealed that W0410-09 is surrounded by an exceptional swarm of Lyα-emitting galaxies making this circumgalactic environment ($\approx$ 400 kpc) one of the densest regions in the Universe observed so far. However, the Lyαnebula around W0410-09 shows an extension of only $\sim$ 30 kpc, much smaller than typically found (up to hundreds of kpc) around luminous, unobscured QSOs at z$\sim$2-4. ALMA observations of W0410-09 detected a massive rotationally supported fast rotating molecular disk, which challenge our current understanding of dust-enshrouded BH growth via major mergers. I will present a study of the nuclear properties of W0410-09 based on a deep Chandra ($\sim$ 300 ks) observation, to

complement the information from MUSE and ALMA. The X-ray spectral analysis was very challenging due to the high level of intrinsic obscuration and, remarkably, resulted into the discovery of the most absorbed (Nh $\sim$ 1e24 cm-2) luminous (Lx >1e45 erg/s) QSO at z>3.5. This heavy Compton-thick absorber might account for the lack of "standard" Lyα nebula around W0410-09. As a matter of fact, X-ray data hints to the presence of multiple obscured AGN activity among companion galaxies, which is likely promoted by the exceptional evolutionary stage in a dense environment undergone by Hot DOGs. The Chandra analysis coupled with the multiwavelength MUSE and ALMA coverage allows us to shed light on the close environment of this peculiar high-z QSO.

Fast SMBH growth in high-redshift gas-rich protoclusters

Sept 27 10:30 Contributed

Fabio Vito

The large-scale environment is one of the main drivers of galaxy evolution, but its effect on the growth of SMBHs has been still poorly studied. As part of a larger effort to characterize the AGN population of protoclusters, we have recently investigated with dedicated X-ray observations the AGN content of two extremely gas-rich ($M_{\rm H2}$ >1e12 Msun) and compact (few 100s kpc) protocluster cores at z$\sim$4, namely DRC and SPT2349. We found that the AGN incidence in these two structures is higher than in the field environment at the same redshift. Surprisingly, the central regions of both protoclusters host a luminous (Lbol$\sim$1e47 erg/s) and Compton-thick ($N_{\rm H}$ >1e22 cm-2) AGN, which were not identified with previous multi-band observations due to the heavy obscuration. The space density of such powerful AGN is extremely low, and we exclude with high significance to have found two of them in two similar protocluster cores at the same redshift by chance only. These results support the scenario in which SMBH growth, and especially the fastest accretion phase, is significantly enhanced in dense regions at high redshift characterized by large gas reservoirs and high rates of galaxy mergers. I will discuss these findings in the broader context of galaxy and structure evolution, and compare them with other protocluster and the field environment at different cosmic epochs.

The quest for high redshift galaxies

Sept 27 10:45 Contributed

Barbara Balmaverde

We have started an exploratory project aimed at assessing the nature of high redshift radio galaxies (HzRGs) candidates for the next upcoming of Rubin-LSST survey. Powerful radio-loud AGNs represent the most extreme manifestation of nuclear activity and play a pivotal role in galaxy evolution. The epoch at z∼4 is essential for studying the processes that connect supermassive black holes with their hosts. However, our knowledge is extremely limited as only a handful of HzRGs at z∼4 are currently known. We then started a comprehensive search of HzRG candidates by combining existing large area radio and deep optical surveys. We selected 'g-dropout' sources that are expected to be at z∼3.5-4.5. The preliminary results obtained from spectroscopic observations indicate that a large fraction of the sources selected with the 'g-dropout' method are indeed HzRGs. These study will refine the selection criteria to apply the drop-out technique to the LSST data.

The sharpest view of jets at z $>$ 6 with VLBI

Sept 27 11:00 Contributed

Cristiana Spingola

Active Galactic Nuclei (AGN) are among the brightest sources in the Universe, thus visible up to the earliest epochs. Among them, those that are also radio-loud come at prime, as we can observe them at the highest possible angular resolution with Very Long Baseline Interferometry (VLBI). Hence, they provide a viable way to study the smallest scales out to the largest distances, and can be used as cosmological probes. In this talk, I will present a broad-band sensitive radio campaign of the first blazar at z>6 from the lowest frequencies probed by LOFAR(-VLBI) up to cm-wavelengths. Our observations can infer several physical properties of this blazar, demonstrating the power of a broad-band multi-scale study with VLBI and unveiling surprising structures extended on 100s kpc scales. The plethora of multi-wavelength observations and the presence of an extended jet from pc- to kpc-scales makes this source unique for studying jetted AGN at the end of the reionization epoch. I will finally discuss the future prospects for this research with the INAF-VLBI array and the next generation of telescopes, such as the ngVLA(-LONG) and SKA(-VLBI).

The brightest QSOs with QUBRICS: fundamental physics and cosmology

Sept 27 11:15 Contributed

Stefano Cristiani

Discussion

Discussion and conclusion of AGN 15

Sept 27
11:30 Contributed

Paola Marziani and Mauro D'Onofrio

Highlights of AGN 15 — Proclamation of best talks and best poster prizes - Announcement of AGN 16.

Poster abstracts

Spectroscopic analysis of quasars in the distant Universe through a main sequence

Nancy Jenaro

Sept 23—27 Poster# 1

We report a new "Main Sequence" diagram for quasars in the UV spectra. The study presented in this work aims to spectroscopically classify 714 high-redshift (z >1.09) quasars from the SDSS-V IPL-1 database. We propose utilizing this diagram to organize UV quasar spectra according to their intrinsic physical characteristics derived from population-averaged spectra. Additionally, this work investigates the contribution of the wind component in UV high ionization lines along the E1 UV diagram. We also explore the relationship between the bolometric luminosity and equivalent widths of the virialized lines along the E1 UV diagram.

AGN contribution to the infrared luminosity function up to $\mathbf{z = 6}$

Alberto Traina

Sept 23—27 Poster# 2

AGN are known to play a fundamental role in shaping the evolution and formation of galaxies, however, several uncertainties are still present in our understanding of the so-called AGN-galaxy co-evolution. To this, it is fundamental to study the physical and statistical properties of galaxies hosting an AGN. In particular, the bulk of the star formation and black hole growth, especially at high redshift, is obscured by gas and dust, hence, IR and mm bands are well suited for investigating such properties, being unaffected by the obscuration. We took advantage of the recently developed A3COSMOS database (consisting on all the ALMA archival images in the COSMOS field) to investigate the stellar masses, SFRs and dust masses of star forming galaxies with and without AGN evidences in their emission, to study how these properties are being affected by the presence of an AGN. I will present the result of this comparison, along with the physical properties of the AGN in this sample, as obtained from a multi-wavelength SED fitting. Finally, I will present new quantitative constraints on the contribution to the infrared luminosity function from sources hosting an AGN, and their impact on the dust-obscured SFRD at $0.5 < z < 6$.

Tracing the origin of giant Black Holes at high redshifts: a Cosmic Archaeology Tool

Nazanin Davari

Sept 23—27 Poster# 3

Observations of the most luminous quasars at z >7 have revealed the existence of supermassive black holes (SMBHs) in the early Universe. Understanding the formation and growth of SMBHs within the first billion years of cosmic evolution provides crucial insights into the early Universe's structure and evolution. The James Webb Space Telescope (JWST), with its incomparable sensitivity, has already begun to revolutionize our understanding of SMBH formation in these early epochs. Additionally, future missions such as the Laser Interferometer Space Antenna (LISA) and the Einstein Telescope (ET) will offer unprecedented opportunities to explore the Universe through gravitational wave astrophysics, enabling the detection of various black hole binaries, from stellar-mass to supermassive, at extremely high redshifts ($z \sim 20$). In this study, we aim to explore the origins, growth, and impact of ancient SMBHs to provide predictions for the black hole "seed" population as their progenitors. Our research utilizes the Cosmic Archaeology Tool (CAT), a newly developed semi-analytic model enables us to comprehensively describe the hierarchical growth of dark matter halos, their stellar and gas components as well as their central black holes, ensuring consistency with the observed population of active galactic nuclei (AGNs) and galaxies at high redshifts. This model allows us to explore how the earliest black holes and their host galaxies appear in observational data from ongoing JWST surveys of active galactic nuclei (AGNs) and in gravitational wave spectra from binary black hole signals, which will be detectable by upcoming missions such as LISA and ET.

Powerful radio sources in the southern hemisphere: the G4Jy-3CRE catalog

Ana Jimenez-Gallardo

Sept 23—27 Poster# 4

Observations of the most luminous quasars at z >7 have revealed the existence of supermassive black holes (SMBHs) in the early Universe. Understanding the formation and growth of SMBHs within the first billion years of cosmic evolution provides crucial insights into the early Universe's structure and evolution. The James Webb Space Telescope (JWST), with its incomparable sensitivity, has already begun to revolutionize our understanding of SMBH formation in these early epochs. Additionally, future missions such as the Laser Interferometer Space Antenna (LISA) and the Einstein Telescope (ET) will offer unprecedented opportunities to explore the Universe through gravitational wave astrophysics, enabling the detection of various black hole binaries, from stellar-mass to supermassive, at extremely high redshifts ($z \sim 20$). In this study, we aim to explore the origins, growth, and impact of ancient SMBHs to provide predictions for the black hole "seed" population as their progenitors. Our research utilizes the Cosmic Archaeology Tool (CAT), a newly developed semi-analytic model enables us to comprehensively describe the hierarchical growth

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The MUSE view of galactic-scale Lyman Alpha outflows at cosmic noon

Sept 23—27 Poster# 5

Miguel Coloma Puga

The study of AGN feedback is one of the keys to understanding galactic evolution, and quantifying its large-scale effects at the peak of cosmic star formation (z 2-3) can help uncover its role in quenching or enhancing star forming regions, driving gas out of the inner regions and into the CGM, and regulating black hole accretion rates. Within this context, we present optical integral field spectroscopic data from MUSE (VLT) of two High redshift Radio Galaxies (HzRGs) , which corresponds to their rest-frame UV emission. The nearmost galaxy, TXS 0952-217 (z=2.94), displays a large-scale (20 kpc) bipolar outflow, visible in its heavily absorbed Lyman Alpha emission, and seemingly unrelated to the young radio source present in the host. The other source we present, TN 1049-1258 (z=3.7), is embedded within a protocluster environment and also presents outflow signatures, aligned with the radio axis. In both cases, the estimated outflow power appears to be relatively much lower (10^{-4} times) when compared to low-z radio galaxies, and its effects on ongoing star formation appear to be negligible. We also discuss the feasibility of utilizing Lyman Alpha as a tracer of ionized outflows at high redshift, in spite of its resonant nature and the zoo of differing spectra it produces.

Optical follow-up of a sample of gamma-ray emitting jetted AGN

Sept 23—27 Poster# 6

Benedetta Dalla Barba

The reclassification of approximately 3000 gamma-ray extragalactic sources from the Fourth Fermi LAT Catalog resulted in an increased number of gamma-ray emitting Seyfert galaxies, including Narrow-Line Seyfert 1, misaligned active galactic nuclei (AGN), changing-look AGN, and several ambiguous objects (Foschini et al. 2022). To confirm or reject the new classifications and resolve the ambiguities, we requested new high-quality optical spectra from GranTeCan and ESO/VLT UT1/FORS2. Here, we present the preliminary results of these new observations.

Exploring Low-Luminosity AGN Feedback at the center of M58

Sept 23—27 Poster# 7

Iván López

We investigate the effects of low-luminosity AGN (LLAGN) feedback through an in-depth study of Messier 58. This galaxy hosts a radio-loud AGN, with evidence of advection-dominated accretion flows (ADAF) at its center. Spitzer spectral maps reveal a luminous, warm H_2 disk at the galaxy's core. Higher resolution imaging from Gemini NIRI, ALMA CO 2-1, and HST multiband imagery expose in-situ shocks within the inner 2.6 kpc, suggesting radio-jet-driven outflows. The temperature of the inner disk is higher than that observed in the spiral arms, where star formation is active. We determine that star formation is suppressed in the inner disk, while polycyclic aromatic hydrocarbons (PAH) are not destroyed, unlike in more luminous AGN. Forbidden line ratios from ionized gas indicate shock heating by low-velocity shocks, suggesting that the gas emissions are excited by shocks and turbulence driven by the radio jet and outflows. JWST NIRSpec and MIRI observations reveal the impact of this feedback on a 10-parsec scale, providing unprecedented clarity on AGN influence on star formation processes and molecular outflows. Additionally, eight other massive, nearby galaxies exhibit luminous H_2 structures associated with radio-loud AGN, suggesting that radio-jet feedback is a key driver of the observed H_2 emission and the disruption of the interstellar medium (ISM).

Accretion disk and wind emission in the Population B, jetted quasar 3C 47

Sept 23—27 Poster# 8

Paola Marziani

An optically thick, geometrically thin accretion disk around a supermassive black hole might contribute to broad line emission in type-1 active galactic nuclei (AGN). We show that the double-peaked profiles of the strongest low-ionization lines (LILs) in the 3C 47 optical spectrum can be explained by a relativistic Keplerian accretion disk model. The profiles of prototypical high ionization lines (HILs) such as CIVλ1549 were also modeled by the contribution of the accretion disk, but required an additional component, possibly due to a failed wind. The observations of 3C 47 suggest an intriguing hypothesis for the origin of the "double-peakers," sources found at the low end of radiative power per unit black hole mass along the quasar main sequence.

Deciphering dual AGN in merging galaxies

Manali Parvatikar

Sept 23—27 Poster# 9

In this talk, I will present our multiwavelength study on a sample of optically selected Dual-AGN candidates with separations ranging from 3-100 kpc, which appear as X-ray single and double sources. To study the role of mergers in triggering dual AGN, we performed optical and X-ray spectral analysis using SDSS, XMM-Newton, and Chandra and investigated their absorption properties using mid-IR diagnostics with WISE. Our studies on both the samples revealed that (i) X-ray dual and single AGN systems exhibit higher nuclear obscuration compared to isolated systems and (ii) X-ray dual AGN show increasing luminosity with decreasing projected separation, but trends for X-ray single AGN are uncertain (iii) The infrared classification of the X-ray single AGN counterpart poses questions about their true nature, the role of X-ray absorption, and optical classification. We also determine the fraction of dual AGN in our sample and the X-ray detection efficiency, giving insights into the role of mergers in dual SMBH activation.

The jet and core of 4C 71.07, and the first detection of an outflow in blazars

Claudia M. Raiteri

Sept 23—27 Poster# 10

4C 71.07 is a bright blazar at redshift of about 2, showing a prominent big blue bump and a strong Compton dominance in the spectral energy distribution. This makes it the ideal target to study both the beamed jet and unbeamed nuclear contributions to the observed emission. The source was the subject of an intensive 2-yr long monitoring campaign by the Whole Earth Blazar Telescope (WEBT) Collaboration. The optical and radio data from the WEBT were complemented with high-energy observations by the Swift and Fermi satellites to have a complete broad-band knowledge of the multiwavelength behaviour (Raiteri et al. 2019, MNRAS 489, 1837). During the campaign, the source experienced a gamma-ray outburst , which allowed us to analyse the variability properties of the jet (Vercellone et al. 2019, A&A, 621, A82). Moreover, we performed optical spectroscopic monitoring at the NOT and WHT, and obtained near-infrared spectra at TNG. These observations were meant to reveal the unbeamed properties of the blazar quasar-like core. We could not identify any narrow emission line, and estimated the systemic redshift from the Hbeta and Halpha broad emission lines. In spite of the blazar orientation, which implies a nearly face-on accretion disc, the high-ionization lines are very broad. They are also blueshifted, the shift increasing with ionization potential. This indicates the presence of a strong ionized outflow (Raiteri et al. 2020, MNRAS, 493, 2793). We are now investigating the presence of outflows in a sample of blazars at about the same redshift as 4C 71.07 observed by the Gemini and SOAR telescopes to assess what are the physical conditions that lead to this phenomenon and what information we can extract from it.

Combining HST and SDSS spectroscopy to reach the peak of the accretion disc

Sept 23—27 Poster# 11

Bartolomeo Trefoloni

Accretion onto super-massive black holes can produce radiation across the whole electromagnetic spectrum, giving rise to the class of astrophysical sources known as active galactic nuclei (AGN). The powerhouse of these ubiquitous astrophysical sources is a radiatively efficient accretion disc, whose spectral properties should, in theory, depend on the accretion parameters, namely the black hole mass (M_{BH}) and the bolometric luminosity (L_{bol}). Yet, many works in the last decades have shown a remarkable similarity of the continuum in AGN over several decades in M_{BH} and L_{bol}, thus challenging the accretion disc theory. One possibility is that the changes in the accretion disc spectra are hidden in the far-UV (FUV) and extreme-UV (EUV), inaccessible to ground-based facilities. I will present a new approach to this problem, which takes advantage of the combination of the SDSS optical and the HST FUV spectroscopy to constrain the shape of the accretion disc in a large sample of $\sim$ 100 quasars. The broad virialised emission lines in the optical SDSS spectra (e.g. Hβ) allowed to robustly estimate M_{BH}, not possible with the FUV data alone, and consequently to test several accretion disc models. Thanks to these newly combined dataset, I will show that even including the FUV spectral information, systematic changes with any of the accretion parameters are not detected. This finding seriously challenges classical accretion disc models, such as the Shakura and Sunyaev disc, which predicts systematically 'hotter' spectra with respect to those actually observed.

Star formation processes in the circumnuclear environment of galaxies

Sept 23—27 Poster# 12

Sandra Zamora

The inner zones of some galaxies show star formation rates higher than the average observed in galactic discs, frequently arranged in ring structures with a diameter of about 1kpc, named circumnuclear starforming regions (CNSFR). They are commonly referred to as 'hotspots' and they appear in early spiral galaxies, many of them showing bars, with or without an active nucleus. They are a common mode of star formation showing similar and large luminosities of disk HII regions but look more compact and show higher peak surface brightness. Due to their specific locations, these regions constitute excellent places to study how star formation proceeds in high metallicity and high density environments. Hence, the main goal of this project is to understand the star formation processes in the young stellar clusters powering CNSFRs using optical integral field spectroscopy observations from MUSE (Multi Unit Spectroscopic Explorer) and MEGARA (Multi-Espectrógrafo en GTC de Alta Resolución para Astronomía). Thus, the principal aim of this work is to investigate the origin of the nuclear emission and its connection with the star formation processes which are taking place in this hostile environment through a simultaneous analysis of the ionized gas and the stellar emission.

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Abstract book last updated on September 24, 2024.