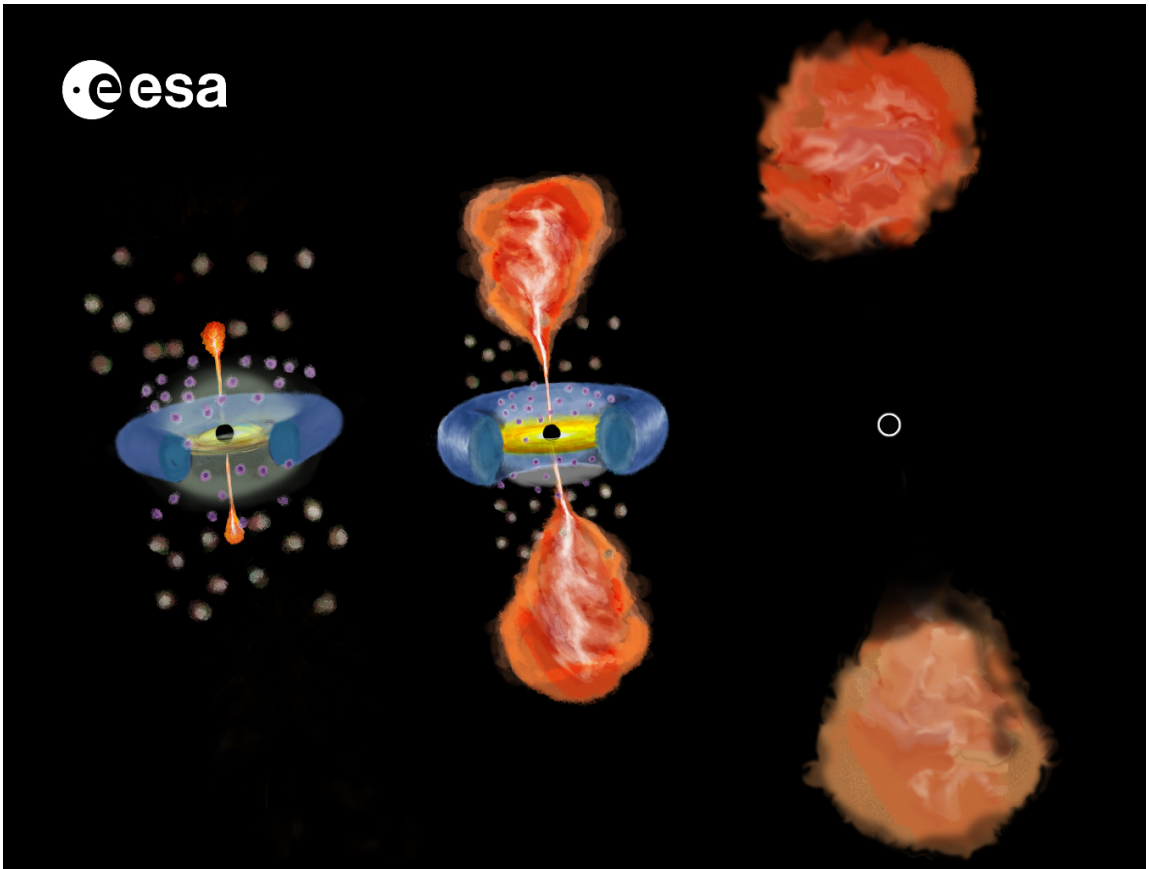
PANCHROMATIC VIEW OF THE LIFE-CYCLE OF AGN



PANCHROMATIC VIEW OF THE LIFE-CYCLE OF AGN

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Topics

Narrow-line Seyfert 1 galaxies
Early-stage AGN
Intermittent activity
Duty cycle of AGN
Quasar main sequence
Multifrequency observations

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ABSTRACT BOOK

Invited talks

Jetted Active Galactic Nuclei by Luigi Foschini

I will review the current understanding of the observational and physical properties of jetted active galactic nuclei.

The Panchromatic View of Narrow-Line Seyfert 1 Galaxies by S. Komossa

Narrow-line Seyfert 1 (NLS1) galaxies are AGN with extreme properties across the electromagnetic spectrum. As such they represent laboratories par excellence for studying extreme AGN activity, including the physics of (super-)Eddington accretion, (rapid) supermassive black hole growth, the driving of large-scale, high-velocity outflows, the formation of radio jets in low-mass host galaxies, the origin of gamma-ray emission, and the physics of X-ray spectral complexity and of the highest-amplitude X-ray outbursts among AGN. This talk provides a review of the panchromatic properties of NLS1 galaxies, their interpretation, and important questions still open.

An (almost) panchromatic view of the quasar Main Sequence by Paola Marziani

The last 30 years have seen a major leap forward in the analysis of multifrequency data of large quasar samples. One of the main advancements is likely due to the main sequence of quasars, a concept developed from the "Eigenvector 1" correlation space. The main sequence organizes observational properties along a set of correlations that provide basic inputs to physical and dynamical models of the emitting regions. Of special relevance in this context are the trends associated with the spectral energy distribution (SED) from the X-ray to the radio frequency domain. After reviewing some basic SED properties, I'll present some inferences on the interpretation of the main sequence.

The life cycle of radio source: the birth by Magdalena Kunert-Bajraszewska

The evolution of extragalactic sources has been an important issue in the study of active galactic nuclei for many years. Numerous observations led to creation of a standard

evolutionary model for radio sources, according to which the younger and smaller Gigahertz-Peaked Spectrum (GPS) and Compact Steep Spectrum (CSS) sources expand and become large-scale FRI and FRII objects. However, the excess of compact sources in comparison to fully developed radio-galaxies indicates that a part of GPS and CSS sources never evolve into extended structures. Among several explanations for this early cessation of radio activity, there are indications that some sources may be transient objects on timescales of 10^4 - 10^5 years, representing the new population of active galaxies that needs to be explored. This phenomenon is naturally associated with a discussion about the conditions/factors needed to initiate the radio emission in AGNs. My talk will be a subjective look at these issues.

The radio view of AGN populations and life cycles by Martin Hardcastle

Radio selection gives us a unique view of the AGN phenomenon for two reasons: firstly, it allows us to select objects from the presumably very numerous radiatively inefficient population, though radiatively efficient AGN can also be studied in this way; secondly, radio studies of extended objects can reveal details of their past activity recorded in their spectral and morphological properties. With the LOFAR wide and deep surveys we have been able to select very large numbers of AGN and study their morphology and, to a lesser extent, their spectral properties; I will discuss some insights from past work as well as future prospects.

Jet evolution: the inner kiloparsec by Manel Perucho

In my talk, I will present 3D RHD simulations of jets propagating through the inhomogenous ambient media of the inner kiloparsecs of active galactic nuclei. Our code handles relativistic electron/proton and pair flows, on the one hand, and atomic hydrogen, including the effects of ionization and recombination. This allows us to consistently set-up ambient media formed by cold clouds and a hotter interstellar medium and study the role of the passing jets in the evolution of these clouds: jets produce strong shocks in this medium and can trigger, e.g., ionization, which can result in observable line emission. This work is aimed to reveal the role of galactic activity on the evolution of the host galaxies, both in terms of positive and negative feedback, i.e., triggering and quenching star formation. If time permits, I will present our results on low-power jet deceleration induced by mass-load from stellar winds along the inner kiloparsec.

Contributed talks

Extreme radio variability in NLS1s by Emilia Järvelä

Narrow-line Seyfert 1 (NLS1) galaxies are a subclass of active galactic nuclei (AGN) identified almost 40 years ago, but still not well understood. They are mostly hosted by disk-like galaxies, and harbour fast-growing, low-mass supermassive black holes, accreting close to, or even above, the Eddington limit. Some NLS1s have also been detected in gamma-rays, proving that they are able to launch and maintain powerful relativistic jets. An intriguing subset of jetted NLS1s was discovered about five years ago when seven previously radio-silent sources were detected at Jy-levels at 37 GHz at Metsähovi Radio Observatory (Finland). This launched an extensive, still ongoing, multiwavelength investigation into these sources. In this talk I will summarise our efforts so far to understand and explain the nature of these sources.

INVISIBLE by Marco Berton

Recently, a handful of relativistic jets in narrow-line Seyfert 1 (NLS1) galaxies with negligible radio emission were discovered by the Metsähovi radio telescope. These peculiar sources, also known as absorbed jets (AJs), are not fully understood, and every observation aimed at characterizing their physical properties seemingly complicates the picture with unexpected results. In this talk, I will present some of the new results we obtained on these sources, and I will outline some possible explanations that could account for their observational properties. I will also present a new, large INVISIBLE project devoted to understanding the role of these sources in galaxy evolution, and the open questions that still require an answer.

Radio observations of nearby X-ray and optically bright giant elliptical galaxies and their interaction with the intergalactic medium by Romana Grossová

Many massive early-type galaxies host central radio sources and hot X-ray atmospheres indicating the presence of radio-mechanical active galactic nucleus (AGN) feedback. The duty cycle and detailed physics of the radio-mode AGN feedback is still a matter of debate. To address these questions, we present 1-2 GHz Karl G. Jansky Very Large Array (VLA) radio observations of a sample of the 42 nearest optically and X-ray brightest early-type galaxies. We detect radio emission in 41/42 galaxies. However, the galaxy without a radio source, NGC 499, has recently been detected at lower frequencies by the Low-Frequency Array (LOFAR). Furthermore, 27/42 galaxies in our sample host extended radio structures and 34/42 sources show environmental interactions in the form of X-ray cavities. We find a significant correlation between the radio flux density and the largest linear size of the radio emission and between the radio power and the luminosity of the central X-ray point-source. The central radio spectral indices of the galaxies span a wide range of values, with the majority of the systems

having steep spectra and the rest flat spectra. These results are consistent with AGN activity, where the central radio sources are mostly switched on, thus the duty cycle is very high. 7/14 galaxies with point-like radio emission (Fanaroff-Riley Class0; FR0) also show X-ray cavities indicating that, despite the lack of extended radio structures at 1-2 GHz, these AGN do launch jets capable of inflating lobes and cavities.

Tracing jet-driven star formation in infant radio galaxies by Chetna Duggal

The lifecycle of a typical radio galaxy encompasses an early growth phase where the radio sources lie entirely within the galaxy atmosphere, before continuing expansion into large-scale radio sources. At projected linear sizes of 1-20 kiloparsecs, the galaxy-sized Compact Steep-Spectrum (CSS) radio sources are key to understand radio-mode AGN feedback. It is in this infancy phase that the effects of the powerful jet activity on host galaxy are much more pronounced than in more evolved, extended radio sources. Our new high-resolution imaging with the Hubble Space Telescope found extended UV emission closely aligned with radio structure in six out of seven CSS sources in the sample. Such spatial alignment of UV emitting regions— likely due to newly formed stellar population— with the jet axis could be strong evidence of jet-induced starbursts and hence crucial in understanding the interaction of young radio sources with their environments.

A compact jet-driven outflow in a radio-quiet AGN? by Mainak Singha

AGN-driven outflows play a crucial role in expelling gas out of their host galaxies' reservoirs. In radio-loud, luminous AGN, radio jets are associated with these outflows. But the launching mechanism of these outflows in radio-quiet AGN remains highly debated. As a part of the Close AGN Reference Survey (CARS), we have demonstrated that the approaching side of the outflow (visible as [O III] blue-wing) in radio-quiet type 1 AGN is usually unresolved and originates < 100 pc away from the nucleus. Among the CARS sample, HE 0040-1105 stands out because the peak of its [O III] blue-wing emitting region shows a significant offset of 92 pc away from the nucleus. Using high-resolution VLA and EVN observations, we detected a radio emission to be co-spatial with a high [O III] and Ha turbulence regions. Our EVN observations indicate a collimated nature of the radio emission, suggesting a radio jet is driving the outflow. Our findings will address if the radio emissions in radio-quiet AGN are closely related to the AGN activities.

Host Galaxies and Dark Matter Halos of Obscured and Unobscured Quasars: Evidence for Evolution by Grayson Petter

We probe the dark matter host halo environments of ~1.5 million WISE-selected obscured and unobscured quasars with angular clustering measurements and through cross-correlation measurements with CMB lensing convergence maps. We interpret these signals within a Halo Occupation Distribution (HOD) framework to conclude that obscured systems reside in more massive halos and are more often satellites than their unobscured counterparts. We also construct composite spectral energy distributions (SEDs) of the systems from the ultraviolet to the far-infrared, finding that obscured quasars reside in galaxies forming stars at ~twice the rate of unobscured systems' hosts. These findings are in tension with models that ascribe obscuration to orientation of the dusty torus along the line of sight, and appear consistent with the notion that some obscured quasars are attenuated by galaxy-scale material during an evolutionary phase.

Low redshift jetted quasars in the Main Sequence context by Shimeles Mengistue

Quasars have historically been classified into two distinct classes, radio-loud (RL) and radio-quiet (RQ), taking into account the presence and absence of relativistic radio jets, respectively. Although different attempts were made to unify these two classes, there is an long-standing open debate involving the possibility of a real physical dichotomy between RL and RQ QSOs. In this work, we present new simultaneous optical and near-UV spectra of 11 powerful jetted QSOs with redshift $0.35 < z < 1$, observed at Calar Alto Observatory (Spain), and aims to quantify broad emission line differences between RL and RQ sources in a parameter space defined by measures with no dependence on radio properties as is the four-dimensional eigenvector one scheme and its optical plane, the QSOs Main Sequence. Emission lines are analysed by doing two complementary approaches, a multicomponent non-linear fitting to account for the individual components of the broad emission lines, and by analysing the full profile of the lines through parameters as total widths, centroid velocities at different peak intensities, or asymmetry and kurtosis indexes. We measured different physical and profile parameters by using mainly the H-beta and MgII 2800A lines. We found a clear redward asymmetry in both lines, larger in H-beta than in MgII 2800A, and FWHM of the latter is systematically narrower than in H-beta by about 10\%. No clear correlation was found between the equivalent widths of FeII in UV and in optical. In addition, the optical plane looks similar to the UV plane but, with a larger range of occupation in the UV. In comparison to RQ QSOs, our RL QSOs show larger FWHM, weaker FeII 4570A emission, larger black hole masses and lower Eddington ratios, and a restricted covered space domain in the optical plane.

Existence of AGN in the CALIFA sample at X-rays by Natalia Osorio Clavijo

Studies on optical detection of AGN suggest 4% of nuclear activity in the nearby Universe. The most classical detection method to classify AGN is through the diagnostic (BPT) diagrams, where emission line ratios are associated with different ionization mechanisms

such as star formation or nuclear activity, among others. However, the detection of the AGN could be prevented by the dilution and obscuration due to both the emission by the host galaxy itself and its dust content, respectively. On the other hand, X-rays have proved to be a great tool to detect AGN because they are less affected by both the host galaxy and dust. AGN are seen as point-like sources at X-rays and the spectra are characterized by a power-law. In this work, we aim to study the AGN population in the CALIFA survey, which is one of the most complete surveys to study the local universe at optical wavelengths using spatially-resolved spectroscopy for 900 galaxies. In this work, we use the X-ray satellite Chandra as it provides the best spatial resolution, essential to isolate the nucleus from the extended emission. We base our analysis on the existence of a nuclear point-like source in the 0.5-10.0 keV image of 138 sources detected with Chandra, finding that there are 66 AGN candidates. Moreover, we study the spectra of 21 objects with enough signal-to-noise and find that 11 objects are consistent with an AGN spectrum. With the us of X-ray data the fraction of AGNs in the CALIFA sample increases a 25% compared with the optical selection. Furthermore, we discuss in detail the comparison between both selection criteria, exploring possible benefits and biases.

The relation between quasars' Eigenvector 1 and optical variability by Shumpei Nagoshi

Brightness variation is an essential feature of quasars, but its mechanism and relationship to other physical quantities are not understood well. We aimed to find the relationship between the optical variability and spectral features to reveal the regularity behind the random variation. It is known that quasars' FeII/Hβ flux ratio and equivalent width of [OIII]5007 are negatively correlated, called Eigenvector 1. In this work, we visualized the relationship between the position on this Eigenvector 1 (EV1) plane and how they had changed their brightness after ∼ 10 years. We conducted three analyses using different quasar sample each. The first analysis showed the relation between their distributions on the EV1 plane and how much they had changed brightness, using 13,438 Sloan Digital Sky Survey quasars. This result shows how brightness changes later are clearly related to the position on the EV1 plane. In the second analysis, we plotted the sources reported as Changing-Look Quasars (or Changing-State Quasars) on the EV1 plane. This result shows that the position on the EV1 plane corresponds activity level of each source, the bright or dim state of them are distributed on the opposite sides divided by the typical quasar distribution. In the third analysis, we examined the transition vectors on the EV1 plane using sources with multiple-epoch spectra. This result shows that the brightening and dimming sources move on the similar path and they turn into the position corresponding to the opposite activity level. We also found this trend is opposite to the empirical rule that RFeII positively correlated with the Eddington ratio, which has been proposed based on the trends of a large number of quasars. From all these analyses, it is indicated that quasars tend to oscillate between both sides of the distribution ridge on the EV1 plane, each of them corresponds to a dim state and a bright state. This trend in optical variation suggests that significant brightness changes, such as Changing-Look quasars, are expected to repeat.

The role dust in formation of the low-ionized broad emission lines in AGNs by Mohammad Hassan Naddaf

Broad emission lines are the most characteristic features in the spectra of active galaxies. They mostly show either a single-peaked or double-peaked profiles; and originate from a complex dynamics of the likely discrete clouds moving in a spatially extended region so-called Broad Line Region (BLR). We previously showed that our approach to the BLR dynamics based on the dust-driving model of Czerny & Hryniewicz (2011), is appropriate for the low ionized region of the BLR, and it can provide us with the 3D geometry of the BLR. Now, calculating the spectral line generic profiles based on our large grid of simulations of the dynamics of BLR material, we show that the resulted shape of profiles can consistently explain the low ionized broad lines of the mean spectrum of quasars, such as MgII and Hbeta.

Spectacular 240 kpc double-sided relativistic jets in a spiral-hosted narrow-line Seyfert 1 galaxy by Amelia Vietri

Narrow-line Seyfert 1 (NLS1) galaxies are a peculiar sub-class of active galactic nuclei (AGN). The narrowness of their permitted lines is not related to the obscuration, but can instead be explained as a consequence of a low rotational velocity around a low-/intermediate-mass supermassive black hole (BH). Furthermore, their accretion luminosity is close to the Eddington limit. Due to this ensemble of properties, NLS1s are thought to be unevolved AGN. Some authors, instead, proposed that the low BH mass of NLS1s is due to an inclination effect. Studying host galaxy morphologies can be useful to disentangle these two scenarios since the supermassive BH interacts and co-evolves with its closest environment. Moreover, NLS1s have demonstrated that the presence of relativistic jets in an AGN is not strictly related to its radio-loudness, the BH mass, or the host galaxy type. Here, I present a remarkable example of a radio-quiet NLS1, 6dFGS gJ035432.8-134008 (J0354-1340). From the Karl G. Jansky Very Large Array observations at 5.5 GHz, I found that the source shows a bright core with a flat spectral index and extended emission corresponding to very elongated jets. These are the largest double-sided radio jets found to date in an NLS1, with a de-projected linear size of almost 250 kpc. I also measured the viewing angle from the jet/counter-jet flux density ratio, which does not imply a face-on view of the nucleus, so the BH mass should not be understimated due an inclination effect. I also analysed near-infrared and optical images obtained with the Magellan Baade and the European Southern Observatory New Technology Telescope. By means of photometric decomposition and colour maps, I determined that J0354-1340 is hosted by a spiral or a disc-like galaxy. Fully evolved relativistic jets have traditionally been associated with high-mass elliptical galaxies hosting the most massive black holes. Instead, my results confirm that powerful jets can also be launched and sustained by less massive BHs in spiral galaxies, implying that the launching of the jets is governed by factors other than those previously believed to be at play.

Tracking the transition of CL AGNs on the quasar main sequence by Marzena Sniegowska

In radio-quiet active galactic nuclei (AGN) energy is emitted mainly by radiative processes around the supermassive black hole and the expected variability from stochastic origin alone cannot explain the drastic changes in brightness that are observed in changing look/changing-state AGN (CL AGN). The process behind such changes remains a mystery, however, with bigger samples of CL AGN, we can test various possible mechanisms and proceed towards a better understanding of those unexpected changes. We compile SDSS/BOSS/eBOSS repeat spectra for an up-to-date sample of 111 known-changing look/changing-state AGNs. We perform a systematic and homogenous spectral fitting of the sample using publically available software PyQSOFit. We classify the sources as Turn-on/Turn-off based on their multi-epoch spectra. We estimate the physical parameters, e.g., BH mass, Eddington ratio. We show/realize the movement of the sources on (a) the Eddington ratio-MBH plane and, (b) the optical-plane of the Eigenvector-1 diagram (also known as quasar main sequence), i.e. FWHM(Hbeta) vs. RFe. Changes in the Eddington ratio may suggest changes in the BLR conditions, e.g. BLR density, chemical composition, or changes in the spectral energy distribution. In order to better understand the physical mechanism behind these rapid changes, we evaluate the various timescales including (i) dust cloud eclipses, where the change is most likely caused by extinction, (ii) intrinsic disturbances in the flow of matter around the black hole due to star tidal disruption events or (iii) accretion disk instabilities. Such an intermittent variability can be an important aspect of the global life-cycle of an AGN.

The trends of high-z quasars along the Main Sequence by Alice Deconto-Machado

The Main Sequence (MS) of quasars emerged, in the early 2000s, as a powerful tool to contextualize and organize the observed spectroscopic diversity of the quasars on different spectral types according to key observational (in optical, UV, and X-rays) and physical parameters, such as outflow prominence and accretion mode, that are systematically changing along it. However, the work on the MS has been restricted mainly to low redshift ($z<1$), where it is well established. Little is known about the MS at earlier cosmic epochs and high luminosity, because the most widely used parameters for its definition are shifted into the infrared domain, where spectroscopy is more difficult. In this work we provide new spectrophotometric measurements in the optical range for a sample of 22 quasars at high redshift ($z=2-4$) observed in the infrared at ESO/VLT, together with complementary measurements in the UV region obtained from the re-analysis of SDSS optical spectra. Spectral analysis, in both spectral ranges, was performed through the decomposition of the emission line profiles by using multi-component non-linear fitting. Results are obtained to first identify the location of high-z sources within the Main Sequence. The analysis is supplemented with data previously obtained by our group for a sample of 53 quasars at high z and luminosity. Our analysis confirms the validity of the quasar Main Sequence at high z. An interline comparison has been afterwards performed with the aim to highlight the similarities found between the optical and UV range. Emission lines like [O III]λλ4959,5007 and C

IVλ1549 appear to follow very similar trends. This result mirrors the behaviour observed at low z for sources whose high-ionization lines are dominated by an outflow component. At variance to the low-z samples, more than 60% of our high-z objects show [O III] blueshift higher than 250 km/s. The main factor governing the outflows in both [O III]λλ4959,5007 and C IVλ1549 is most likely the Eddington ratio, with a non-negligible role of luminosity affecting shift amplitudes.

Characterising the gamma-ray sky with new generation radio surveys: the emerging population of radio galaxies by Gabriele Bruni

The advent of new all-sky radio surveys such as VLASS, RACS, and LoTSS, performed with the latest generation radio telescopes, is opening new possibilities on the classification and study of extragalactic gamma-ray sources, specially the underrepresented ones like radio galaxies. In the past years, we characterised radio galaxies previously identified by INTEGRAL/IBIS, Swift/BAT, and Fermi/LAT, unveiling their peculiar properties with respect to radio-selected samples. In particular, I will review the results of the GRACE project (Giant RAdio galaxies and their duty CyclE) that, making use of LOFAR data among others, revealed how giant radio galaxies are more abundant and particularly active in soft gamma-ray samples, showing hints of more than one radio activity cycle during their history. I will also discuss the recent discovery of new gamma-ray radio galaxies from the 4th Fermi/LAT catalogues, among which an INTEGRAL FRII radio galaxy with hints of GeV emission from its lobes. Their classification, only possible thanks to new generation radio surveys, unveils an emerging population of radio galaxies in the gamma-ray sky, that could be studied in the next decade with SKA.

The radio morphology, spectra, and variability of narrow-line Seyfert 1 galaxies by Sina Chen

We present the results of recent radio observations carried out with VLA and ATCA for a sample of NLS1s. In the morphology aspect, the radio emission of NLS1s is mainly concentrated in a central region at kpc-scale and only a few sources show extended emission. We discover a new RQ NLS1 harboring a 200-kpc radio jet, and a few objects dominated by an outflow or star formation. In the spectroscopy aspect, the radio emission of most NLS1s is characterized by a steep spectrum, which may be related to AGN-driven outflows, which are likely more prevalent in high Eddington ratio AGN. Combining with archival data, the radio spectra of most NLS1s flatten at lower frequencies with a median spectral turnover of 1 GHz, which implies synchrotron self-absorption in a source with a size of only a fraction of 1 pc, possibly a compact wind or a weak jet. Radio variability is another way to study the origin of radio emission. Quasi-simultaneous radio and X-ray monitoring of two RQ NLS1s were carried out with VLA and RXTE. Radio variability is likely detected in one of the objects. A Pearson cross-correlation analysis suggests an apparently strong and highly significant correlation with the radio lagging the X-ray by tens of days. However, a further

analysis of uncorrelated data sets reveals that this correlation is not significant. This occurs since the Pearson correlation assumes white noise, while both the X-ray and the radio light curves follow red noise, which dramatically increases the chance to get significant correlations.

Are black-hole accretion states similar across the mass scale? by Abhijeet Borkar

To understand black hole growth, we need to understand the physical processes that drive the accretion of the gas on to the black hole and how they evolve over time. Stellar-mass black holes in X-ray Binaries (XRBs) exhibit extreme spectral state transitions that occur on observable timescales and as a function of accretion rate. A comparison of spectral state changes between stellar and supermassive black holes can inform our understanding of AGN accretion. However, observable timescales for state transitions of AGN are typically not attainable, but can be explored with a large sample of AGN. Here, I will present our analysis of a sample of 3500+ AGN with simultaneous UV and X-ray observations from the XMM-Newton and Neil Gehrels Swift satellites, complemented with radio, optical and infrared data. Our results establish that AGN and XRBs display analogous spectral states, most notably linking the radio emission from the relativistic jet with the energetic emission from the X-ray corona and thermal emission from an accretion disc. I will highlight our unique result demonstrating how the AGN radio morphology correlates with the accretion state change, analogous to the presence of radio jets during a typical XRB outburst. Further, I will present the salient results of our analysis of how different AGN properties, viz. nuclear obscuration, Seyfert type, optical classification are correlated with their observed accretion states, along with their relation to the star formation and stellar masses of their host-galaxies, hinting at the co-evolution of AGN and host galaxy with feeding and feedback.

The extreme challenge of reproducing the clustering and duty cycle of quasars at z~4: Insights from large-volume cosmological simulations by Elia Pizzati

Luminous quasars are the most highly clustered objects known at $z \approx 4$. This has profound consequences for our understanding of supermassive black holes (SMBHs) and their evolution over cosmic time. Such a large clustering implies that quasars are a rare phenomenon, arising only in the most massive halos and shining for a large fraction of the Hubble time. Previous work on quasar demographics highlighted that these conclusions contrast with the situation at lower redshifts, where quasars represent a relatively common, brief phase in galaxy evolution. Studying this problem theoretically is particularly challenging, as one has to obtain a reliable statistical sample of the most biased and extreme dark matter environments at high redshift. In this project, we overcome this obstacle by populating the new, extremely large-volume ($L\approx 5$ cGpc) FLAMINGO cosmological simulation with quasars using a demographic model that makes only a few assumptions on the phenomenology of galaxy formation. In this way, we are able to investigate the predictive

power of quasar observables in a pure LCDM framework. By simultaneously matching the correlation function of luminous quasars and the bolometric quasar luminosity function, we obtain physical constraints on the Eddington ratio distribution function, the halo mass distribution of quasar hosts, and the quasar duty cycle. Finally, we discuss the implications of these results in light of the current paradigm of SMBHs growth and their interplay with the surrounding environment.

The obscuration of high-redshift AGN can be produced by their host galaxies by Chiara Circosta

AGN obscuration is usually ascribed to a pc-scale absorber, the nuclear torus of dust and gas surrounding the central engine postulated by the unified model. However, at high redshift more AGN are observed to be obscured, and galaxies have larger gas reservoirs, meaning that there is more material on galaxy scales able to obscure the central SMBH. We have tested the latter scenario by analyzing a sample of high-redshift AGN selected to have good FIR detections from a deep field of the sky (the CDF-S). A direct measurement of the total hydrogen column density along the line of sight is obtained by modeling the X-ray spectra, while an estimate of the column density associated with the interstellar medium of the host is derived through a multi-wavelength analysis. In this talk, I will discuss how the comparison between these two quantities shows that the host interstellar medium is capable of providing significant absorption on kpc scales, that adds to or even replaces the absorption produced on pc scales by the torus. This result challenges the view of the obscured/unobscured AGN dichotomy as due to inclination effects only, and attributes to the host galaxy a crucial role in obscuring the AGN emission. In addition, the lack of unobscured AGN among the selected FIR-bright targets supports the scenario where obscuration may also be a property of the evolutionary phase of the AGN and its host galaxy, meaning that AGN with a high SFR are also more obscured.

Investigating the link between feedback and radio AGN life-cycle by Pranav Kukreti

Radio AGN are known to affect the host galaxy's gas, by driving strong multiphase gas outflows. But, the main driving force behind these outflows - winds (radiation driven) or radio jets, is still under debate. Radio AGN are also known to have a life-cycle and episodic activity. Young radio AGN are expected to show a peaked radio spectrum, with the spectrum getting steeper as the jets evolve. Thus, the spectral shape of the radio AGN can be used to classify them in different stages of their life-cycle. There is indication that the early phase of the jet can highly impact the medium (Holt et al. 2008, Murthy et al. 2022, Mukherjee et al. 2016,2018) but the results are mostly from single object studies or small (and often biased) samples. The effect of this life-cycle on the surrounding gas is also not well understood. Our aim is to investigate whether the outflows in radio AGN are mainly driven by radio jets, and whether the feedback evolves with radio jet’s life-cycle. To do this, we use a sample of radio AGNs and high resolution surveys like LoTSS (144 MHz), FIRST (1.4 GHz) and VLASS (3 GHz), to identify the spectral shape of our sources. The high resolution of the surveys (3”-6”)

means we trace the radio spectra of the central few kpc (at median z ~ 0.1 of the sample), for which we also have the [OIII] emission line data from SDSS. This allows us to study the feedback effects in a systematic manner. By stacking the [OIII] spectrum of different groups of radio AGN, we find that gas kinematics evolves with the radio jet's life-cycle, with younger peaked spectrum sources showing an ionised gas outflow (velocity ~ 600 km/s) compared to older steep spectrum sources that do not show an outflow. We also find no dependance of the outflow on the Eddington ratios and ionisation states of the AGN, thus strengthening our result that the outflow is driven by radio jets and not radiation, and evolves with it. We also conclude from the width of the [OIII] core component that the [OIII] gas is turbulent throughout the radio AGN life-cycle, even more than typically seen in optical AGN (for instance, Seyferts). Thus we are able to link the life-cycle of radio AGN to both long term feedback in the form of turbulence, and short term feedback in the form of outflows.

Radio Galaxies: the role of environment in the HERG-LERG dichotomy by Duccio Macconi

The environment is often invoked to be the main driver in shaping radio galaxies (hereafter RGs) by various authors. To evaluate the Mpc-scale environment with a multi-wavelenght approach, we have built two samples of RGs in the local universe (z<0.3) in the mJy sky, collecting data from literature (Best & Heckman 2012, Wen et al. 2012, Wen et al. 2015). They belong to different Mpc-scale environments: 2504 RGs are in cluster and 4579 RGs are in poor (field) environment. We analyze and compare their behavior (accretion, host galaxies properties, jet power, BH masses) and cluster relative position (BCGs vs outskirt RGs), according to their optical LERG-HERG classification, which depends on the accretion rate (on pc-scales) onto the central supermassive BH. The main difference remains, independently from the Mpc-scale environment, the HERG-LERG dichotomy: these two populations show strong differences in any environment in terms of mass, gas availability, accretion, jet power. They are found to prefer different environments and being hosted in different host galaxies. Given all their differences, HERG and LERG are probably objects with different histories: the former show signs of recent gas-rich merging processes, while the latters can be formed through secular hot-gas accretion within red and dead giant ellipticals. The second important result is the role played by the environment in enhancing the total radio luminosity of RGs, independently on their optical classification. This is reasonably due to the jet-medium interaction through dissipative phaenomena. However, the environment is not found to be the main driver in shaping the RGs morphology and/or power for different reasons.

Narrow-line Seyfert 1 galaxies at 3 GHz as seen by VLASS by Guillermo García López

A cross-match is done between a sample of narrow-line Seyfert 1 galaxies, obtained after the modelling of their optical spectra from the Sloan Digital Sky Survey, with the early release of the Very Large Array Sky Survey (VLASS) on the radio domain. After finding the non-radio-quiet sources, and checking the validity of the matches (using common astronomical databases such as SIMBAD, NED, PANSTARRS), several radio properties of the sources are

computed. It is determined whether the AGN show point or extended emission, a new cross-matching is done with other radio surveys and spectral indexes are computed. Radio luminosities are found in order to enable the possibility of comparing with the observations of these sources.

CON-quest: Dynamical modelling and properties of molecular gas in nearby moderately luminous infrared galaxies by Kyoko Onishi

Recent observations towards luminous infrared galaxies (LIRGs) discovered a population of galaxy nuclei that seem to be undergoing intensive growth. Such a nucleus is called a compact obscured nucleus (CONs), and one of the key points of CONs is the extreme environment indicated by it's compactness (<100pc) and large column density ($N_{H_2}>10^{25}/cm^2$). A survey for CONs (Falstad et al. 2021; CON-quest) showed that CONs exists primarily in (U)LIRGs, and galaxies with moderate infrared luminosity (subLIRGs) do not seem to have CONs. We present ALMA band 6 ~100pc resolution observations of 15 subLIRGs, that are a complete sample of galaxies within 15Mpc distance with their FIR luminosity of 10^10 L_solar, FIR<L_FIR<10^11 L_solar, FIR. The spectral range covers the HCN and HCO+ (J=3-2) emission line that allows us to estimate the dense molecular gas structure and its kinematic properties. We compare the dense gas properties to the estimated SMBH mass and X-ray luminosity to see the correlation, and also discuss the existence of non-circular motions that will possibly build up CON-like environment in the future.

On the Large-Scale Environment of Seyfert Galaxies by Harold A. Peña Herazo

We recently released the 1st version of Turin-SyCAT, an extremely homogeneous and statistically clean (i.e., with well-defined selection methods) catalog of Seyfert galaxies. Here, we propose to test the unification scenario of active galaxies using the Turin-SyCAT. The unification scenario predicts similar large-scale environments for type 1 and type 2 Seyferts, as their difference is only due to orientation respect to the line of sight. We adopted a procedure based on the spatial distribution of the so-called cosmological neighbors lying within 500 kpc and 1 Mpc from the Seyfert galaxy, i.e., sources with all SDSS magnitude flags indicating a galaxy-type object and having a spectroscopic redshift z with $\Delta z = |z_{src} - z| \leq 0.005$, corresponding to the maximum velocity dispersion in groups and clusters of galaxies. We carried out our analysis in several redshift bins, a requirement strictly necessary to avoid cosmological biases and artifacts. From our analysis, we found no difference in the large-scale environments of type 1 and type 2 Seyfert galaxies up to redshift $z_{src} = 0.15$. On the other hand, we found that radio galaxies inhabit richer large-scale environments than Seyfert galaxies. According to our investigation, we conclude that the large-scale environments of Seyfert galaxies are in agreement with the unification scenario of active galaxies. The differences found among Seyfert and radio galaxies are indeed expected based on their host galaxies, mostly spirals for the former class and elliptical for the latter one.

A hard X-ray view of the AGN-galaxy interplay through spectral modeling and multiphase outflows by Alejandra Rojas Lilayú

High velocity (> 1000 km s-1) and extended AGN-driven outflows are frequently detected in local and high-redshift galaxies, at different luminosities, in ionized, neutral and molecular gas. However, despite the huge improvement in the knowledge of AGN-driven outflows, most of the samples considered by these studies are incomplete due to biases against absorption in the optical/soft X-ray band. Therefore, it has been difficult to place the outflow signatures of galaxy populations in the context of both obscured and unobscured AGN.

The BAT AGN Spectroscopic Survey (BASS) now allows us to exploit a unique local sample of > 800 hard X-ray selected AGN to study the occurrence of ionized outflows traced by the [O III]λ4959,5007 emission lines and how they relate to other key AGN properties (bolometric luminosity, Eddington ratio, column density, intrinsic X-ray luminosity). This sample is almost unbiased against obscuration or AGN types and covers a large range of luminosity, therefore the occurrence of outflows and its dependence with the different AGN power tracers is providing us a new point of view on the unification scenarios.

Additionally, we present the incidence and properties of ionized outflows and how they relate, in terms of wind velocities, outflowing mass rate, and wind power, to the host galaxy properties by using the recently developed X-ray module for CIGALE to analyze and characterize their host galaxies thanks to ancillary multi-wavelength data. Finally, we will present preliminary results on the properties of those outflows detected in the molecular phase, by searching for cold gas reservoirs.

A panchromatic view of infrared quasars: excess star formation and radio emission in the most heavily obscured systems by Carolina Andonie

To understand the Active Galactic Nuclei (AGN) phenomenon and their impact on the host galaxies, a complete AGN census is necessary. However, finding heavily obscured AGNs is challenging due to observational and instrumental limitations. We use the deep and extensive multi-wavelength data in the COSMOS field to select a complete sample of 578 infrared (IR) quasars (L_AGN,IR>1e45 erg s-1) at z<3, with minimal obscuration bias, using detailed UV-to-far IR spectral energy distribution (SED) fitting. We complement our SED constraints with X-ray and radio observations to further investigate the AGN and host galaxy properties of the sample. Overall, 322 of the IR quasars are detected by Chandra and have published X-ray spectral fitting results. From a combination of X-ray stacking and L_2-10keV - L_6mum analyses, we show that the majority of the X-ray undetected quasars are heavily obscured and many are Compton thick, highlighting the effectiveness of the mid-IR band to find obscured AGNs. We find that the average properties of obscured and unobscured quasars are different: (1) obscured systems have star-formation rates ~3 times higher and stellar masses 0.15 dex lower than unobscured sources; and (2) obscured quasars have stronger radio emission compared to their unobscured counterparts, with ~1.1 times more radio detections and a radio-loudness parameter 0.2 dex higher. I will discuss the implications of

these results in the context of the SMBH galaxy co-evolution scenario and the AGN orientation model.

Public release of Near-infrared and Optical Spectroscopy of Reionization-era Quasars at z>6.5 by Silvia Onorato

We present the results of near-infrared and optical spectroscopic observations for a sample of quasars at z > 6.5 which will be made publicly available. The spectra are taken with Keck/NIRES, Gemini/GNIRS, and VLT/X-Shooter spectrographs and reduced with the open-source Python-based spectroscopic data reduction pipeline PypeIt. These spectra will be useful for several scientific goals, i.e. studying the Ly Forest, IGM metal content and temperature, quasar properties themselves (e.g. super massive black hole masses and growth, Eddington ratios, Quasar Luminosity Function), and also damping wings and proximity zones. The strengths of this data sample consist in different factors, such as the big amount of public quasar released, their homogeneity and reproducibility, but also the high spectral resolution. All of these properties allow for improved modeling of both damping wings and proximity zones. This represents an essential step for reconstructing quasar spectra continuum predicting the intrinsic blue-side from the observed red-side (PCA continuum model), and thus inferring information both on the average hydrogen neutral fraction at the epoch of Reionization and on the growth of the first super massive black holes.

Follow-up study of newly-born candidates for short-lived radio AGN found with VLASS by Aleksandra Wołowska

During their lifetime the radio sources go through different phases of development. They start as young and compact Gigahertz-Peaked Spectrum (GPS) and Compact Steep Spectrum (CSS) sources, then expand and become large-scale FRI and FRII objects, with the estimated age of an adult radio source of ~10^8 years. However, statistical studies show that there is an excess of compact sources in comparison to large-scale radio-galaxies, suggesting that many of the young sources never evolve into extended structures. For some time now, many authors have suggested that there is a distinct, poorly studied population of active galaxies that are transient on a timescales of 10^4-10^5 years, which requires more observational multi-frequency data, and careful analysis of their properties. I would like to present observational data for a sample of newly-born candidates for short-lived radio AGN found with VLASS, as well as to discuss possible explanations of short term activity based on study of both previous and current samples.

Dirty Dancing: piercing the dusty environment of merging supermassive black holes by Matteo Guainazzi

It is a posit of modern astrophysics that most galaxies host a super-massive black hole (millions to billions of times more massive than the Sun). These black holes affect the evolution of galaxies well beyond their gravitational sphere of influence (which does not extend wider than 1/1000th of a typical galaxy linear size). In turn, the evolution of galaxies affects the growth of black holes through, e.g., galaxy merging. Interacting galaxies, or galaxies with a multiple (active) nuclei are key laboratories to investigate these processes.

While the extragalactic astrophysical community share a broad consensus on each of the above statements taken individually, how these feed-back loops work in the Universe, and the relative importance of various feed-back channels remain largely not understood. Furthermore, the existing samples of dual/binary/multiple active galaxies are remarkably scarce and incomplete.

My talk will offer a glimpse of the recent efforts that a group of scientists in the MAGNA ("Multiple AGN Activity"; "Eat" in Roman dialect) collaboration have been undertaking to acquire large observational samples of dual/binary AGN, and to use them to inform the cosmological and "local" simulations aiming at predicting the concurrent galaxy/black hole evolution. This talk will allow you to pierce your (X-ray) view through the dusty environment of these systems.

Parental guidance not needed.

POSTERS

Exploring the connection between CSS, NLS1 and FSRQ through the modelling of the multiwavelength SED by Jessica Luna

In this work we present preliminary results of the analysis of the jet properties of a selection of jetted AGNs: CSS, NLS1 and FSRQ (z<1.5), all of them known to be gamma-ray emitters. We employ the JetSeT framework that reproduces the radiative processes acting in relativistic jets to fit the multiwavelength SED from radio to gamma-rays. By fitting numerical models to observed data, and employing a Monte Carlo Markov Chain approach, we estimate the physical parameters such as disk luminosity, black hole mass, accretion efficiency, Compton dominance, jet power, among others. We analyzed the parameters found in the SED fitting in the context of a jet-disk connection, and we used them to find possible similarities/differences between the three classes. In particular, we focus on the results obtained in the so-called hybrids sources, i.e., those jetted AGN that have been previously found to be sharing characteristics between CSS/NLS1 or NLS1/FSRQ. Thus, we show results on PKS0440-00, a source previously classified as FSRQ, but also as NLS1 due to its characteristics in its optical spectrum. After reproducing the Optical-UV data with a multi temperature disk model to estimate the black hole mass and disk luminosity, and applied a leptonic model with an SSC and EC components, we found that some parameters such as the bulk Lorentz factor, jet power, as well as the contribution of the SSC emission component to the X-ray spectrum, are more compatible with the properties shown by the NLS1 class.

The curious case of Hercules A: A massive (>30 kpc) jet-driven outflow by Mainak Singha

We present high-resolution integral field unit and Hubble Space Telescope imaging observations for Hercules A, the brightest cluster galaxy in the constellation of Hercules, a system that harbours radio jets. We find that not only the ionized gas is extended about ~ 31 kpc from the central engine along the direction of the radio jet but neither the weak accretion disk nor the ongoing merger cannot shape the ionized gas kinematics. Furthermore, we report that the jets are decelerating and picking up the dense (~ 250/cc) ionized gas as they traverse several kpc. distances. Our results strongly suggest that the radio jets are strongly interacting with the ambient medium and entraining gas in this process. Using the Chaotic Cold Accretion model of Gaspari et a. 2018, we estimate a mass outflow rate in the warm, ionized gas phase ~ 2000 solar mass/yr. Our findings show that not radio jets can heat up the ambient medium and they are efficient at expelling a large amount of gas from their host galaxies' reservoir. Our results in Hercules A are hence crucial to understanding Active Galactic Nuclei (AGN) driven feedback in the local universe.