VI Meeting of AGN Research in Spain in the Era of the New Observatories

IAA-CSIC, Granada

From January 30th to February 1st, 2023

PROGRAM AND ABSTRACTS BOOK

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The Meeting

Active galactic nuclei (AGN) represent one of the most extreme phenomena in the Universe. They occur when the supermassive black hole (SMBH) at the center of galaxies accretes material and emits large amounts of radiation across the electromagnetic spectrum, from Γ-rays to radio frequencies, sometimes exceeding the combined luminosity of all the stars in the host galaxy. Since their discovery in the 60´s AGN have received high interest in the astrophysical community, first seen as exotic objects and now recognized as major players in the evolution of galaxies and also recently as standard candles for cosmology.

Since the 90´s has been well established that massive galaxies (and possible all galaxies) harbor a SMBH at their center, whose mass is strongly correlated with certain properties of the galaxy. The evolution of star formation history and AGN appears to follow similar trends up to very early ages of the Universe, at the same time as theoretical models indicate that nuclear activity is essential for regulating star formation through feedback mechanisms.

Significant progress has recently been made in understanding the physical processes associated with AGNs, although important questions still remain open, mainly about their intrinsic nature and role in the formation and evolution of galaxies. Advances in the knowledge of AGN are supported by the availability of new astronomical technology that in the present and near future will reduce some of the most severe limitations of the previous instrumentation. Spatial resolutions will be achieved that will make it possible to study the vicinity of the supermassive black hole and will cover ranges of the electromagnetic spectrum that have been little explored to date.

Following the success of the prior Spanish AGN meetings, once again this meeting will allow to revise the current understanding in AGN research, discuss the potential of recent and upcoming instrumentation, and to find synergies among different Spanish AGNs teams. A particular attention will be devoted to the new instrumental projects of relevant interest for AGN studies in which Spain is involved. The main aim of these meetings is to have an open and friendly discussion on the recent results about AGN research which impact in our projects.

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Almudena Alonso-Herrero (CAB)
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Amalia Corral (IFCA)
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Monday, 30th January 2023

Time	Session	Speaker	Pag
14:30	Registration		
15:15 - 15:30	Welcome	Isabel Márquez, Martín Guerrero, LOC	
	Session 1 : Central Engine, Accretion Disk and Torus	**Chairs: Isabel Márquez and Álvaro Labiano**	
15:30 - 16:00	**JWST view of Polycyclic Aromatic Hydrocarbons and Dust in Seyfert galaxies**	**Ismael García Bernete**	O01
16:00 - 16:12	Exploring the infrared nuclear emission of nearby GATOS Seyfert galaxies	Almudena Alonso Herrero	O02
16:12 - 16:24	Anatomy of dusty molecular tori and nuclear outflows in nearby AGNs	Santiago García-Burillo	O03
16:24 - 16:36	Exploring the properties of the dust-gas torus of AGN through mid-IR and X-ray wavelengths	Donaji Esparza Arredondo	O04
16:36 - 17:10	Coffee break		
17:10 - 17:40	**Seeing the invisible: imaging supermassive black holes with the Event Horizon Telescope**	**José Luis Gómez**	O05
17:40 - 17:52	Representative AGN spectral shapes for Automatic redshift extraction from X-ray AGN spectra	Koushika Vaiyapuri Palanimuthu	O06
17:52 - 18:04	The origin of the optical intermediate classification of AGN	Lorenzo Barquín González	O07
18:04 - 18:16	Compact jets dominate the continuum emission in low-luminosity active galactic nuclei	Juan Antonio Fernández Ontiveros	O08
18:16 - 18:28	Exploitation of AGN in Euclid with an empirically generated catalog	Xavier López López	O09

Tuesday, 31st January 2023

Time	Session	Speaker	Pag
	Session 2 : Instrumentation from a multiwavelength perspective	**Chairs: Lourdes Verdes Montenegro and Martín Guerrero**	
09:30 - 10:30	**Spotlight on AGNs with SKAO, the future most sensitive radio facility**	**Theresa Wiegert and Marie Lou Gendrón Marsolais**	O10

10:30 - 11.00	**Think about your AGN science with HARMONI**	**Begoña García Lorenzo**	O11
11:00 - 11:30	Coffee break		
11:30 - 12:00	**TARSIS, the future IFU for the Calar Alto observatory**	**Jorge Iglesias Páramo**	O12
12:00 - 12:30	**The forthcoming revolution in X-ray spectroscopy: AGN science with XRISM**	**Matteo Guainazzi**	O13
12:30 - 13:00	**Prospects for AGN Research at Very High Energies for the Coming Decades**	**Iván Agudo**	O14
13:00 - 15:00	Lunch break		
	Session 3 : Outflows and relativistics jets	**Chairs: María Santos LLeó and Amalia Corral**	
15:00 - 15:12	Outflows in low-luminosity AGNs: the case of NGC1052	Sara Cazzoli	O15
15:12 - 15:24	Detecting outflows with MEGARA in a sample of nearby LINERs	Laura Hermosa Muñoz	O16
15:24 - 15:36	Multi-phase outflows in local type-2 quasars	Giovanna Speranza	O17
15:36 - 15:48	AGN feedback in the Local Universe: the multiphase outflow of Seyfert galaxy NGC 5506	Federico Esposito	O18
15:48 - 16:00	Obscuring winds in AGN: the case of NGC 985	Jacobo Ebrero Carrero	O19
16:00 - 16:12	JWST/MIRI MRS view of the jet-ISM interaction in NGC 7319. Missing jet energy?	Miguel Pereira Santaella	O20
16:12 - 16:24	The impact of radio-jets on the molecular gas reservoirs of obscured quasars	Anelise Audibert	O21
16:24 - 17:00	Coffee break		
17:00 - 17:12	Characterisation of molecular outflows in ULIRGs using ALMA	Isabella Lamperti	O22
17:12 - 17:24	AGN feedback along the quasar Main Sequence at high redshift	Alice Deconto-Machado	O23
17:24 - 17:36	AGN feedback: connecting molecular outflows and X-ray fast winds in Narrow Line Seyfert 1 Galaxies	Anna Lia Longinotti	O24
17:36 - 17:48	Role of AGN in galaxy evolution through the green valley studies	Mirjana Pović	O25
17:48 - 18:00	The short term variability in Blazars as observed by TESS	Jose Acosta Pulido	O26
18:00 - 18:12	Finding the pieces to explain the optical spectropolarimetric variability of blazars	Jorge Otero Santos	O27

18:12 - 18:24	Polarimetry of GSN 069: the source of the quasi-periodic eruptions	Beatriz Agis González	O28
20:30	Meeting Dinner		

Wednesday, 1st February 2023

Time	Session	Speaker	Pag
	Session 4 : Feedback	**Chair: Rubén García-Benito**	
09:30 - 09:42	Quantifying the impact of AGN-driven winds on the stellar populations of their host galaxies	Patricia Bessiere	O29
09:42 - 09:54	Understanding the impact of quasar-driven outflows on galaxies at z ~ 0.3-0.4	Kiara Hervella Seoane	O30
09:54 - 10:06	The cold molecular gas kinematics of type-2 quasars as seen by ALMA	Cristina Ramos Almeida	O31
10:06 - 10:18	The impact of AGN on the molecular gas reservoir of their host galaxies at Cosmic Noon	Chiara Circosta	O32
10:18 - 10:30	The JWST/NIRSpec Galaxy Assembly Survey: environment and spatially resolved outflows in two AGN at z~3.5	Michele Perna	O33
10:30 - 11:00	Coffee break		
	Session 5 : AGN evolution and black hole growth as a tracer of galaxy evolution	**Chair: Ascensión del Olmo**	
11:00 - 11:30	**The seeds of the first supermassive black holes**	**Mar Mezcua**	O34
11:30 - 11:42	AGN triggering: the “twin galaxies” approach and the CAVITY survey project	Ignacio del Moral Castro	O35
11:42 - 11:54	AGN and quasar science with the J-PAS narrow-band photometric survey	Silvia Bonoli	O36
11:54 - 12:06	GOGREEN reveals the minor role of the environment in AGN activity	Irene Pintos Castro	O37
12:06 - 12:18	AGN incidence in massive clusters across cosmic time: Simulations vs. Observations	Iván Muñoz Rodríguez	O38
12:18 - 12:30	Using narrow UV emission-line components to derive gas-phase chemical abundances in AGN	Enrique Pérez Montero	O39
12:30 - 12:42	The chemical content of the NLR as estimated from IR emission lines in AGNs	Borja Pérez Díaz	O40
12:42 - 13:15	Concluding Remarks	Josefa Masegosa and Miguel Pereira	

Poster presentations

TALKS

Session 1 : Central Engine, Accretion Disk and Torus

JWST view of Polycyclic Aromatic Hydrocarbons and Dust in Seyfert galaxies

Ismael Garcia-Bernete, Universtiy of Oxford
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Abstract: Nowadays, it is widely accepted that most galaxies undergo an active phase in their evolution. The impact of the energy released by active galactic nuclei (AGN) in the interstellar medium (ISM) of the host galaxy has been proposed as a key mechanism responsible for regulating star formation (SF). The mid-infrared (IR) is the ideal spectral range to investigate the nuclear/circumnuclear regions of AGN since dust extinction is significantly lower compared to the visible range. Furthermore, it provides unique tracers to study the AGN-SF connection such as H2 rotational lines, fine structure lines and Polycyclic Aromatic Hydrocarbons (PAHs). PAHs are also a powerful tool to characterize the ISM in different environments.

In this talk, I will summarise our recent and on-going work using JWST. Recently, we presented new JWST/MIRI MRS spectroscopy of three Seyfert AGN in which we compare their nuclear PAH emission with that of star-forming regions (Garcia-Bernete+22). This study represents the first of its kind to use sub-arcsecond angular resolution data of local luminous Seyferts (Lbol > 10^44.46 erg/s) with a wide wavelength coverage (4.9-28.1 μm). Our results showed that a suite of PAH features is present in the innermost parts of these Seyfert galaxies. We found that the nuclear regions of AGN lie at different positions of the PAH diagnostic diagrams, whereas the SF regions are concentrated around the average values of SF galaxies. Furthermore, we find that the nuclear PAH emission mainly originates in neutral PAHs while, in contrast, PAH emission originating in the star forming regions favours small ionised PAH grains. Therefore, our results provide evidence that the AGN have a significant impact on the ionization state and size of the PAH grains on scales of ~142-245 pc. Finally, I will summarise our prospects for JWST Cycle-2 and recent/ongoing JWST work within the GATOS (Galactic Activity, Torus and Outflow Survey) collaboration.

Exploring the infrared nuclear emission of nearby GATOS Seyfert galaxies

Almudena Alonso Herrero, Centro de Astrobiología (CAB), CSIC-INTA
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Abstract: The nuclear infrared emission of active galactic nuclei (AGN) originates from dusty molecular tori and possibly nuclear dusty winds. Indeed, simulations of dense clumpy dusty disks around AGN predict the launch of dusty winds, whose strength and orientation depend on the AGN Eddington ratio and the column density of the dusty clumps. I will present high angular resolution ground-based mid-infrared observations of nearby Seyfert galaxies, as well as new observations obtained with two JWST Cycle 1 proposals as part of the Galactic Activity, Torus, and Outflow Survey (GATOS). The JWST imaging observations make use of five MIRI filters to probe the dust continuum emission and the 9.7micron silicate feature, while avoiding spectral regions with strong polycyclic aromatic hydrocarbon (PAH) emission. The JWST/MIRI IFU 5-28micron observations include dust continuum and PAH emission, fine structure lines and molecular hydrogen lines. All these observations allow us to study the dust emission and gas cycle in the nuclear regions of Seyfert galaxies with resolutions of tens of parsecs.

Anatomy of dusty molecular tori and nuclear outflows in nearby AGNs

Santiago García-Burillo, OAN-IGN, Spain
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Abstract: ALMA has made possible to study the distribution and kinematics of molecular gas in active galaxies down to ~parsec scales. We review the last results derived from a number of high-resolution ALMA surveys imaging molecular tori in a representative sample of AGNs in the local universe (NUGA and GATOS). The GATOS project expands the range of AGN luminosities and Eddington ratios covered by previous surveys and allows us to study the gas feeding and feedback cycle in a combined sample of 19 Seyferts with spatial resolutions ~7-10pc. These observations detect 870 μm continuum and molecular line emission stemming from spatially-resolved molecular dusty disks, which tend to be perpendicular relative to the AGN wind axes, as expected for dusty molecular tori. The median values of the sizes and molecular gas masses of the tori are ~ 42 pc, and ~ 6 × 10^5 Msun, respectively. The inner section of these disks are within the sphere of influence of the BH. The radial distributions of molecular gas in the circumnuclear disks (CND) of the targets show the imprint of AGN feedback reflected in the presence of nuclear-scale molecular gas deficits, which are more extreme in higher Eddington ratio sources and linked to the detection of molecular outflows. More recently, new 2-3pc spatial resolution images of two galaxies of the sample have fully resolved the tori and their dusty winds associated with polar components with unprecedented detail. We discuss an extension of the survey to higher AGN luminosities more akin to those of QSO-like sources.

Exploring the properties of the dust-gas torus of AGN through mid-IR and X-ray wavelengths.

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Omaira González Martín, IRyA, UNAM
Cristina Ramos-Almeida, IAC
Begoña García Lorenzo, IAC
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Abstract: In recent decades, several multiwavelength studies have been dedicated to exploring the properties of the obscuring material in active galactic nuclei (AGN). Mainly, various models at mid-IR and X-ray wavelengths have been developed to describe the structure and distribution of this material and constrain its physical and geometrical parameters through spectral fitting techniques. However, questions around how torus mid-infrared and X-ray emission are related remain unanswered. In this talk, I will present the results obtained from a comparison of the dust and gas distributions in a sample of nearby AGNs with NuSTAR and Spitzer spectra available. We find that a combination of smooth and clumpy distributions of gas and dust, respectively, is preferred for ~80% of sources. However, considering other available information about each source, such as the absorption variability, we find that ~50% of our sources are best described by a clumpy distribution of both dust and gas. The remaining ~50% of our sources can still be explained by a smooth gas distribution and a clumpy dust distribution. At least six alternative scenarios could resolve the observed properties of our sample. I will also describe how a simultaneous fitting technique, which combines data and models of both ranges of wavelengths, is helpful in exploring the complexity of this torus and improving the constrain of the physical parameters of this structure.

Seeing the invisible: imaging supermassive black holes with the Event Horizon Telescope

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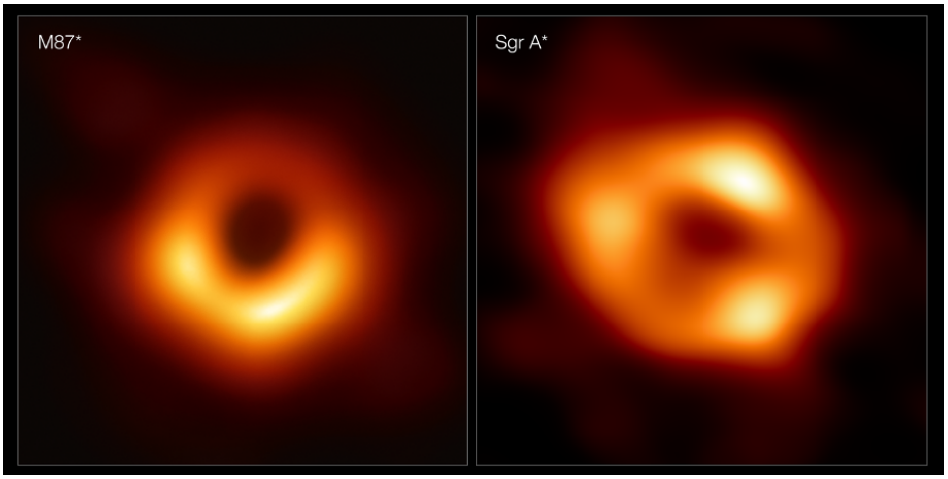

Abstract: Black holes are perhaps the most fundamental and striking prediction of Einstein's General Theory of Relativity (GR), and are at the heart of fundamental questions attempting to unify GR and quantum mechanics. Since the 1970s, astronomers have been accumulating indirect evidence for the existence of black holes by studying the effects of their gravitational interaction with their surrounding environments, but it was not until April 10th 2019, when the Event Horizon Telescope (EHT) Collaboration revealed to the world the first image of a black hole, the one located at the center of the active galaxy M87. More recently, in May 12th 2022, the EHT Collaboration provided extra confirmation for the existence of black holes by releasing the first image of the black hole at the center of our own galaxy, SgrA*. The images (above) show an asymmetric bright emission ring, which encompasses a central depression in brightness, known as the "shadow" of the black hole, produced by the photon capture within the event horizon of the black hole. Overall, the size, circularity, asymmetry, and brightness contrast of the observed black holes images in M87 and SgrA* are consistent with the shadow of Kerr black holes as predicted by GR and provide the strongest evidence to date of the existence of supermassive black holes in the nuclei of galaxies. The next-generation Event Horizon Telescope (ngEHT) is a visionary project that will extend the EHT capabilities to perform GR tests with ever refining precision and will allow capturing the first real-time movies of black holes. These movies will resolve the complex structure and dynamics at the event horizon, bringing into focus not just the persistent strong-field gravity features predicted by general relativity, but also details of active accretion and relativistic jet launching that drive galaxy evolution and may even affect large scale structures in the Universe.

Representative AGN spectral shapes for Automatic redshift extraction from X-ray AGN spectra

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Amalia Corral, Instituto de Física de Cantabria (CSIC-Uni. de Cantabria)
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Abstract: In Extragalactic X-ray surveys, spectroscopic redshift extraction is an expensive process. In this work, we develop an automated method to extract redshift information solely from the X-ray AGN spectra. For this purpose, we have used highly quality NuSTAR hard X-ray spectra to obtain a set of models that best represent the X-ray spectral shape of AGN. We have used UXCLUMPY, a novel clumpy torus model that allows for self-consistent multi-wavelength analyses. These models were then used to simulate moderately Compton thick spectra with Athena/WFI response matrices in the redshift range z=1-4, and Luminosity $LX_{2−10 keV} = 5×10^{44}$ erg/s with different exposure times. These simulated spectra were then used to compare the performance of our previous method with that of the more sophisticated one using wavelets for denoising and better feature detection. We will report on the preliminary results of this comparison.

The origin of the optical intermediate classification of AGN

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Francisco J. Carrera, UNICAN-IFCA
Silvia Mateos, UNICAN-IFCA
Amalia Corral, UNICAN-IFCA
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Abstract: The standard unification model of AGN assumes that optically obscured (Type 2) and unobscured (Type 1) can be explained with a clumpy structure of dust and gas – the torus – surrounding the central engine. For those AGN classified as intermediate types, the standard unification model assumes they are intermediate states of obscuration. However, this apparent change in extinction could be instead differences of other properties misinterpreted. These possible differences could be associated with the nuclear region of the AGN (a decreasing luminosity or BLR emission with intermediate class) or with properties of the host galaxy (an increasing luminosity or optical extinction)

To shed light on this issue, we have studied a unique sample of 165 X-ray selected AGN drawn from the Bright Ultra-hard XMM-Newton Survey (BUXS). The sources span more than 3 orders of magnitude in X-ray luminosity, from ~1e42 erg/s to ~1e45 erg/s, and redshifts from ~0.06 to 0.75. Of these, 117 sources have been spectroscopically classified as type 1 (98% with intermediate classification) and 48 as type 2. Thanks to the high-quality multi-wavelength data available for all sample objects, we have been able to determine their obscuration properties, host galaxy properties and the effect of AGN luminosity on the BLR and torus properties. The uniform selection, large sample size and high optical spectroscopic classification completeness assure us the derived results are statistically robust.

We have found a clear increase in the observed optical extinction with intermediate classification. The same trend was confirmed using X-ray obscuration. At the same time, we have not found differences between host galaxy optical obscuration. Neither significant changes between AGN luminosities or BLR emission have been detected for intermediate classes. However, 1.8-9/2.0 AGN seem to live in more luminous galaxies than 1.0-1.5 AGN.

Based on our results, we can conclude that extinction is the main driver of the intermediate classification, revealing 1.2/1.5/1.8 AGN as intermediate states of obscuration between type 1.0 and type 2. However, the highest luminosity of the host galaxies of type 1.9 and 2 becomes the dominant effect behind the classification origin for those of them with low extinction.

Compact jets dominate the continuum emission in low-luminosity active galactic nuclei

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Xavier López López, INAF-OAS
Almudena Prieto, IAC
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Abstract: The disappearance of the accretion disc in low-luminosity active galactic nuclei (LLAGN) leaves behind a faint optical nuclear continuum whose nature has been largely debated, mainly due to serious observational limitations in the IR to UV range. We combine multi-wavelength sub-arcsecond resolution observations -able to isolate the genuine nuclear continuum- with nebular lines in the mid-IR, to indirectly probe the shape of the extreme UV continuum. We found that 8 of the nearest prototype LLAGN are compatible with pure compact jet emission (self-absorbed synchrotron plus the associated self-Compton component) over more than ten orders of magnitude in frequency. When compared with typical radio galaxies, the LLAGN continua show two peculiarities: i) a very steep spectral slope in the IR-to-optical/UV range ($-3.7 < a < -1.3$; $F_\nu \sim \nu^a$); and ii) a very high turnover frequency (0.2-30 THz; 1.3mm-10μm). These attributes can be explained if the synchrotron continuum is mainly dominated by thermalised particles at the jet base or corona with considerably high temperatures, whereas only a small fraction of the energy (~20%) would be distributed along the high-energy power-law tail of accelerated particles. On the other hand, the nebular gas excitation in LLAGN is in agreement with pure photo-ionisation from inverse Compton radiation with a spectral index of ~ -0.7, which would dominate the nuclear continuum shortwards of ~3000 AA. Our results suggest that the LLAGN continuum can be dominated at all wavelengths by undeveloped jets, powered by a thermalised particle distribution, similar to the case of compact jets in quiescent black hole X-ray binaries. This has important implications in the context of galaxy evolution, since LLAGN may represent a major but underestimated source of kinetic feedback in galaxies.

Exploitation of AGN in Euclid with an empirically generated catalog

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Abstract: Realistic and large simulations are a fundamental tool in order to maximise the scientific exploitation of Euclid and other surveys.
In this work, we present a simulated catalog of galaxies and AGN based on an empirical model. Starting from a Dark Matter simulation and making use of state-of-the-art observed relations, we built a catalog which is able to reproduce observed properties such as the number density of galaxies and AGN, or their redshift and spatial distributions. We aim at deriving properties such as the duty cycle, number densities and M*/Lx relation from a sample of AGN identified from Euclid Q1-DR1 data as expected from our simulated catalog.

Session 2 : Instrumentation from a multiwavelength perspective

Spotlight on AGNs with SKAO, the future most sensitive radio facility

Marie-Lou Gendron-Marsolais, IAA-CSIC
Theresa Wiegert, IAA-CSIC
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Abstract: The SKA Observatory interferometers will be the most sensitive radio telescopes on Earth. The unprecedented sensitivity of these instruments will help to address a wide variety of fundamental questions covering astrophysics, fundamental physics and astrobiology. Their sensitivities, angular resolutions, and fields of view supersede, by at least one order of magnitude, the performances of all current radio astronomical facilities. The SKAO thus represents a unique opportunity to study one of the most extreme phenomena in the Universe - active galactic nuclei (AGN). In particular, SKAO's high-sensitivity and high-resolution capabilities will allow to disentangle the nuclear and stellar contributions in galaxies, enabling the study of the innermost regions of galaxies. Moreover, SKA telescopes will probe the widely unknown physics of AGN jets down to parsec scales. Its high sensitivity and resolution, combined with the full polarization observations it will provide, will allow to determine jets' composition, dynamics and effects on the surrounding gas and dust, and the role and structure of the magnetic fields.

With its unprecedented sensitivity and survey speed, SKAO will also gather samples of millions of AGN at all ranges of radio luminosities, delivering access to two widely unexplored populations: radio-quiet sources and high-redshift radio-loud sources (up to z=10). These samples will allow for statistical studies, helping to solve issues such as the division of AGN in radio-loud and radio-weak objects, the nature of the interplay between AGN and their environments (host galaxies, groups and clusters), and their cosmological evolution (when and how AGN formed). In this talk we will present an overview of SKAO's telescopes capabilities and the Spanish involvement in the project, and dicuss how SKAO will yield transformational advances for the AGN research accomplished by the Spanish astrophysical community

Think about your AGN science with HARMONI

Begoña García Lorenzo, IAC
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Abstract: The High Angular Resolution Monolithic Optical and Near-infrared Integral field spectrograph (HARMONI) is a first instrument for the Extremely Large Telescope (ELT). HARMONI is very versatile, supporting a wide range of science programs. In this talk, I will summarize the main characteristics of HARMONI, highlighting the Spanish technical contributions. I briefly review some mock HARMONI observations for a few science cases related to the evolution of galaxies and, in particular, how HARMONI will show AGN hosts around Cosmic Noon. The main aim of this talk is to promote, mainly among young researchers, thinking about programs on AGN-related topics to maximize the scientific return from HARMONI to the Spanish community

TARSIS, the future IFU for the Calar Alto observatory

Jorge Iglesias Páramo, IAA-CSIC
& the TARSIS/CATARSIS team
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Abstract: In this talk I will show the main characteristics of TARSIS, the future bidimensional spectrograph that will work at the 3.5m telescope of the Calar Alto observatory. In addition to this, I will explain the scientific goals of CATARSIS, the survey that will observe clusters of galaxies during the first years of operation of TARSIS.

The forthcoming revolution in X-ray spectroscopy: AGN science with XRISM

Matteo Guainazzi, ES/ESTEC
Contact:

Abstract: X-ray spectroscopy is at the eve of a true revolution. A micro-calorimeter X-ray detector with a resolving power of ~1000 at 7 keV will fly on the JAXA-led XRISM mission ("X-Ray Imaging Spectroscopy Mission"; launch due by the end of the Japanese Fiscal Year 2023). Building on the solid technological heritage of the "Hitomi" soft X-ray payload, XRISM aims at pioneering unprecedented high-resolution X-ray spectroscopy, with four main scientific objectives:

1) Structure formation of the Universe and evolution of clusters
of galaxies;
2) Circulation history of baryonic matters in the Universe;
3)Transport and circulation of energy in the Universe;
4) New science with unprecedented high-resolution X-ray spectroscopy.

I will review the main contributions that XRISM will deliver on the astrophysics of Active Galactic Nuclei, from studying the innermost regions of the accretion disk where sub-relativistic outflows are launched and inflows are shaped by General Relativity effects, to probing the physical properties and geometrical distribution of the torus and of the Broad and Narrow Line Regions.

Prospects for AGN Research at Very High Energies for the Coming Decades

Iván Agudo, IAA-CSIC
Contact: iagudo@iaa.es

Abstract: In this talk I will give an overview of the most relevant research lines regarding AGN that are planned to be developed by the next generation of very high energy facilities, this is the Cherenkov Telescope Array Observatory (CTAO). The status of the construction, as well as the remaining of the timeline, of the CTAO will also be reported.

Session 3 : Outflows and relativistics jets

Outflows in low-luminosity AGNs: the case of NGC1052

Sara Cazzoli, IAA-CSIC
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Abstract: NGC1052 is considered the prototype of AGN-LINERs, an AGN family at low-luminosity for which, so far, the role of outflows in their evolution has been studied the less.

Thanks to MUSE and MEGARA IFS-cubes we found that the stars are distributed in a dynamically hot disc whereas the ionised gas is detected mostly in the polar direction up to 3.3 kpc. We found evidences evidence of an ionised gas outflow (jet-powered) propagating in a cocoon of gas with enhanced turbulence and triggering the onset of kpc-scale buoyant bubbles. The hints of the presence of a neutral gas outflow are weak.

Detecting outflows with MEGARA in a sample of nearby LINERs

Laura Hermosa Muñoz, IAA-CSIC
Sara Cazzoli, IAA-CSIC
Isabel Márquez, IAA-CSIC
Josefa Masegosa, IAA-CSIC
Beatriz Agís-González, IAA-CSIC
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Abstract: Outflows play a major role in the evolution of galaxies and are said to be ubiquitous within the Active Galactic Nuclei (AGNs) population. However, we are far from having a complete picture of their properties, specially considering their impact on the evolution of Low-Ionisation Nuclear Emission-line Regions (LINERs).

Although resolved kinematic information is crucial for the fully characterisation of these phenomena, imaging techniques can be really useful for the systematic search of outflow candidates. With this aim we created the largest up-to-date atlas of ionised gas outflow candidates in a sample of 70 nearby LINERs; when combining imaging and spectroscopic data from the current literature we found that outflows are present in 48% of the nearby LINERs (Hermosa-Muñoz et al. 2022).

We have selected our best LINER candidates for hosting outflows coming from our previous imaging and long-slit spectroscopic works (Masegosa et al. 2011, Cazzoli et al. 2018, Hermosa Muñoz et al. 2020, 2022). We aim to confirm and characterise the outflows by means of the use of integral field spectroscopic data with MEGARA/GTC. We obtained data for nine objects in the low resolution mode (R~6000) of MEGARA to analyse the properties of their ionised gas. We have detected various kinematical components for the great majority of the targets (75%), and for ~65% of the sample, the components detected in the emission lines are consistent with signatures of outflows. Our results are in agreement with our previous works, and further confirm that outflows are present also in low luminosity AGNs, such as LINERs.

Multi-phase outflows in local type-2 quasars

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Abstract: Active galactic nuclei (AGN) have an indisputable role in the evolution of their host galaxy through the continuous exchange of energy and matter. To characterize AGN impact on the surrounding environment, it is worthy to observe outflows of gas in different phases (ionized, neutral and molecular). Despite the importance of this multi-phase characterization, studies so far have been mostly focused on a single outflow phase. In this talk, I will instead present detailed results for the Type-2 quasar (QSO2) J0945+1737, in which we detect high-velocity wings associated with outflows in its near-infrared spectrum, where low-ionization (Paα, Brδ), high-ionization ([Si VI]) and molecular (H_2) emission lines are present. The ionized outflow has a mass rate of 51 $M_\odot$ yr^{-1} and it is aligned with the radio jet structure in the central kpc. This might be indicating that the line-emitting gas is being compressed and accelerated by the shocks generated by the radio jet. Furthermore, I will present analogous results for ionized outflows detected in a sample of five QSO2s, observed with GTC/MEGARA, using the [O III] and Hβ profiles from their optical spectra. In addiction, I will compare the ionized outflow properties with those of the cold molecular outflows reported in Ramos Almeida et al. (2022). By comparing their geometry, kinematics and energetics, we aim to explore AGN feedback with a multi-phase approach. This provide a more comprehensive view on the feedback process and how it affects the evolution of galaxies in the local Universe.

AGN feedback in the Local Universe: the multiphase outflow of Seyfert galaxy NGC 5506

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Abstract: Observations have revealed that gas accretion onto supermassive black holes and their hosts can be regulated through the launching of molecular outflows in galaxies. This phenomenon is broadly known as active galactic nucleus (AGN) feedback, and it is also required in simulations to regulate the build-up of stellar mass in galaxies. To fully address the impact of this process, multi-wavelength observations are needed. In this context, I will present a detailed study of ALMA submillimeter and GTC/MEGARA IFU optical observations of NGC 5506, a nearby Seyfert galaxy, part of the GATOS sample. Using the ALMA CO(3-2) observations, we modelled the cold molecular gas kinematics with the 3D-Barolo tool, using a rotating nuclear ring and an outflow component with radial velocities around 30 km/s, in the central ~1.2 kpc. Thanks to the good spatial resolution of ALMA, we have been able to study the radial profile of the molecular outflow. Furthermore, we analyzed the kinematics of the ionized gas using the GTC/MEGARA [OIII]λ5007 line observations and separated the rotation from the outflow on a spaxel-by-spaxel basis. By comparing the molecular and ionized outflow properties, we provide a comprehensive scenario of the feedback processes on the evolution of NGC 5506.

Obscuring winds in AGN: the case of NGC 985

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Abstract: Transient obscuration events in nearby AGN are deemed to be more common than originally thought and, if monitored, they are excellent laboratories to probe the physical properties of the circumnuclear gas. We present the results of a monitoring campaign on the Seyfert 1 galaxy NGC 985, which was observed twice in 2015 with XMM-Newton in X-rays and HST-COS in the UV. These observations showed that NGC 985 was recovering from a low flux state with strong soft X-ray obscuration and broad, fast UV absorption, first observed in 2013. The XMM-Newton observations revealed the presence of a multi-component warm absorber (WA). Re-analysis of archival observations showed that some of these components were still present in 2003 and 2013, when the source was obscured, albeit with different ionization states. In the UV, the 2015 observations show diminished obscuration as well as a weakening of the associated broad UV absorption, plus a complex set of six narrow absorption features presumably associated with the X-ray WA. These troughs show variability on timescales as short as the 12 days, and up to the many-year timescales probed by prior HST observations in 2013 and 1999. Assuming these changes are due to photoionization and recombination mechanisms, we have obtained upper and lower limits on the density of the gas that were used to pinpoint the location of the WA finding that the closest two components are at parsec-scale distances, while the rest may extend up to tens of parsecs from the central source. We found that the fastest, most ionized WA component accounts for the bulk of the kinetic luminosity injected back into the interstellar medium of the host galaxy, which is on the order of 0.8% of the bolometric luminosity of NGC 985. According to the models, this amount of kinetic energy per unit time would be sufficient to account for cosmic feedback. These results will be put in the context of other ambitious multi-wavelength monitoring campaigns, which are proving to be a unique tool to obtain an unprecedented view of the gas dynamics and photoionization processes in the innermost regions of AGN.

JWST/MIRI MRS view of the jet-ISM interaction in NGC 7319. Missing jet energy?

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Abstract: Radio-jet/kinetic mode AGN feedback is an important evolution driver for the majority of galaxies. Contrary to high-power radio jets, which easily pierce the ISM, low-power radio jets can remain for a longer time trapped in the ISM around the AGN affecting larger gas volumes, thus potentially having a much larger impact on the nuclear regions.

MIRI/MRS mid-IR spectroscopy of NGC7319 (the largest spiral in the Stephan's Quintet which hosts a Sy 2 AGN with a low-power radio jet) was obtained as part of the JWST Early Release Observations.
I will present the initial analysis of the MIRI data which, for the first time, spatially resolve the interaction between the radio jet and the ISM.
We detect extended coronal emission ([MgV], [NeVI], and [NeV]) close to the jet axis and enhanced warm/hot molecular H2 and ionized gas emission at the radio hotspots.
The mechanical energy of these gas phases at the radio hotspots is

The impact of radio-jets on the molecular gas reservoirs of obscured quasars

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Abstract: One of the potential drivers of multi-phase outflows are jets launched by the supermassive black hole. These jets can have a strong impact on (sub-)kpc scales, by altering the properties of the interstellar medium (ISM) of the host galaxies. In order to investigate the impact of radio jets on the cold gas reservoirs of galaxies hosting an AGN, we present a kinematic analysis of ALMA CO(2-1) and CO(3-2) observations at subarcsecond resolution of a sample of radio-quiet type 2 quasars (QSO2s) at z~0.1. For the case of the Teacup galaxy, the compact low-power radio jet is almost coplanar with the molecular gas disc. Enhanced emission line widths perpendicular to the jet orientation have been reported for several nearby AGN for the ionised gas. For the molecular gas in the Teacup, we do not only find this enhancement in the velocity dispersion, but also a higher brightness temperature ratio (T32/T21) perpendicular to the radio jet compared to the ratios found in the galaxy disc. Our results suggest that the low-power radio jet is compressing and accelerating the molecular gas, and driving a lateral outflow that shows enhanced velocity dispersion and higher gas excitation. These results provide further evidence that the coupling between jet and the ISM is relevant to AGN feedback even in the case of radio-quiet galaxies.

Characterisation of molecular outflows in ULIRGs using ALMA

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Abstract: Local ultra-luminous infrared galaxies (ULIRGs) host the most intense starbursts in the local Universe and many of them host bright active galactic nuclei (AGN) as well. For this reason, they are the ideal places to study AGN and starburst driven outflows, and their feedback effects. Additionally, ULIRGs are found predominantly in mergers or interacting systems, representing a crucial stage in the cosmological evolution of galaxies.

We use spatially resolved (~400pc) CO(2-1) and continuum ALMA observations for a representative sample of 25 low-redshift ULIRGs ($z< 0.17$) to study their feedback properties. Taking advantage of the high spatial resolution, it is possible, for the first time, to map the outflow spatial extent and orientation, and to properly evaluate their effects on the host systems.

We will present the first results of this study (Lamperti et al. 2022) in terms of prevalence of the outflows, outflow energetics and quantify their impact on the host galaxy. Using a spectro-astrometry technique, we mapped the direction of the outflow and found that outflow powered by starbursts tend to escape along the path of least resistance; in contrast, outflows powered by AGN do not have a preferred orientation with respect to the disk. We also developed a new diagnostic technique to discriminate between energy- and momentum-driven outflows, and found that these molecular outflows are more consistent with the momentum-driven scenario. Moreover, we found that the mass outflow rates do not follow a tight relation with the AGN luminosities, as reported in previous works (e.g. Cicone et al. 2014), which means that the AGN luminosity is not the only factor influencing the power of the outflows.

AGN feedback along the quasar Main Sequence at high redshift

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Abstract: Winds appear to be a ubiquitous feature of Active Galactic Nuclei (AGN). Especially at high and intermediate redshift, many sources seem to harbor a powerful central mechanism that allows for strong jets in radio and/or winds observed in the optical and UV ranges of their spectra. Through the decomposition of the broad emission line profiles, we are able to find some hint of the real relevance of winds for the structure and dynamics of the broad and narrow line emitting regions. High-ionization lines usually present a significant asymmetry towards the blue that is strong evidence of outflow motions. Notable blueshifted components can be seen in the many blends of the UV region, most notably in the high ionization line of CIV λ1549; however, in the optical spectrum they are most often seen in [OIII] λλ4959,5007. In this work, we present a remarkable sample of 32 high-luminosity and high-redshift quasars (z = 1.5 – 3.7) observed with ESO-VLT. 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 properties as well as the presence of winds/outflows depending on their location along the MS through the decomposition and analysis of optical and UV line profiles. Feedback contribution are estimated through the decomposition of [OIII] λλ4959,5007 and of CIV λ1549.

AGN feedback: connecting molecular outflows and X-ray fast winds in Narrow Line Seyfert 1 Galaxies

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Abstract: The well-established relations observed between the properties of host galaxies and their nuclear black hole activity suggest the presence of a solid yet still mysterious mechanism that makes BH behavior at nuclear scale impacting the galaxy-scale environment.

Multi-band observations of AGN-driven outflows support the idea that energy-conserving outflows may induce AGN feedback not only in powerful active galaxies, but also at lower luminosity regime.

In this context, tracing each phase of the outflow from the X-ray accretion disc winds to the large scale optical and molecular massive outflows offers a tool to understand how the initial energy of the nuclear wind is transferred outward.

I will present and discuss recent results on a sample of Narrow Line Seyfert Galaxies where we are studying powerful X-ray Ultra Fast Outflows in XMM-Newton grating spectra, and in which the properties of the molecular gas were studied via mm observations with the IRAM-30m telescope. If time allows, NOEMA follow-up observations available for some of these sources will be presented too.

Role of AGN in galaxy evolution through the green valley studies

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Abstract: Green valley galaxies showed to be very important for understanding the quenching of star formation, morphological transformation of galaxies from late- to early-types, and galaxy evolution across cosmic time. Most of the X-ray detected AGN have been found in the green valley in optical, suggesting that AGN might be responsible for stopping the star formation in galaxies. Many optical studies that analysed large samples of galaxies suggested the same. This picture however seems to become more complex when we use multi-wavelength data, such as in FIR. This talk will provide a general overview of the most recent studies regarding green valley galaxies and the role that AGN may have in the morphological transformation of galaxies and galaxy evolution from both the optical and multi-wavelength perspectives.

The short term variability in Blazars as observed by TESS

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Abstract: Blazars are active galactic nuclei that show extreme variability properties. Blazar emission mostly comes from a relativistic plasma jet that is oriented closely to the line of sight. As a consequence, the flux is Doppler beamed and boosted, and time-scales are shortened. Blazar variability is mostly chaotic and unpredictable. Some objects show almost continuous activity, while others undergo extreme outburst events after periods of almost constant emission. Variability time-scales range from years down to hours, likely implying that different mechanisms are at work, both of intrinsic (i.e. energetic) and extrinsic (i.e. geometric) nature.

Here we present the results of our analysis of short term variability of several blazars based on TESS observations. TESS observes continuosly a sector of the sky, for a period of nearly one month. Few targets are observed with a cadence of 2 min and most of them with 30 min. The timeline is dense and long enough to discover patterns of duration shorter than few days.

Several characteristic short time scales have been identified in the studied blazars, ranging from few hours to few days. Generally, the short term variations are strongly chromatic whereas the long term changes are almost achromatic.

A particularly interesting case is the blazar 3C 371 which has been observed by TESS in more than 20 sectors, or equivalently by more than 20 months. Preliminary analysis of the light curves will be presented, showing the structure and autocorrelation functions. A multiwavelength approach will be also included showing lights curves from the optical to the X-ray range.

Finding the pieces to explain the optical spectropolarimetric variability of blazars

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Abstract: Blazars are a subclass of active galactic nuclei (AGNs) with a relativistically boosted jet pointing towards the Earth. They are one of the most violent and variable objects in the Universe, showing extreme variability across the entire electromagnetic spectrum. The jet generally dominates the optical emission of these sources. However, other components such as the stellar emission from the host galaxy or the accretion disk may contribute significantly to this emission. Disentangling the different contributions to the optical emission is challenging due to the high dominance of the jet, but is crucial to study and understand the variability detected in these objects.

In this talk we will present the results of the spectropolarimetric variability analysis performed in a sample of gamma-ray blazars monitored by the Steward Observatory from 2008 to 2018, which include an average of around 250 spectra per target. We make use of the non-negative matrix factorization (NMF), a statistical tool of dimensionality reduction to decompose the spectra of each source in the minimum number of components required to account for the observed spectral variability. We propose an approach based on a meaningful association of each component with the different expected contribution in the AGN, namely the jet, broad line region, accretion disk and stellar population. We find that the chaotic variability observed in the whole set of target spectra can be explained with a maximum of 4 components. Using this decomposition we study the contribution of each component, and its corresponding physical association, to the flux evolution and the overall variability of the AGN, together with a possible interpretation of the different variability signatures observed in each blazar. The presence of these components will also be related to the behaviour displayed by the polarized emission of the blazar sample and their variability, evaluating interesting features such as rotations of the polarization angle, periods of high polarization or differences between blazar types. The results of this decomposition will be compared to the modeling of the spectra using an independent software for fitting AGN spectral features, in particular the commonly used QSOfit.

Polarimetry of GSN 069: the source of the quasi-periodic eruptions.

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Abstract: GSN 069 is a high Eddington-ratio Seyfert galaxy that exhibits an unabsorbed highly variable X-ray spectrum typical of a Seyfert 1, but it does not show broad emission lines in its optical spectrum, which leads to a Seyfert 2 classification. It could be then considered as a true Seyfert 2 candidate. Those candidates are thought to accrete at low Eddington rates, unable to sustain the broad line region (BLR). Nevertheless, GSN 069 exceeds the theoretical accretion rate at which a BLR is formed.

On the other hand, since December 2018 and during 54 days, GSN 069 has exhibited a new X-ray variability pattern characterized by high-amplitude quasi-periodic X-ray bursts over a rather stable quiescent flux level. This new phenomenon has been dubbed X-ray quasi-periodic eruptions (QPEs) (Miniutti et al. 2019, Nature, 573, 318). Since its discovery with GSN 069, QPEs have been identified in a very few sources and their driving mechanism remains unknown. In the specific case of GSN 069, some models point to a possible tidal disruption event (TDE) as possible origin of the exhibited QPEs, but more observational efforts are needed for a better understanding.

Polarimetry is the only technique capable of demonstrating the existence of hidden-BLRs. It has also been demonstrated that the degree of polarization is sensitive to TDEs (e.g., Lee at al. 2022, ApJ, 892, 1, Kishore et al 2022, MNRAS, 515, 138). Thus, in this work we report imaging polarimetry and spectropolarimetry of GSN 069 with FORS2@VLT to explore both scenarios, the true Seyfert 2 candidacy and the possibility of a TDE in GSN 069.

Session 4 : Feedback

Quantifying the impact of AGN-driven winds on the stellar populations of their host galaxies

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Abstract: If AGN-driven winds directly impact the evolution of their host galaxies then we should expect to find evidence of suppressed or enhanced star formation in relation to matched inactive galaxies. I will present the initial results of our analysis of the stellar populations of the host galaxies of the 48 luminous, obscured AGN which form the QSOFEED sample. We also perform an identical analysis of a matched control sample and compare the prevalence of young stellar populations (YSP; tysp < 100 Myr) in both groups. Although such large studies are important in understanding the global nature of this relationship, it is also important to make more detailed studies of individual objects to enable us to understand the mechanism by which AGN outflows may impact star formation. Therefore, I will also outline the results of our spatially resolved investigation into the well-studied type II quasar Markarian 34. Using spectral synthesis modelling, we determine the spatial distribution of the YSP and employ the [OIII]5007 emission line as a tracer of the warm ionised gas kinematics. We demonstrate a spatial correlation between the outer edges of the blue-side of the outflow and an enhancement in the proportion of the YSP flux, suggesting that the outflow is responsible for triggering star formation in this region. In regions with more highly disrupted gas kinematics, we find that the proportion of YSP flux is consistent with that found outside the outflow region, suggesting that the increased disruption is preventing a similar enhancement in star formation from occurring. Our analysis suggests that Mrk 34 is an example of quasar driven outflows simultaneously producing both positive and preventive feedback, further demonstrating the complex nature of the relationship between quasars and their host galaxies.

Understanding the impact of quasar-driven outflows on galaxies at z ~ 0.3-0.4

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Abstract: We present a detailed study of the kinematics of 19 type-II luminous quasars (QSO2s), with the aim of advancing in our understanding of the AGN feedback phenomenon by correlating outflow properties with the galaxies young stellar populations (with ages < 100 Myr), morphologies, environments and radio emission. To this end, we model intermediate-resolution optical nuclear spectra of the quasars, wich have redshifts in the range 0.3 < z < 0.41 and [OIII]λ5007 luminosities of L[OIII] > 108.5L$_\odot$. We implement and discuss three different outflow detection methods: parametric multicomponent, flux-weighted nonparametric and the non-parametric from Speranza et al. (2022). We confirm the presence of ionised AGN-driven outflows in 17 of the 19 QSO2s through all the methods, obtaining outflow mass rates of $\dot{M}_{OF}$ = [0.03, 6.54] M$_\odot$/yr and kinetic powers of $\dot{E}_{kin}$ = [37.2, 42.5] erg/s.

We do not find clear correlations between the outflow properties and the previously mentioned galaxy-wide properties. The lack of evidence for negative feedback (i.e., star-formation quenching) within our
sample can be explained by the different spatial scales considered for the outflows (measured in apertures of ~ 2 kpc) and the young stellar populations (~ 8 kpc), aside from the complex relation between AGN
and star formation (see Bessiere & Ramos Almeida 2022). This difference in spatial scale could also explain the lack of correlation with the galaxy morphologies and environment. Besides, although mergers can ignite nuclear activity, outflows are a reaction to gas accretion, making it very difficult to spot correlations between mergers and outflow properties. Lastly, the small radio luminosity range covered by our sample (log (L_{5GHz}[W Hz^{-1} sr^{-1}]) = [22.04, 24.7]) may be impeding the detection of any correlation between radio emission and outflow properties.

The cold molecular gas kinematics of type-2 quasars as seen by ALMA

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Abstract: In this contribution I will present the first CO(2-1) and adjacent continuum observations of a sample of seven nearby radio-quiet type-2 quasars (QSO2s) obtained with ALMA at ~0.2" resolution (370 pc at z ~ 0.1). Our CO kinematic analysis reveals that the QSO2s with higher Eddington ratios, which are hosted in spiral galaxies, have more massive and extended molecular outflows than the QSO2s in merging galaxies. Moreover, the ionized gas outflows in the spirals are almost coplanar with the CO disks (i.e., more favorable orientation for entraining the molecular gas), whereas those in the merging QSO2s subtend a relatively large angle. This could be contributing to drive more massive and extended molecular outflows in the spirals. These molecular outflows might be responsible for the smaller molecular gas concentrations measured in the central kpc (5-12% of the total gas mass), in comparison with the merging systems (18-25%). The radii ($r \leq 1$ kpc) and dynamical timescales of the outflows (~1-11 Myr) are consistent with them being driven by the current AGN episode. These outflows represent 0.2-0.7% of the QSO2s' total molecular gas mass and have maximum velocities of 200-350 km/s and outflow rates of 8-16 Msun/yr. These outflow properties are intermediate between those of the mild molecular outflows measured for Seyfert galaxies and the fast and energetic outflows shown by ULIRGs. This suggests that it is not only AGN luminosity that drives massive molecular outflows. Other factors such as jet power, coupling between winds, jets, and/or ionized outflows and the CO disks, and amount or geometry of dense gas in the nuclear regions might also be relevant. Observations of quasar-driven molecular outflows are important because the constraints on mass-loss rates provided by observations of small ULIRG-dominated samples are biasing AGN feedback models towards extreme energetics that are not representative of the general AGN population.

The impact of AGN on the molecular gas reservoir of their host galaxies at Cosmic Noon

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Abstract: AGN feedback is thought to be key in shaping the life-cycle of host galaxies by injecting a significant amount of energy into the interstellar medium and potentially being able to suppress or inhibit future star formation through mechanisms such as outflows. This process is expected to be maximized at z~2, the peak of supermassive black hole and galaxy assembly. Measuring the gas content out of which stars form is essential to understand the impact of AGN on star formation. So far, studies of AGN hosts at cosmic noon have been limited to inhomogeneous samples or bright objects. In this talk, I will present the first systematic study of the molecular gas content of AGN hosts at z~2 for a representative and sizeable sample of targets using ALMA observations of carbon monoxide (CO) emission. When comparing the CO properties of AGN with a matched sample of non-AGN galaxies, we found indications that AGN feature lower CO luminosities, at given stellar masses and star-formation rates. I will explore the physical processes driving this finding with a particular focus on the role of ionized outflows in regulating the gas content in AGN, as traced by spatially-resolved VLT/SINFONI observations of the [OIII] line.

Session 5 : AGN evolution and black hole growth as a tracer of galaxy evolution

The JWST/NIRSpec Galaxy Assembly Survey: environment and spatially resolved outflows in two AGN at z~3.5

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Abstract: In this talk I will present the IFS observations of two AGN at z ~ 3.5 observed with the NIRSpec instrument on board of the JWST, as part of the GTO programme ''The physics of galaxy assembly: IFS observations of high-z galaxies''. The IFS observations of the Compton thick AGN GS00133 allow us to explore the connection between unresolved rest-frame UV winds (traced by narrow absorption lines) and a spatially extended outflow traced by rest-frame optical lines (e.g. [OIII]5007). The second source is LBQS 0302-0019, a type 1 QSO associated with a complex environment consisting of multiple small companions (Jil1-to-4, Husemann+2021; Jil5-to-7, Perna+in prep.); NIRSpec data trace all prominent rest-frame optical lines associated with this system, and reveal kinematic structures in the QSO host galaxy, and within projected distances of 10 kpc from the QSO.

The seeds of the first supermassive black holes

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Abstract: Supermassive black holes of 10^10 solar masses already existed at z~6-7, when the Universe was less than 1 Gyr old. To reach this mass in such a short time they should have started as seed intermediate-mass black holes (IMBHs) of 100-10^6 solar masses at z > 8.

I will show that a population of actively accreting IMBHs (i.e. low-mass AGN) exists in local dwarf galaxies and that they can be detected out to z~3 with the use of deep multiwavelength surveys. Whether these are the relics of those early seed IMBHs that did not become supermassive is still a matter of debate, since processes such as AGN feedback could significantly impact black hole growth in dwarf galaxies. The next generation of observational facilities will open a new window by detecting seed IMBHs at birth.

AGN triggering: the “twin galaxies” approach and the CAVITY survey project

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Abstract: Unveiling the mechanisms that trigger active galactic nuclei (AGN) is crucial for our understanding of the galaxy formation and evolution. While mergers are often associated with the triggering of powerful AGN, less luminous AGN would be driven by secular processes.

During my PhD, taking advantage of the CALIFA survey, we built a sample of pairs of galaxies differing only in nuclear activity (twin galaxies) and performed one to one comparisons. In this contribution, we present a comparison of the spin parameter (λR), measured in a region dominated by the galaxy disc (del Moral-Castro et. al 2020). This parameter allows us to assess the rotational support of a galaxy. We find that active galaxies show higher values of λR than their corresponding non-active twin(s), indicating larger rotational support in the discs of the AGN. Furthermore, we will also present our most recent results (del Moral-Castro, et.al prep) on the stellar content of the sample. For this, we recover the star formation history (SFH) of our galaxies finding that active galaxies have a different chemical enrichment history.

The idea that every massive galaxy goes through a few short active phases during its life is becoming popular. In this scenario, we should not expect to find large-scale differences between the twins either in dynamics or stellar population properties over longer-timescales than the current AGN episode. Different active phases in both the active and non-active twins should dilute them. However, the results presented here indicate that some galaxies are more likely to go through active phases than others, at least in the redshift ($0.005 < z < 0.03$) and mass ranges ($10^{10} < M^* < 10^{11}$ Mo) considered.

Finally, I will also present to the AGN community the on-going CAVITY survey. The first statistical study of galaxies in voids, the least dense areas of the Universe. The void galaxies might have gone through a different dark halo mass assembly than galaxies in denser environments, suggesting an influence of the void large-scale environment on the black-hole growth. Using this sample, we will analyse the possible influence of the large-scale environment on the AGN triggering.

AGN and quasar science with the J-PAS narrow-band photometric survey

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Abstract:
The J-PAS survey started observing thousands of square degrees of the Northern Sky with its unique set of 56 narrow band filters covering the entire optical wavelength range, providing, effectively, a low resolution spectra for every object detected. Active galaxies and quasars, thanks to their strong emission lines, can be easily identified and characterized with J-PAS data. A variety of studies can be performed, from IFU-like analysis of local AGN, to clustering of high-z quasars. I will present preliminary results based on the miniJPAS proof-of-concept dataset, focusing in particular on a new method for the determination of BH masses using single-epoch narrow-band photometry.

GOGREEN reveals the minor role of the environment in AGN activity

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Abstract: We investigate the effect of the environment over the AGN population in the sample of clusters from the GOGREEN and GCLASS surveys (0.8<z<1.5). We select AGN candidates following three different selection methods: (i) the presence of the [NeV] line in emission, (ii) the TBT diagram adapted to observed wavelengths (TBT-mod), and (iii) a MIR colour selection method. We define the fraction of AGN in two ways: relative to the total number of galaxies and relative to the star-forming population. We find that, after matching the stellar-mass and redshift distributions of both cluster and field environments, there is a marginal drop of the number of AGN in the cluster core. We interpret that the effect of the cluster environment in the AGN activity at z~1.2 is minor compared to internal processes and, if any, it goes in the direction of suppressing the AGN.

AGN incidence in massive clusters across cosmic time: Simulations vs. Observations

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Abstract: An increasing body of evidence suggests an intimate relation between galaxy evolution and the growth of the super-massive black hole hosted at their centers. Constraints on the conditions and environments that promote accretion events onto super-massive black holes can help to improve theories of galaxy formation. In this contribution I will present new results on the role of small-scale environment ($\lesssim$1Mpc) in the activation of super-massive black holes. We developed a flexible data-driven model under the zero order assumption that the incidence of AGN in galaxies is independent of the environment. Using a forward-modeling approach, I will compare the predictions of the semi-empirical model with observational results on the fraction and radial distribution of X-ray selected AGN in massive clusters of galaxies out to redshift z$\sim$1.5. These results will be discussed in the context of physical mechanisms that operate in dense environments and modulate the triggering of accretion events onto the super-massive black holes of galaxies. Evidence for variations of the incidence of AGN in galaxy clusters as a function of redshift will also be presented and discussed.

Using narrow UV emission-line components to derive gas-phase chemical abundances in AGN

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Abstract: The advent of deeper and deeper surveys using diverse large ground-based and space telescopes has largely incremented the number of emission-line objects at very high redshifts. This implies that rest-frame ultraviolet lines are commonly detected and measured in many of these surveys, even if these are focused on optical and near-IR regimes. Emission-lines are fundamental to derive physical properties and chemical abundances in these objects but, unfortunately, the UV lines are not properly characterized in the local Universe to provide accurate calibrations of their relative fluxes with the corresponding gas-phase chemical abundances, neither for star-forming nor for AGN. This knowledge could thus in principle be used to characterize the observed galaxies at very high z.

In this contribution I will present an adapted version of the bayesian-like code HII-CHI-mistry to derive total oxygen abundance, carbon-to-oxygen abundance ratio and ionization parameter in large samples of objects in a consistent way using as input the most prominent emission-lines detected in the rest-frame UV from Lya 1216å up to CIII] 1909 å. I will discuss how diverse assumptions on the used grids of photoionization models affect the results, and its application for several surveys using these lines such as VUDS and VANDELS both for star-forming and narrow-line regions in AGN, along with the comparison with similar samples of objects analyzed in the rest-frame optical range.

The chemical content of the NLR as estimated from IR emission lines in AGNs

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Abstract: Future and on-going infrared and radio observatories such as JWST, METIS or ALMA will increase the amount of rest-frame IR spectroscopic data for galaxies by several orders of magnitude. While studies of the chemical composition of the ISM based on optical observations have been widely spread over decades for SFGs and, more recently, for AGNs, similar studies need to be performed using IR data. This regime can be especially useful in the case of AGNs given that it is less affected by temperature and dust extinction, traces higher ionic species and can also provide robust estimations of the chemical abundance ratio N/O. We present a new tool based on a bayesian-like methodology to estimate chemical abundances from IR emission lines in AGNs. The estimations of the chemical abundances based on IR lines in our sample of AGNs are later compared with the corresponding abundances derived from the optical emission lines in the same objects. HII-CHI-Mistry-IR takes advantage of photoionization models, characterized by the chemical abundance ratios O/H and N/O and the ionization parameter U, to compare their predicted emission-line fluxes with a set of observed values. Instead of matching single emission lines, the code uses some specific emission-line ratios sensitive to the above free parameters. We report mainly solar and also subsolar abundances for O/H in the nuclear region for our sample of AGNs, whereas N/O clusters around solar values. We find a discrepancy between the chemical abundances derived from IR and optical emission lines, being the latter higher than the former. This discrepancy is independent from the gas density or the incident radiation field to the gas. These results are also found when analyzing other samples of AGNs with IR spectroscopic observations.

POSTERS

From XMM-Newton to the future large multi-wavelength missions

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Abstract: We will present the XMM2ATHENA project, an European Commission funded project with participation of nine research institutes across Europe. XMM2ATHENA is aimed to develop and test new methods and software to allow the community to follow the X-ray transient sky in quasi-real time, identify multiwavelength/messenger counterparts of the sources detected with XMM-Newton and determine their nature using advanced machine learning methods, and probe the faintest sources by using innovative stacking and detection algorithms. The Galaxies and AGN group at the Instituto de Física de Cantabria (IFCA, CSIC-UC, Santander, Spain) participates in most of the ten work packages, and leads two of them: Spectra and Communication.

Near-UV and Optical spectroscopic analysis of low redshift powerfull jetted quasars

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Abstract: There is a long-standing open debate involving the possibility of a real physical dichotomy between radio-loud (RL) and radio-quiet (RQ) quasars. Here we present new optical and near-UV simultaneous spectra of 11 extremely powerful jetted quasars with radio to optical ratio > 1000. We aim to quantify broad emission line differences between RQ and RL quasars by using the 4D eigenvector 1 (4DE1) parameter space and its main sequence (MS), and to check the effect of powerful radio ejection on the broad emission line region. The Hβ and MgIIλ2800Å emission lines were measured by using non-linear multicomponent fittings as well as by analysing the full broad profiles. We found for our RL sample that broad emission lines show large redward asymmetry both in Hβ and MgII, with the Hβ FWHM being systematically greater than MgII by about 10%. The location of our RL sources in a UV plane defined by the MgII FWHM and an FeIIUV prominence parameter looks similar to the optical one, with weak FeIIUV emission and broad MgIIλ2800Å. Compared to RQ, our RL quasars show larger median Hβ FWHM, weaker FeII emission, larger black hole masses, lower Eddington ratio, and a restricted domain space occupation in the optical and UV MS planes. The differences are more elusive when the comparison is carried out by restricting the RQ population to the region of the MS occupied by RL sources, albeit an unbiased comparison matching in Black Hole Mass and Eddington ratio suggests that the most powerful RL quasars show the highest redward asymmetries in Hβ.

NGC 6552 seen with Webb's Mid-Infrared Instrument

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Abstract: During the commissioning of the James Webb Space Telescope (JWST), the Mid-Infrared Instrument (MIRI) observed NGC 6552 with the MIRI Imager and the Medium-Resolution Spectrograph (MRS). NGC~6552 is an active galactic nucleus (AGN) at 120 Mpc, classified as a Seyfert 2 nucleus in the optical, and Compton-thick AGN in X-rays. We obtained the nuclear, circumnuclear, and central mid-IR spectra of NGC 6552. They provide the first clear observational evidence for a nuclear outflow in NGC~6552. The outflow contributes to 68% of the total emission line flux, showing an average blue-shifted peak velocity of -126+/-44 km/s and an outflow maximal velocity of 689+/-37 km/s. Nine pure rotational molecular Hydrogen lines are detected and spectrally resolved, and exhibit symmetric Gaussian profiles, consistent with the galactic rotation, and with no evidence of outflowing molecular Hydrogen. We detect a warm Hydrogen mass of 1.7x10^7 Msun in the central region (1.8 kpc in diameter) of the galaxy, with almost 20% of that mass in the circumnuclear region. Line ratios confirm that NGC6552 has a Seyfert nucleus with a black hole mass estimated in the range of 0.8 to 8 million solar masses. Even though these observations were not optimized for scientific studies, this work demonstrates the performance and power of the MIRI instrument to study the physical conditions and kinematics of the interstellar medium around the dusty nuclear regions of nearby active galaxies.

Connecting the circumnuclear ionising cluster with their active galactic nuclei: NGC 7469

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Abstract: The nearby galaxy NGC7469 is an ideal candidate to study the connection between circumnuclear star formation and nuclear activity of galaxies. It is one of the luminous infrared galaxy first listed by Seyfert (1943) and the variability of its emission-line spectrum and the nucleus envelope physical conditions has been studied through the years (Pronik, I. I.1975, Alla I. Shapovalova 2017). Its nucleus is surrounded by (i) an inner circumnuclear star-forming ring (~830 pc radius) accompanied by a nuclear gas bar (Laine et al. 2002, Davies) and extended circumnuclear outflows (A. C. Robleto-Orús 2021); and (ii) an outer circumnuclear ring (~1.6 kpc radius) with a large-scale stellar NIR bar (Knapen et al. 2000). In this work we have studied the individual ionising clusters of their circumnuclear star forming rings using MUSE integral field spectroscopy data. The physical properties of the gas, chemical abundances, ionising cluster properties and their evolutionary stage have been characterised trying to establish a connection with the kinematics and the nuclear activity of the galaxy.