AGN13 - ABSTRACT BOOKLET

SESSIONS:

GRAVITATIONAL WAVES

➢ **Speaker: *Monica Colpi* (INVITED)**

Affiliation: *Dipartimento di Fisica, Università degli Studi di Milano Bicocca*

Title: *Coalescing black holes in the cosmic landscape*

Abstract: The majestic discovery of the first source of high frequency gravitational waves, GW150914, and of four companion sources by the LIGO and Virgo Collaboration herald the birth of a new era of exploration of the Universe. In this context, I review on our current understanding on the formation of stellar black holes, and their impact on fondamental physics. I then move into the low frequency gravitational wave domain and describe the prospective sources for LISA, the space mission that will uncover for the first time massive coalescing binary black holes. LISA will tell us about the formation of massive black holes from seeds and how they later evolve in concordance with the assembly of galactic structures. There is a close link between the high and low frequency gravitational wave universe that I will describe in my closing remarks.

➢ **Speaker: *Marco Chiaberge***

Affiliation: *Space Telescope Science Institute and Johns Hopkins University*

Title: *AGN outflows in the emission-line region of the gravitational wave recoiling black hole candidate 3C 186*

Abstract: 3C 186 is a powerful radio-loud QSO at z~1. Recently we found that its spectrum shows evidence for significant velocity offsets between the broad and narrow emission line systems. This, as well as the presence of a spatial offset between the QSO and the center of its host galaxy, led us to propose this object as one of the rare examples of gravitational wave recoiling black hole candidates known so far. I will present new results from our Keck/OSIRIS IFU observations. The goal of the observations is to study both the morphology and the kinematics of the [OIII]5007 emission line region of the quasar. The results show that i) the spatial structure of the NLR is complex and we find evidence for AGN feedback; ii) we detect both the narrow and the broad components of the Hbeta line. The narrow component generally follows the kinematics of the [OIII] line, while it is likely that the broad component is significantly blue-shifted. The results are in agreement with the interpretation of the QSO as a GW recoiling black hole. The observed outflows are most likely the effect of radiation pressure on the (photoionized) gas in the interstellar medium of the host galaxy.

THE NON THERMAL WORLD: MULTI-MESSENGER AND JETS

- **Speaker: *Roberto Aloisio* (INVITED)**

Affiliation: *Gran Sasso Science Institute*

Title: *Ultra High Energy Cosmic Rays and the Highest Energies Universe*

Abstract: We review the physics of the highest energy cosmic rays, i.e. those astrophysical particles with energies larger than 100 PeV, the so-called Ultra High Energy Cosmic Rays (UHECR). We will review the main experimental evidences connected to UHECR and discuss the details of propagation of these high energy particles, their interaction with astrophysical photon backgrounds and the production of secondary cosmogenic particles associated to their transport. The discovery of UHECR sources, still unknown, will reveal the most energetic astrophysical objects in the universe. We will examine different models of acceleration, reviewing the principal astrophysical objects that could energise cosmic rays until the highest energies.

- **Speaker: *Fabrizio Tavecchio* (INVITED)**

Affiliation: *INAF – Osservatorio Astronomico di Brera*

Title: *High-energy neutrinos from blazars*

Abstract: The origin of the astrophysical neutrino signal detected by IceCube is still mysterious. Several extragalactic sources have been proposed as possible accelerators of the high energy protons (or nuclei) whose interaction with gas or radiation is expected to trigger the neutrino emission. The detection of the well reconstructed event IC-170922A on September 2017, potentially associated with the BL Lac TXS 0506+056 is drastically changing the scenario. I will discuss the interpretation of this event in the framework of the blazar models and the consequences for our knowledge of the jet physics.

- **Speaker: *Ranieri Baldi***

Affiliation: *University of Southampton*

Title: *LeMMINGS: the eMERLIN radio legacy survey of nearby galaxies*

Abstract: I will present the first data release of high-resolution 1.5-GHz radio observations of 103 nearby galaxies with the eMERLIN array, part of the LeMMINGs survey. The sample consists of active and non-active galaxies, taken from the Palomar sample. The radio images reveal a broad variety of morphologies: one/two-sided jets, double-lobed jets, complex structures and star formation regions on a typical scale of ~100 pc, down to a radio luminosity of 10^{32} erg/s. The most important result is the detection of pc-scale jetted structures associated with black hole masses down to 10^{6} solar mass. By dividing the sample into optical classes, LINERs show more core-brightened radio morphologies and appear to be the scaled-down version of FRI radio galaxies; Seyferts show less collimated jets than LINERs; HII galaxies and Absorption-line galaxies are a mixed population of weakly active and silent black holes. In addition, I also find that that jetted radio sources follow the optical fundamental plane of black hole activity, suggesting a common disc-jet relationship.

- **Speaker: *Barbara Balmaverde***

Affiliation: *INAF – Osservatorio Astronomico di Brera*

Title: *The MURALES project: a MUse RAdio Loud Emission lines Snapshot*

Abstract: We report the first results of the MURALES survey, a complete program of MUSE observations of nearby (z<0.3) 3C radio galaxies. The MUSE data can be combined with the unique multiband dataset available for these sources, produced with all major observing facilities at all accessible wavelengths, adding a key ingredient for our understanding of the radio-loud AGN phenomenon. It is now possible to explore the gas kinematics, its relationship with the relativistic outflows, and unveil jet-triggered star forming regions, enabling us to explore quantitatively the feedback process. We already fully modelled the MUSE data obtained for the first 20 (out of 40) sources. The line emission images of unprecedented depth revealed the widespread presence of filamentary structures extending

several tens of kpc, preferentially oriented perpendicularly to the radio jets, likely the remnants of the gas rich mergers which triggered the AGN. We also found a dual AGN associated to 3C459, formed by a radio-loud AGN and a Seyfert 2, separated by 4 kpc.

- **Speaker:** ***Gabriele Bruni***

Affiliation: *INAF - Istituto di Astrofisica e Planetologia Spaziali, Roma*

Title: ***Probing restarting activity in soft gamma-ray selected giant radio galaxies***

Abstract: Cross-correlating the INTEGRAL/IBIS - Swift/BAT AGN population with radio catalogs (NVSS, FIRST, SUMSS), we found that 25% of extended radio sources are Giant Radio Galaxes (GRG), i.e. the largest individual objects in the Universe. This fraction is four time more abundant than what found in previous studies. In 2014, we observed a pilot sample of these soft-gamma ray selected GRG at low radio frequencies with the GMRT, with the aim of studying the morphological and spectral properties of these objects. Thanks to these data, we discovered the second X-shaped GRG to date, and a previously unidentified radio galaxy. Another object, observed both at kpc and pc scales (VLBI), showed an extreme jet re-orientation (about 90 degrees). Moreover, the majority of these objects show signs of restarting activity from previous observations in the literature. Given these intriguing premises, we embarked on a radio observing campaign, using both single dish (Effelsberg) and interferometers (VLBA), to probe the lifecycle of these soft gamma-ray selected GRG. The results of this campaign will be presented, that potentially shed light on the origin and evolution of the radio phase for this extreme class of objects (and radio-loud AGN in general), and the connection with high-energy emission. The X-ray properties, and in particular the correlation between the X-ray luminosity of the AGN and the radio luminosity of both the core and the lobes, will be discussed as well.

- **Speaker:** ***Luca Foffano***

Affiliation: *Università degli Studi di Padova*

Title: ***Hunting for extreme blazars in the TeV band***

Abstract: Blazars are a particular class of active galactic nuclei with their relativistic jets pointing close to the line of sight of the observer. Their spectral energy distributions are dominated by non-thermal emission from the jet, consisting of two main bumps. For the so-called extreme blazars, these components each peak in the X-ray and GeV-TeV bands. Recent observations have revealed that in a few of these objects, the energy of the second peak exceeds several TeV (e.g. 1ES 0229+200). These intriguing objects have been suggested as sources of hadronic gamma-ray emission as well as high-energy neutrinos. Their hard TeV spectra are also valuable for indirectly probing the extragalactic background light and the intergalactic magnetic field. In this contribution, we present the results of our observing campaign on ten promising targets performed in very-high-energy gamma rays with the MAGIC telescopes. Modelling of their broadband spectra is also discussed. Furthermore, we propose new targets for current and future TeV gamma-ray telescopes, selected on the basis of hard X-ray and GeV gamma-ray emission.

- **Speaker:** ***Luigi Foschini***

Affiliation: *INAF – Osservatorio Astronomico di Brera*

Title: ***Jetted Active Galactic Nuclei***

Abstract: The term "blazar" refers to a cosmic source with a relativistic jet viewed at a small angle, so that the electromagnetic emission is affected by beaming. Historically, blazars are divided into flat-spectrum radio quasars (FSRQs) and BL Lac Objects (BL Lacs). However, the recent discovery that also Seyfert galaxies (particularly Narrow-Line Seyfert 1 Galaxies, NLS1s) could host powerful relativistic jets, has set some problem of classification of jetted active galactic nuclei (AGN). I would like to review these problems and to advance one possible solution.

- **Speaker:** ***Marco Landoni***

Affiliation: *INAF – Osservatorio Astronomico di Brera*

Title: ***The Cherenkov Telescope Array view of some peculiar AGN classes***

Abstract: Active Galactic Nuclei (AGNs) are one of the most studied classes of objects at energies above tens of GeV with current Cherenkov Telescopes and will be a major topic for the upcoming Cherenkov Telescope Array (CTA), the next-generation ground-based gamma-ray observatory. The CTA full array, distributed over two sites, one in the northern and one in the southern hemisphere, will provide whole-sky coverage and will improve the sensitivity with respect to the current Imaging Air Cherenkov Telescope (IACTs) by a factor of five to twenty, depending on the energy. In particular, we focus our studies on three main classes: extreme BL Lacs as the possible source of Ultra-High Energy Cosmics Rays (UHECR) beams and probes of exotic physics, Narrow Line Seyfert 1 (NLS1) and AGN-driven winds as sources of very-high energies (above tens of GeV) gamma rays. In all cases we discuss the scientific relevance and we show dedicated simulations to assess the feasibility of these observations with CTA.

- **Speaker:** ***Rocco Lico***

Affiliation: *Max Planck Institute for Radio Astronomy*

Title: ***Radio and GeV-TeV gamma-ray emission connection in the different blazar sub-classes***

Abstract: The Fermi-LAT revealed that blazars dominate the census of the gamma-ray sky, and a significant correlation was found between radio and gamma-ray emission in the 0.1-100 GeV energy range. However, the possible connection between radio and very high energy (VHE, E>0.1 TeV) emission still remains elusive, owing to the lack of a homogeneous VHE sky coverage. With this work we aim to quantify and assess the significance of a possible connection between the radio emission on parsec scale measured by the very long baseline interferometry and GeV-TeV gamma-ray emission in blazars, which is a central issue for understanding the blazar physics. We use two large and unbiased AGN samples extracted from the 1FHL and 2FHL catalogs, and for comparison, we perform the same analysis by using the 3FGL 0.1-300 GeV gamma-ray energy flux. Overall, the radio and gamma-ray emission above 10 GeV turns out to be uncorrelated for all the blazar sub-classes with the exception of high synchrotron peaked objects. Conversely, when 0.1-300 GeV gamma-ray energies are considered, a strong and significant correlation is found for all of the blazar sub-classes. We interpret these results within the context of the blazar spectral energy distribution properties.

- **Speaker:** ***Duccio Macconi***

Affiliation: *DIFA - Università di Bologna; INAF - Osservatorio di Astrofisica e Scienza dello Spazio di Bologna*

Title: ***Large-scale radio morphology and nuclear accretion in FRII-low-excitation radio galaxies***

Abstract: Radio galaxies (RGs) are among the most energetic manifestation of the AGN phenomenon and, as such, are extraordinarily relevant to address important unknowns relating accretion and ejection, and to investigate the role of the surrounding environment in shaping the radio morphology. The best candidates for this pioneering study are the RGs classified as FRII-LERGs, since they show both a radio morphology typical of powerful RGs (expected to have a standard accretion disc) and have an inefficient engine, as suggested by their optical spectra. In this work we study the X-ray properties of all the FRII-LERGs of the 3CR sample at z<0.3 testing three possible scenarios: (i) FRII-LERGs are recently switched-off high-excitation RGs (HERGs) with efficient accretion disc; (ii) FRII-LERGs are strongly absorbed HERGs; (iii) FRII-LERGs are inefficient accretors and their large-scale radio emission is mainly determined by the environment. These results will be further supplemented by multi-wavelength observations, with particular attention to the radio band.

- **Speaker:** ***Manuela Magliocchetti***

Affiliation: *INAF - Istituto di Astrofisica e Planetologia Spaziali, Roma*

Title: ***Hosts and environments of radio-active AGN***

Abstract: We investigate the environmental properties of radio-active AGN in a two-folded way. On the one hand we analyse the clustering properties of radio-selected AGN from the VLA-COSMOS survey, finding that they inhabit group-to-cluster like structures with halo masses M>~10^13.6 Msun, independent of both redshift and radio luminosity, at least up to z~2.5-3. Moreover, comparisons between the observed space density of radio-selected AGN and that of dark matter halos indicates that the radio-active phase should be a recurrent phenomenon. As a second step, we investigate the occurrence of radio-selected AGN within cosmological environments such as filaments, clusters or the field up to z~1.2. In agreement with previous results obtained in the local universe, we find that ~20% of radio-selected AGN reside in clusters. We also observe a marked preference for more radio-luminous AGN to be found in over-dense structures with respect to fainter sources (~38% vs ~15%), as we find a strong dependence of the environmental properties of radio-active AGN on the stellar mass of their hosts. Our results suggests a scenario whereby physical processes at sub-pc and Kpc scales are strongly interconnected with the large-scale structure properties of the AGN itself

- **Speaker:** ***Francesca Panessa***

Affiliation: *INAF - Istituto di Astrofisica e Planetologia Spaziali, Roma*

Title: ***Disc-jet coupling in AGN***

Abstract: A rich phenomenology of jets, winds, and accretion states has been observed in both active galactic nuclei (AGN) and X-ray binaries (XRBs), suggesting a connection between the accretion and ejection flows at different black hole masses, from supermassive down to stellar mass. The X-ray emission, associated with the accretion flow, is strongly coupled with the radio emission, associated with a jet. Strong correlations between the radio and the X-ray luminosities are found in XRBs, as well as in radio-loud and radio-quiet AGN. I will review observational evidences in favour of the disc-jet coupling at different luminosities and accretion rate scales in AGN and compare this phenomenology with XRBs. The co-existence of jets and winds in AGN will be also discussed in comparison with XRBs. The results will be discussed within the current accretion-ejection physical scenarios.

- **Speaker:** ***Chiara Righi***

Affiliation: *Università Insubria; INAF - Osservatorio Astronomico di Brera*

Title: ***Blazars as neutrinos factories***

Abstract: The recent detection of gravitational waves together with the discovery, few years ago, of an extraterrestrial component of high-energy neutrinos, inaugurate the era of multi-messenger astrophysics. The relativistic effects owing to the beaming of the jet, that is pointing at us, make blazars the most energetic, persistent particle accelerators of the Universe. Recent observations show the evidence for a possible positional correlation between the neutrino directions detected by IceCube and the position of a flaring BL Lac object (the case of TXS0506+056). Based on a simple theoretically-motivated framework, we postulated a direct proportionality between high-energy gamma-ray and neutrino fluxes from BL Lac objects. The non-detection of high-energy neutrinos associated to Mkn421, and more in general to the most brightest gamma-ray BL Lacs, leads us to investigate on the photons target density involved in the neutrino production. We discuss a scenario that explains the neutrino emission from TXS disfavouring the brightest gamma-ray sources.

CENTRAL ENGINE AND CIRCUM-NUCLEAR REGIONS

- **Speaker: *Stefano Bianchi* (INVITED)**

Affiliation: *Università degli Studi Roma Tre*

Title: *The physics of ionized gas in AGN: testing predictions from first principles*

Abstract: The presence of ionized gas in Active Galactic Nuclei is revealed by the observed emission lines, which imply a wide range of ionization states, densities, geometries and kinematics. Dense, fast gas occurs on sub-pc scales (Broad Line Region), while slow tenuous gas appears at scales from pc to kpc (Narrow Line Region). Despite this varied phenomenology, very clear predictions can be derived from first principles, and directly compared to the observations.

- **Speaker: *Giorgio Calderone* (INVITED)**

Affiliation: *INAF - Osservatorio Astronomico di Trieste*

Title: *Weighting a beast: how to measure the mass of an accreting Super Massive Black Hole?*

Abstract: An accreting super massive black hole lurks at the center of AGNs and QSOs. Measuring its mass is not trivial due to the very small size of the sphere of influence, and the high luminosity of the AGN itself when compared to the stars in the host galaxy. I will review the currently available methods to measure the black hole mass of Type 1 AGNs (reverberation mapping, virial methods, empirical relations, accretion disk fitting), and compare their results and reliability.

- **Speaker: *Susanna Bisogni***

Affiliation**:** *Università degli Studi di Firenze; INAF - Osservatorio Astrofisico di Arcetri; Harvard-Smithsonian CfA*

Title: *Orientation effects on quasars SED: the torus IR emission*

Abstract: We performed a spectroscopic analysis of a SDSS DR7 sample of >12000 quasars as a function of their orientation with respect to the line of sight, as indicated by the equivalent width (EW) of the [OIII] line. This confirmed the presence of orientation effects in both the narrow and the broad lines, thus providing information on the geometry and kinematics of the Narrow Line Region and the Broad Line Region. We now use the EW[OIII] indicator to shed light on the geometry of the obscuring structure, the torus in the Unified Model. Through an analysis of the photometry available for the same sample, we study the Spectral Energy Distribution (SED) from the UV to the IR as a function of the EW[OIII]. From the IR bands of the SED we confirm that the torus must be clumpy and co-planar with the accretion disk and BLR, as predicted by many theoretical models in the literature.

- **Speaker: *Samuele Campitiello***

Affiliation**:** *Scuola Internazionale Superiore di Studi Avanzati*

Title: *Relativistic accretion disks*

Abstract: The Shakura-Sunyaev model is the mostly adopted description of the thermal emission produced by the accretion disk around a black hole and infers rough estimates of the disk luminosity and the black hole mass. More advanced models have been developed in order to account for general relativistic effects, including the role of the black hole spin. My aim here is to describe and compare two relativistic disk models, KERRBB and SLIMBH, to show: i) their effects on the fitting process of the Spectral Energy Distribution, and ii) the possible usage to shed light on the geometry of the dusty torus surrounding the AGN central engine.

- **Speaker:** ***Alessandra De Rosa***

Affiliation**:** *INAF - Istituto di Astrofisica e Planetologia Spaziali, Roma*

Title: ***Unveiling Multiple AGN activity with multi-wavelength observations***

Abstract: We report on an optical (SDSS) and X-ray (XMM-Newton) study of an optically selected sample of four dual AGN systems at projected separations of 30–60 kpc. Six of eight objects are obscured in X-rays with NH~10^23 cm-2; three of those, whose X-ray spectrum is dominated by a reflection component, are likely Compton-thick. This finding is in agreement with the hypothesis that galaxy encounters are effective in driving gas inflow toward the nuclear region, thus increasing the obscuration. We compare the absorption properties in our dual AGN with those in larger samples observed in X-rays but selected in different ways (optical, IR and hard X-rays). We find that the obscured (NH~10^22 cm-2) AGN fraction within the larger sample is 84\pm4 per cent (accounting for the 90 per cent error on the NH measure) up to large pair separations (100 kpc). i.e. statistically higher with respect to the fraction of obscured AGN in isolated galaxies found in X-ray surveys. The talk will reflect on broader implications of these findings and will present future perspective.

- **Speaker:** ***Riccardo Middei***

Affiliation: *Università degli Studi Roma Tre*

Title: ***Estimating coronal parameters using MoCA***

Abstract: The primary emission in Actve Galactic Nuclei (AGN) is widely believed to be due to Comptonization of the thermal radiation from the accretion disk in a "corona" of hot electrons. The resulting spectra can, in the first approximation, be modelled with a cut-off power law. Taking advantage of MoCA, a Monte Carlo code calculating spectral and polarization properties of the coronal emission, we computed Comptonization spectra for different parameters of the hot corona, comparing them with cut-off power laws. Plots to convert phenomenological parameters (cut-off energy and photon index) into physical ones (temperature and optical depth) will be presented and discussed.

- **Speaker:** ***Fabrizio Nicastro***

Affiliation: *INAF - Osservatorio Astronomico di Roma*

Title: ***When a Seyfert … has a Crash on a model***

Abstract: Back in the late eighties - early nineties, Mkn 590 was ingesting mass at a rate that only NLSy1s do. Consequently, its permitted optical broad emission lines (BELs) were narrow (FWHM~2500 km/s) and its soft X-ray spectrum rather steep. Twenty five or so year later, the source had dramatically slowed down eating (factor of 100) and both its BELs and soft X-ray excess (SXE) had disappeared, which gained Mkn 590 the name of "changing-look AGN". We used more recent UV and X-ray proprietary data, as well as additional historical optical data, to track back the changes of accretion rate and BELR FWHMs from 1990 to date. Here I will show that these changes follow extremely closely the predictions from a zero-free-parameter model that I published in 2000 and that relates the AGN accretion rate to the widths of its BELs, and rule out at high statistical significance alternative models.

- **Speaker:** ***Alessia Tortosa***

Affiliation**:** *INAF - Istituto di Astrofisica e Planetologia Spaziali, Roma*

Title: ***Coronal parameters in Seyfert galaxies: the NuSTAR view and the future IXPE perspectives***

Abstract: I will show the results of the hot corona parameters of active galactic nuclei (AGN) that have been recently measured with *NuSTAR* in collaboration with other X-rays observatories. In the work I will present, we analyzed values taken from the literature of a sample of 19 bright local Seyfert galaxies to look for correlations between coronal parameters, such as the photon index and cut-off energy or the optical depth and temperature, and other parameters of the systems, such as the black hole mass or the Eddington ratio. Moreover I will give some highlights on how the future IXPE mission (Imaging X-ray Polarimetry Explorer) could contribute to understand the AGN coronae geometry.

- **Speaker:** ***Francesco Ursini***

Affiliation: *INAF - Osservatorio di Astrofisica e Scienza dello Spazio di Bologna*

Title: ***The high-energy view of Seyfert galaxies through broad-band monitoring campaign*s**

Abstract: We present results from broad-band (UV to hard X-rays) monitoring campaigns, carried out in recent years, on three different AGNs: a prototypical Seyfert 1 (NGC 4593), a broad-line radio galaxy (3C 382), and a highly accreting Seyfert 1 (HE 1143-1810). In all cases, the campaigns consisted of five joint XMM-Newton/NuSTAR observations, plus VLBA joint observations for 3C 382. The high-energy data are always consistent with a 'two-corona' scenario, in which the UV emission and soft X-ray excess are produced via thermal Comptonization in a warm ($kT \sim 0.5{-}1$ keV), optically thick ($\tau \sim 10{-}20$) corona, while the hard X-ray emission is produced in a hot and compact corona. Moreover, the warm corona is consistent with covering a large fraction of a quasi-passive accretion disc, i.e. that mostly reprocesses the warm corona emission. We discuss the physical implications of this scenario for the accretion flow, such as the presence of strong magnetic fields and the capability of launching outflows and jets.

- **Speaker:** ***Ludovico Varisco***

Affiliation: *Università degli Studi di Milano – Bicocca*

Title: ***How does the host galaxy affect the BH viral mass estimates?***

Abstract: Virial–based methods for estimating active supermassive black hole masses are commonly used on extremely large spectroscopic quasar catalogs. Most spectral analyses, though, do not pay enough attention to the detailed continuum decomposition. To understand how this affects virial mass estimates, I tested the influence of host galaxy light on them by means of a detailed spectral analysis with the new software QSFit.
I will show that taking or not the host galaxy component into consideration influences the emission line fitting. This can significantly affect the viral mass estimates, especially at low redshift, where in fact dimmer quasars and more visible host galaxies are observed.

- **Speaker:** ***Alessandra Zaino***

Affiliation: *Università degli Studi Roma Tre*

Title: ***A deep NuSTAR view of the buried AGN in NGC 1068***

Abstract: The August 2014 NuSTAR observation of the Seyfert 2 galaxy NGC 1068 allowed us to discover a hard X-ray flux excess with respect to observations performed 20 months earlier and 6 months later. This variability was ascribed to an unveiling event during which Compton-thick material moved temporarily out of our line of sight enabling us to unveil the direct nuclear radiation of this buried AGN. In this talk, I will discuss the results of the latest NuSTAR monitoring campaign performed between July 2017 and February 2018 with the aim of searching for flux and spectral variability on shorter time-scales (from one up to six months) and providing some tighter constraints on the number of clouds of the circumnuclear absorbing Compton-thick material, their physical properties and their distance from the illuminating source.

SMBH, HOST GALAXY AND SCALING RELATIONS

- **Speaker: *Alessandro Marconi* (INVITED)**

Affiliation: *Università degli Studi di Firenze*

Title: *The relation between supermassive black holes and their host galaxies*

Abstract: After a brief overview on mass measurements and their uncertainties, I will review the relations between black hole masses and the properties of their host galaxies, focussing on their physical origin and on the implications for the models of black hole and galaxy formation. I will then present the evidences for a redshift evolution of the local relations, discussing the reliability of existing measurements and future prospects.

- **Speaker: *Andrea Merloni* (INVITED)**

Affiliation: *Max-Planck-Institut für extraterrestrische Physik*

Title: *Understanding AGN evolution with large (X-ray) surveys: current constraints and prospects for eROSITA*

Abstract: In the past 50 years, astronomers have used X-ray surveys to tackle fundamental questions for structure formation such as: How did supermassive black holes form and grow in the nuclei of galaxies? Why are their physical properties today so tightly linked to those of their hosts? What was the impact on the surrounding structures of the copious energy release, either in radiative or mechanical form, associated to the growth of such black holes in active galactic nuclei (AGN)? I will show how state of the art observations with multi-wavelength surveys have been used to give at least partial answers to some of these questions, and discuss the current knowledge of the history of black hole accretion. The next generation of wide-area, sensitive X-ray surveys designed to map the hot and energetic Universe will be heralded by eROSITA (extended ROentgen Survey with an Imaging Telescope Array), the core instrument on the Russian-German Spektrum-Roentgen-Gamma (SRG) mission, scheduled for launch in 2019. eROSITA will perform a deep survey of the entire X-ray sky, and will be about 30 times more sensitive than ROSAT in the soft energy band (0.5-2 keV), while in the hard band (2-8 keV) it will provide the first ever true imaging survey of the full sky. eROSITA is expected to yield a sample of around 3 million active galactic nuclei, which is bound to revolutionize our view of the evolution of supermassive black holes and their impact on the process of structure formation in the Universe.

- **Speaker: *Viola Allevato***

Affiliation: *Scuola Normale Superiore di Pisa*

Title: *Probing clustering of X-ray agn using Chandra Cosmos Legacy*

Abstract: The presence of a SMBH in almost all galaxies in the Universe is an accepted paradigm in astronomy. How these BHs form and how they co-evolve with the host galaxy is one of the most intriguing unanswered problems in modern Cosmology and of extreme relevance to understand the issue of galaxy formation. Clustering measurements can powerfully test theoretical model predictions of BH triggering scenarios and put constraints on the typical environment where AGN live in, through the connection with their host dark matter halos. In this presentation I will talk about the clustering properties of X-ray AGN from both an observational and theoretical point of view, using the new catalog of AGN detected by Chandra in COSMOS and semi-empirical models. The Chandra COSMOS-Legacy catalog is the largest available sample of X-ray AGN for clustering studies, allowing clustering measurements as a function of obscuration, luminosity and AGN host galaxy properties.

- **Speaker: *Elena Dalla Bonta`***

Affiliation: *Università degli Studi di Padova*

Title: *Black Hole Masses from Reverberation and Scaling Relationships*

Abstract: Reverberation mapping and scaling relationships based on reverberation results provide the underpinning of all estimates of quasar black hole masses. When applying these scaling relationships, there are potential pitfalls that are widely unappreciated and can result in biases that can, in turn, lead to systematic errors in the black hole mass

function and therefore conclusions about the evolution of black holes over time. I will discuss potential sources of biases and show how they can be mitigated.

- **Speaker:** ***Quirino D'Amato***

Affiliation: *DIFA - Università di Bologna; INAF - Osservatorio di Astrofisica e Scienza dello Spazio di Bologna*

Title: ***On the dust and gas content of high-redshift galaxies hosting obscured AGN in the CDF-S***

Abstract: Submillimeter Galaxies (SMGs) at high redshift are among the best targets to investigate the early evolutionary phases in the lifetime of massive systems, during which large gas reservoirs sustain vigorous star formation and efficiently feed the central, buried Super Massive Black Hole (SMBH), until it enters into luminous Quasar (QSO) phase, quenching the star formation. I will present the analysis of new ALMA band 4 (1.8-2.4 mm) data of six obscured QSOs (log N_H>23) hosted by SMGs at redshift > 2.5 in the 7 Ms Chandra Deep Field South (CDF-S), and I will show their properties in terms of continuum emission and high-J CO transitions. Sizes and masses of the galaxies are measured to estimate whether and to which extent the host ISM may contribute to the nuclear absorption and describe the role of these systems in the galaxy/BH co-evolution scenario. I will also discuss the kinematics and morphology in some of these objects in order to unveil the dynamical structure of the high-z AGN hosts.

- **Speaker:** ***Ivan Delvecchio***

Affiliation: *CEA-Irfu, PMF*

Title: ***SMBH accretion properties of radio-selected AGN out to z=4***

Abstract: Are all radio AGN weakly accreting SMBHs? If not, does their SMBH accretion rate change with radio power and/or cosmic time? The VLA-COSMOS 3 GHz Large Project (PI: Smolcic) provides a uniquely deep and large radio survey to address these questions. I will present a comprehensive analysis of the average SMBH accretion properties of radio-selected AGN in the COSMOS field. The sample was originally selected from radio-continuum observations at 3 GHz to be fully complete in radio luminosity (Lr), and counts ~1300 radio AGN identified via >2σ excess in radio emission relative to the star formation (SF) of the host. We stacked the latest Chandra COSMOS+Legacy images for all radio-excess AGN, as a function of both Lr and redshift, in order to derive the average X-ray luminosity and specific SMBH accretion rate (s-BHAR) in each Lr-z bin. While the average s-BHAR does not show any significant trend with Lr, at any redshift, we do find a significant increase of s-BHAR with redshift, at fixed Lr. This redshift trend nicely resembles the strong redshift increase in the fraction of blue (star-forming) radio AGN hosts, at fixed Lr. A possible interpretation for these results implies a link between the average AGN radiative power, and the availability of cold gas supply within the host. Our study suggests that radio AGN become radiatively-efficient (Eddington ratio > 1%) at z~2, and it corroborates the idea that the high-redshift Universe facilitates radiative AGN activity, regardless of the AGN radio power.

- **Speaker:** ***Federica Duras***

Affiliation: *Università degli Studi Roma Tre*

Title: ***Probing the AGN/galaxy coevolution in the widest dynamical range ever***

Abstract: The existence of a long-lasting link between the central black hole mass and various physical properties of their host spheroids is now a matter of fact. Studying the correlations between the two at different ages is then the best way to rebuild their cosmic evolution. Within this scenario, we have built up two complementary AGN samples able to probe the accreting phases at both a) very high luminosity (>10^{47} erg/s) and BH masses (10^{9-10} Msol), i.e. the WISSH Sample, and b) very low luminosities (~10^{43} erg/s) and BH masses (~10^{5} Msol), i.e. studying sources extracted from the SWIFT/BAT catalog. By performing AGN-dedicated SED-fitting procedures we derived the main physical properties of both the nuclear engine and the host galaxy of these sources, i.e. bolometric luminosities, star formation rates and stellar masses. We will present the accreting and star formation properties of these sources, comparing the two classes of objects. Moreover, we are able to constrain the BH-galaxy scaling relation over three orders of magnitudes in mass and to follow its evolution from z~3 to z~0. I will show that while the more massive galaxies populate the typical region of the already observed M_{BH}-M_{star} relation, the less massive ones are still on their way to reach the M_{BH}-M_{star} locus, especially obscured AGN which seem to be hosted in less massive galaxies compared to

unobscured ones, given the same BH. We will also present a new bolometric correction, separately for AGN2 and AGN1, which spans five orders of luminosity thus allowing to derive more accurate predictions on the accretion history of the AGN and their host galaxies.

- **Speaker:** ***Chiara Feruglio***

Affiliation: *INAF - Osservatorio Astronomico di Trieste*

Title: ***AGN host galaxies scaling relations***

Abstract: I will present IBISCO, a new multi-dimensional study of AGN scaling relations in a complete unbiased sample of local AGN, that we are conducting with IRAM, ALMA and INTEGRAL. For the first time we have included the information on the molecular gas reservoirs into the scaling relations between AGN and host galaxy properties. I will discuss scaling relations for the local sample IBISCO, and for samples from the SUPER survey and from SDSS out to z~2.

- **Speaker:** ***Roberto Gilli***

Affiliation: *INAF - Osservatorio di Astrofisica e Scienza dello Spazio di Bologna*

Title: ***The J1030 deep survey: an INAF legacy field for AGN***

Abstract: I will present the status of on-going, deep multi-band observations in the field around the z=6.31 QSO SDSS J1030+0524. These include a large program with Chandra, deep JVLA observations, and a strategic LBT program for optical spectroscopy, all with INAF PI-ship. Additional imaging and spectroscopic coverage is provided among others by HST, VLT/MUSE, Keck and Spitzer data. The J1030 field is currently the 4th deepest X-ray survey and one of the few deep radio fields observed at ~uJy depth. We are collecting and organizing all multi-band data in a public database that can be effectively exploited by our AGN community. Some examples of early results from these data will be briefly shown, including i) the discovery of a proto-cluster at z=1.7 around a Compton-thick FRII radio-galaxy and ii) the first spectroscopic confirmation of a few companion galaxies at the redshift of SDSS J1030+0524.

- **Speaker:** ***Antonio Pensabene***

Affiliation: *Università degli Studi di Firenze*

Title: ***The ALMA view of the high redshift relation between Supermassive Black Holes and their Host Galaxies***

Abstract: I will present the relation between black hole mass and the dynamical mass of massive galaxies at high z (z~4-6). We have considered a sample of ~15 quasars at high redshift for which we have obtained measurements of the host galaxy kinematics from ALMA observations of molecular or atomic transitions. For the first time, we are able to measure galaxy masses dynamically, by modelling the kinematics of galaxy disks, thus avoiding all the problems and biases from photometric measurements of stellar masses. Up to redshift z~5, the M_{BH}/M_{gal} ratio is consistent with the extrapolation of the relation inferred at z<3. At z>5 we find a steady decrease of the M_{BH}/M_{gal} ratio with increasing redshift, possibly witnessing the phase of fast growth of the BHs compared to the host galaxies. I will discuss how these results fit within the coevolution scenario and highlight the constraints that they pose on models of galaxy evolution.

- **Speaker:** ***Michele Perna***

Affiliation: *INAF - Osservatorio Astrofisico di Arcetri*

Title: ***The molecular gas content in obscured AGN at z>1***

Abstract: The standard QSO-galaxy co-evolutionary scenario predicts a phase of deeply "buried" supermassive black hole growth coexisting with a starburst (SB) before feedback phenomena deplete the cold molecular gas reservoir of the galaxy and an optically luminous QSO is revealed (``SB-QSO evolutionary sequence''). We tested simple SB-QSO paradigm predictions by comparing the molecular (carbon monoxide, CO) gas properties of 56 obscured and 49 unobscured QSO host galaxies at high-redshift (z ~ 1-6) with those of ~ 170 high-z star forming galaxies from the literature. We found that, on average, obscured AGN at z >1 are associated with higher star formation efficiencies (SFEs) and lower gas fractions with respect to normal star forming galaxies and SBs at given stellar mass and redshift.

These results could suggest that their cold gas content has been already depleted by powerful AGN-driven outflows. Moreover, we did not find any clear separation between the properties of unobscured and obscured QSOs (e.g. they have similar SFEs), suggesting a scenario where feedback can rapidly impact the host galaxy evolution.

- **Speaker:** ***Olena Torbaniuk***

Affiliation: *Università degli Studi di Napoli "Federico II"*

Title: ***Dependence of equivalent width of quasar emission lines on UV spectral index, quasar luminosity and BH mass***

Abstract: The spectral energy distribution (SED) of quasars in UV-optical range is characterised by the Big Blue Bump with a pick around 1000-1300 Å, broad emission lines, broad absorption lines (in ~15% of objects) and the flux decrement redward of 1215 Å caused by absorption in the intergalactic medium. Quasar UV-optical SEDs are remarkably similar from one object to another, the main differences are in spectral index α_{λ} and equivalent width of emission lines. Continuum and emission lines are believed to originate from the hot accretion disc and circumnuclear fast moving clumps, correspondingly. The proximity of these regions is considered to be the most promising explanation of the Baldwin effect: the inverse correlation of equivalent width of some emission lines with the monochromatic luminosities at UV region. On the other hand, the physical explanation of the difference in spectral indices and their dependence on quasar parameters are still not clear. We present the analysis of quasar emission lines properties within the wavelength range 1215-1450 \AA and their dependence on quasar luminosity and spectral index. For this purpose a set of composite spectra is compiled from subsamples of SDSS DR7 medium resolution quasar spectra with similar α_{λ} at this wavelength range and similar monochromatic luminosities at 1450\,\AA\ (l_{1450}). We consider the α_{λ} range of $-2.3\ldots-0.7$, the $\log(l_{1450})$ range of $42.2\ldots43.4$, and emission features around Lyα+N V+Si II, O I+Si II, C II and Si IV+O IV. It is found a dependence of the emission line equivalent width on spectral index (correlation or anti correlation) for several lines, mostly for those lines for which the Baldwin effect (the decreasing of equivalent width with increasing of luminosity) was detected. Also we calculated virial mass of the central supermassive black hole for composite spectra and 3535 individual quasar (using the C IV emission line) and explored dependence on quasar luminosity and spectral index. It is found, that quasar luminosity increases with increase of black hole's mass. But on the other hand, virial mass of the black hole doesn't depend on spectral index.

- **Speaker:** ***Paolo Tozzi***

Affiliation: *INAF - Osservatorio Astrofisico di Arcetri*

Title: ***AGN in Brightest Cluster Galaxies***

Abstract: We present a systematic investigation of the nuclear activity in Brighest Cluster Galaxies through cosmic epochs. By combining X-ray, Radio, optical and IR data, we constrain the origin of the feeding gas and the accretion regime, as well as the feedback processes affecting the surrounding Intra Cluster Medium and star formation events in the BCGs. Our final goal is to constrain the cycle of hot and cold baryons in the core of groups and clusters of galaxies.

- **Speaker:** ***Andrea Travascio***

Affiliation: *INAF - Osservatorio Astronomico di Roma, Sapienza Università di Roma, Università di Tor Vergata*

Title: ***Giant Lyman alpha nebulae around the hyper-luminous quasar SDSS-J1538-0855***

U: Giant Lyman alpha nebulae (GLAN) are the largest coherent cosmic structures associated to luminous quasars. They fill the quasar circumgalactic medium and possibly constitutes an important cold gas reservoir playing a role in the feeding and feedback baryonic cycle and bridging the cold gas phase between the intergalactic and the galactic scales. The advent of the VLT/MUSE integral field spectrograph recently allowed an efficient discovery of GLAN around bright quasars at z~3-4. So far only ~15-20 GLAN have been discovered/studied with MUSE. They exhibit luminosities of $\sim10^{43-44}$ erg/s, sizes of hundreds of kpc and a range of morphologies from symmetric to strongly asymmetric/filamentary. The majority of them do not show a coherent kinematic structure and exhibit narrow line profiles (500-700 km/s). Here we report on MUSE observations of SDSS J1538+0855 and SDSS J2238-0808, two of the most luminous z~3-4 broad absorption line quasars in the Universe. We will present their GLAN detections, compare the nebulae properties with those of GLAN reported around known sources and discuss their link to the central active nucleus.

OUTFLOWS AND FEEDBACK PROCESSES

- **Speaker: *Marcella Brusa* (INVITED)**

Affiliation: *DIFA - Università di Bologna; INAF - Osservatorio di Astrofisica e Scienza dello Spazio di Bologna*

Title: *AGN feedback in the form of powerful outflows: an observational perspective*

Abstract: Gas outflowing from the AGN power source is most likely responsible of the complex interplay between the nuclear engine and the host galaxy properties, which is commonly referred to as feedback. Winds propagating at Galactic scales represent a crucial diagnostic of AGN feedback. Both numerical simulations and observations have shown that the nature of outflows in AGN is multiphase, and that each gas phase embeds a fundamental piece of information on the driving mechanism and on the effect on the host galaxy. I will review the progresses obtained in the past 2 years to shed light on the presence of AGN/Quasar winds, on the characterisation of their physical properties, and on the multi-phase and multi-scale nature of such phenomena.

- **Speaker: *Roberto Maiolino* (INVITED)**

Affiliation: *Kavli Institute for Cosmology, University of Cambridge*

Title: *AGN negative and positive feedback: theory and observational evidence*

Abstract: Numerous models and simulations expect that AGN should have a negative feedback effect on star formation in their host galaxy, by generating outflows and by injecting energy into the ISM and in their circugalactic medium. Recent models predict that AGNs may also have a positive feedback effect by enhancing star formation in some regions of their host galaxies. I will quickly review these models and then mostly focus on the observational evidence (or lack thereof) of such feedback effects, through different observational diagnostics, in different classes of AGNs, both locally and in the early universe.

- **Speaker: *Manuela Bischetti***

Affiliation: *INAF - Osservatorio Astronomico di Roma; Università degli Studi di Roma Tor Vergata*

Title: *[CII] outflows in z=6 QSOs are there: investigating AGN feedback and host galaxy properties in luminous high-redshift QSOs*

Abstract: I will present evidence of AGN-driven outflows in the early Universe, resulting from the stacking analysis of a sample of 48 QSOs at z~5-7 with ALMA [CII] detection. Very broad [CII] wings are on average present, and extend beyond velocities of 1000 km/s. The luminosity associated with the broad [CII] wings correlates with the AGN luminosity, while it remains unchanged in low-high SFR sources. This indicates the AGN as the main driving mechanism of the observed cold [CII] outflows in distant QSOs, with associated atomic mass outflow rates of 200-350 Msun/yr. I will discuss how these outflows relate to those observed in lower-z AGNs and give an estimate of their spatial extent. Thanks to sub-millimetre observations with ALMA and NOEMA, we are also able to have an insight onto the host galaxy properties of high-z QSOs, otherwise outshined by the AGN radiation. I will focus on the high-resolution ALMA observation of a hyper luminous QSO at z=4.4, revealing an exceptional overdensity around the QSO with multiple companions as close as 2 kpc. These crowded surroundings, and the QSO host galaxy itself, are forming stars at a very high rate (hundreds of Msun/yr). I will discuss how the BH and stellar masses are growing in this multi-source system, which likely represents the cradle of what would be a giant galaxy at z = 0. Finally, I will discuss how the huge AGN radiation may regulate the SF activity in the host galaxy and suggest that substantial SF at early epochs may have taken place in the companion galaxies.

- **Speaker:** ***Stefano Carniani***

Affiliation: *Scuola Normale Superiore di Pisa*

Title: ***AGN-driven outflows in the early Universe***

Abstract: The origin of the tight correlations observed between the masses of supermassive black holes (SMBHs) and host galaxy properties is still debated. Negative feedback from AGN can provide a viable explanation for these correlations. According to the theoretical models, the ejective feedback resulting from radiatively-efficient episodes of gas accretion onto SMBHs may be the main responsible for the rapid shut-off of star formation and black hole growth in the early stages of the evolution of present-day massive galaxies, which must have taken place at z>2. Here we present near-IR (SINFONI) and millimetre (ALMA) observations of z~2.5 luminous (Lbol>1e47 Lsun) quasars showing fast and extended ionised outflows. These AGN-driven outflows appear to be able to expel a large fraction of molecular and ionised gas and suppress star formation in the outflow region. However, the detection of Halpha emission along the edges of the outflow cone indicates on-going star formation rates of at least 50 Msun/yr, suggesting either that AGN feedback does not affect the whole galaxy or that many feedback episodes are required before star formation is completely quenched. On the other hand, the detection also lead to a positive feedback interpretation: the AGN-driven outflow compress the surrounding gas inducing star formation. Our results highlight the possible double role of galaxy-wide outflows in host galaxy evolution. This is also supported by recent observations in the local Universe indicate that massive galactic outflows may ignite star formation within the outflow itself. We also present new ALMA observations of a sample of quasars at z~6 optimised to investigate the extended emission associated with outflows as traced by the [CII]158μm line. Although strong and powerful AGN-driven outflows are expected at these redshifts, our analysis suggests that such outflows may not be as effective as expected in removing gas out of their host galaxies.

- **Speaker:** ***Alice Concas***

Affiliation: *Excellence Cluster Universe*

Title: ***Two-Face(s): neutral and ionized light breeze in the local Universe***

Abstract: The physical mechanism(s) driving the "quenching" of the star formation activity in galaxies, remains one of the least understood puzzles in the galaxy formation theoretical framework. According to the most recent theoretical models, the energetic feedback from active galactic nuclei (AGN) is believed to provide an effective mechanism to eject the gas away from the galaxy by powerful winds in very massive galaxies. However, below halo masses of 10^{12} M$_{\odot}$ the galactic winds driven by the energy and momentum imprinted by massive stars to the surrounding ISM, are believed to be sufficiently energetic to eject the gas away from the galaxy potential well and stop the star formation. In order to unmasking the nature of these two quenching processes (AGN and SF), we analyzed a complete spectroscopic galaxy sample (~600 000 spectra) drawn from the SDSS to look for evidence of galactic winds in the local Universe. We focused on the shape of the [OIII]λ5007 emission line and interstellar Na I λ5890, 5895 (Na D) resonant line profiles as tracers of ionizing and neutral gas outflows, respectively. I will show how the average [OIII]λ5007 and NaD line profile changes as function of star formation rate (SFR), stellar mass, disk inclination and nature of the dominant ionizing source in different BPT classes. We find that, statistically, only “Light Breeze" can be observed in the local Universe only in AGN dominated sources. For purely SF galaxies we do not observe ionized gas outflows regardless of the SFR level. Only at very high SFR we detect a blue-shifted NaD line profile, likely indicating bulk motion of neutral gas from the disk. The additional analysis of Manga IFU data for a galaxy subsample (~1000 galaxies) sheds light on the different nature of the [OIII]λ5007 and NaD line profile outflows. Both the integrated and spatially resolved data show that the galactic winds in local Universe have “Two Faces” which are related to two different ejection mechanisms, namely the neutral outflowing gas phase connected to the star formation rate along the galaxy disk and, the ionized winds related to the AGN feedback.

- **Speaker:** ***Davide Decataldo***

Affiliation: *Scuola Normale Superiore di Pisa*

Title: ***Photoevaporation of molecular clumps in quasar outflows***

Abstract: Detection of CO, HCN and H₂O lines show that quasar outflows are in molecular form up to a radius of 1-10 kpc. To reach such distances, the molecular gas has to be structured in clumps, able to provide

sufficient self-shielding against the strong quasar radiation field. I present numerical simulations for the structure of a molecular clumps exposed to a UV radiation field, featuring radiative transfer coupled with hydrodynamics and an accurate chemistry model, including formation and destruction of molecular hydrogen. Molecular clumps are shown to undergo a violent shock-contraction phase, followed by a stationary phase where the molecules are progressively dissociated and flow away from the edge of the clump. The results show photoevaporation timescales of 0.3 Myr for clumps with mass 10³ M_{sun}, compatible with the observed extension of quasar outflows, suggesting that photoevaporation is the main mechanism regulating the size of molecular outflows.

- **Speaker:** ***Enrico Piconcelli***

Affiliation: *INAF - Osservatorio Astronomico di Roma*

Title: ***Exceptional ALMA look at the anatomy of a luminous quasar host***

Abstract: The first ALMA observation of the nearby quasar PDS 456 (z=0.184) was designed to obtain the highest resolution map ever taken of the molecular gas in a hyper-luminous quasar. With a bolometric luminosity of 2e47 erg/s (~ Eddington luminosity) it can be regarded as the local counterpart of the quasars shining at z ~ 2, i.e. the peak of quasar luminosity density. We are able to reveal in unprecedented detail (i.e., 0.2 arsec ~ 600 pc) the distribution of the molecular gas around a very powerful AGN and probe the relationship between nuclear and host galaxy properties at the brightest end of the luminosity function. The most noticeable result is the discovery of a molecular outflow in PDS 456, which also shows the undisputedly most powerful, persistent, X-ray ultra-fast (0.25c) wind discovered so far. This allows us to get new insights on how multi-phase AGN-driven outflows expand outwards. Interestingly, the CO outflow exhibits a very complex, unusual morphology with a compact, sub-kpc component and a ~3 kpc extended, very diffuse approaching one. Finally, multiple gas-rich companions are visible around ~20 kpc from PDS 456 supporting the merger-driven scenario for high-luminosity quasars.

- **Speaker:** ***Ilaria Ruffa***

Affiliation: *INAF - Istituto di Radioastronomia, Università di Bologna*

Title: ***The AGN fueling/feedback cycle in LERGs: a multi-phase study of a sample of local early-type radio galaxies***

Abstract: Galaxy formation theories struggle to explain the role of Black Hole accretion in shaping galaxies over cosmic time. Radio feedback, associated to radio jets, is accepted as a fundamental component of the lifecycle of the most massive radio loud early-type galaxies (Radio Loud ETGs, i.e. Radio Galaxies, RGs), at least in the late stages of cosmic evolution (z < 1). The many details of such process, however, still remain poorly understood. It is generally accepted that High Excitation Radio Galaxies (HERGs) are triggered by cold gas transported to the center through merging or collisions with gas-rich galaxies, while accretion in Low Excitation Radio Galaxies (LERGs) may occur directly from the hot phase of the IGM. The most compelling evidence that cold gas can play a role in fuelling LERGs as well, is that in such systems dust and molecular gas are detected in larger quantities than in radio-quiet ETGs. The origin of this gas (external or secular) remains still unclear. Systematic high-resolution CO imaging of radio galaxies (in which radio jets are currently active) together with kinematic information on the stellar and ionized gas components, is fundamental to isolate the role played by radio-mode feedback in the overall formation and evolution of ETGs, allowing also to do a crucial comparison with existing studies of radio-quiet ETGs (e.g. ATLAS3D sample). For this purpose, we have selected a complete volume-limited sample of eleven nearby (z < 0.03) RGs associated with elliptical galaxies, selected from the Ekers et al. (1989) parent sample of 90 radio galaxies in the Southern sky. All the selected galaxies have low-power (P1.4GHz ≤ 1025 W Hz−1), low accretion rate, and FRI type or (arcsec-scale) compact radio morphology. For all the sources, we have already acquired a set of multi-wavelength data, spanning from the radio to the mm regime. Here we present the results obtained so far by analyzing ALMA Cycle 3 CO(2-1) observations of 9 targets, with resolutions of few hundreds of parsecs at the source redshifts. The CO(2-1) line emission was detected in 6 out of 9 targets (detection significance from 8 to 45 sigma; 66% detection rate). CO(2-1) maps show rotating disc structures in all the sources, with some peculiar cases in which the gas disk shows a disturbed morphology that seems to suggest an interaction with the radio jets. The detected CO discs are mostly located in the inner kpc-sub-kpc scales of the host galaxy. Available optical images were used to investigate the relative distribution of gas and dust: they result mostly co-spatial, with dust extending on larger scales in some cases. The study of the CO kinematics is still ongoing, but preliminary results show hints of the presence of of non-circular motions (i.e. inflow/outflow) in at least one of the detected CO discs.

- **Speaker:** ***Francesco Tombesi***

Affiliation: *Università degli Studi di Roma Tor Vergata*

Title: ***Mapping Black Hole winds, from the event horizon up to galaxy scales***

Abstract: Powerful winds driven by active galactic nuclei (AGN) are often invoked to play a fundamental role in the evolution of both supermassive black holes (SMBHs) and their host galaxies, possibly quenching star formation and explaining the tight SMBH-galaxy relations. Renewed support for this "quasar-mode" feedback came from recent X-ray observations of mildly relativistic disk winds, a.k.a. ultrafast outflows, in some ultra-luminous infrared galaxies and their connection with galactic molecular outflows observed in mm and IR wavebands. In particular, the combination of X-ray (Suzaku, NuSTAR), IR (Herschel), and mm (ALMA) observations of IRAS F11119+3257 allowed us to link the SMBH activity to molecular outflows that may quench star formation. These results appeared as the "cover page" of Nature in March 2015 and a series of ApJ papers. Further follow-up investigations on other ULIRGs and quasars are underway. These results clearly show that synergistic observations between X-rays and other wavebands have the power to map AGN winds from the event horizon up to galaxy scales, providing a promising avenue to study the multi-phase SMBH feeding and feedback. Revolutionary improvements are expected from upcoming X-ray space observatories, such as XARM and Athena, in synergy with other major space- and ground-based facilities, such as JWST, ALMA, E-ELT, SKA.

- **Speaker:** ***Giacomo Venturi***

Affiliation: *Università degli Studi di Firenze, INAF - Osservatorio Astrofisico di Arcetri*

Title: ***Outflows vs star formation in nearby AGN from the MAGNUM survey***

Abstract: AGN outflows are believed to play a major role in shaping the properties of host galaxies, by sweeping away the gas and quenching star formation (negative feedback). In this framework our MAGNUM survey aims at investigating in detail the interplay between AGN activity and star formation processes in nearby active galaxies which, due to their vicinity, are the ideal laboratories to carry out such a study. The sample comprises ten famous nearby Seyfert galaxies, such as Circinus, NGC 1365 and NGC 4945. Thanks to its unique combination of large field of view and spectral coverage, MUSE allowed us to map the ionised gas down to ~10 pc in several nebular emission lines revealing ubiquitous kpc-scale outflows, whose properties (e.g. velocity, mass outflow rate, kinetic rate etc…) as a function of distance from the active nucleus were measured. Furthermore, we inferred the outflow 3D shape and intrinsic physical properties with kinematic modelling. We found evidence of star formation induced by AGN outflows indicating positive feedback. Additionally, recent results from our survey reveal the presence of star formation even within the outflow itself. Moreover, by exploiting ALMA and Chandra X-ray observations we study the gas in its different phases and get unique insights on the properties of the outflows and of the ISM.

- **Speaker:** ***Giustina Vietri***

Affiliation: *Excellence Cluster Universe – ESO*

Title: ***The WISSH survey: BLR vs NLR winds in the most luminous quasars***

Abstract: I will review the most important results from near-IR spectroscopic observations of WISE/SDSS selected hyper-luminous (WISSH) quasars, designed to accurately probe the role of nuclear activity in SMBH-galaxy self-regulated growth via extended outflows. The total sample consists of 90 broad-line quasars at the brightest end of the AGN luminosity function (L_bol > 1e14 L_sun) and at the peak of their number density (z ~ 2.5 - 3.5). We found that WISSH quasars are typically powered by highly accreting (0.3-3 Ledd), ten billion solar masses SMBHs, demonstrating that WISSH provides a simple and valuable tool to complete the census of the extreme SMBH population in the Universe. The huge luminosity drives very powerful winds both at BLR and NLR scales. We discovered [OIII] emission lines with a broad profile, tracing ionized outflows with kinetic power up to ~4% of L_bol in ~30% of the sample. Remarkably, the remaining 70% of quasars lacks [OIII] emission but shows strong winds traced by 3,000-8,000 km/s blueshifts of the CIV broad emission line, revealing strong radiatively driven winds that dominate the BLR kinematics. Finally, I will discuss nuclear and outflows properties of WISSH quasars in terms of inclination angle and fundamental AGN parameters such as bolometric luminosity, SMBH mass, Eddington ratio and the shape of the UV-X-ray continuum.

COSMOLOGY AND HIGH-REDSHIFT

- **Speaker: *Roberto Decarli* (INVITED)**

Affiliation: *INAF - Osservatorio di Astrofisica e Scienza dello Spazio di Bologna*

Title: *Quasars at the dawn of cosmic time*

Abstract: Quasars at z>6 (age of the Universe: <1 Gyr) are arguably the most active astrophysical objects in the early universe. They are powered by fast accretion on their central black holes (which already have masses of 0.1-10 billion Msun). Their galaxies form stars at rates of >100 Msun/yr, and, despite the young cosmic age, they appear chemically enriched. These humongous star formation and accretion rates are fuelled by immense gaseous reservoirs. Here we review how to the quasar redshift frontier has been pushed forward. We discuss the lessons learned on the formation and early growth of massive black holes, on their host galaxies, their environment, and on the intergalactic medium at the end of reionization. In particular, we demonstrate how observations at (sub-)mm wavelengths can shed light, for the first time, on the mass, spatial extent, chemistry, kinematics, and physical properties of the interstellar medium in these quasars, thus constraining the build up of the first massive galaxies and black holes and the AGN impact on their gas, and testing the interstellar medium properties in regimes that are not observable anywhere else in the universe.

- **Speaker: *Raffaella Schneider* (INVITED)**

Affiliation: *Dipartimento di Fisica, Sapienza Università di Roma*

Title: *The prodigious history of the first SMBHs and their host galaxies: Gargantua and Pantagruel at cosmic dawn*

Abstract: The first SMBHs and their host galaxies represent some of the most extreme astrophysical objects that we currently know at z>6. Their observed properties allow to constrain possible evolutionary models. Here we present some recent results on the nature of their black hole seeds, on their mass growth rate, and on the assembly history of their host galaxies.

- **Speaker: *Sivia Belladitta***

Affiliation: *INAF - Osservatorio Astronomico di Brera; Università degli Studi dell'Insubria*

Title: *A very powerful radio loud AGN at z=5. Blazar or not?*

Abstract: Looking for Active Galactic Nuclei (AGNs) in the first Gyr of the Universe is crucial to understand when and how the first super massive black holes (SMBHs) formed, how they are related to galaxy formation and what is their role in the re-ionisation process. Explaining how such massive systems could be built up in the short (< 1Gyr) available cosmic time is still an open issue. Selecting high-z AGN candidates requires a multi-wavelength approach. In particular, we are carrying out a project which combines optical, IR, and radio datasets to identify radio loud AGNs at redshift z>4.5. I will present the newly discovered extremely radio loud quasar DES0141-54 at z=5.0, selected by combining the very recently data release (DR1) of the Dark Energy Survey (DES) with the Sydney University Molonglo Sky Survey (SUMSS) radio catalog. Rest-frame UV-optical spectra were obtained for this object using EFOSC2 at the NTT and X-Shooter at the VLT. This object is extremely bright in the radio band and its radio– loudness (ratio of the radio to optical flux) is one of the largest ever measured (R>10000) at this redshift. However, puzzlingly, the X-ray emission measured by the XMM-Newton and Swift satellites is weaker compared to what expected from a such large radio emission.

- **Speaker: *Fabio Fontanot***

Affiliation: *INAF - Osservatorio Astronomico di Trieste*

Title: *On the relative contribution of AGNs and galaxies to reionization*

Abstract: I will review the arguments in favour of/against a substantial contribution of AGNs and/or star-forming galaxies to the reionization of the Universe at z>5, by using extrapolations of the most recent determination of the AGN and LBG high-z luminosity functions (LFs) and their redshift evolution. A galaxy driven reionization requires a significant contribution of faint dwarf galaxies and a LyC photon escape fraction (f_esc) of the order of ~20 per cent, in tension with observational constraints. I will then focus on the AGN contribution to reionization. In particular, I will

present a recent study based on a sample of 1669 luminous QSOs from BOSS. Their f_esc distribution shows a peak around zero and a long tail of higher values, with a resulting mean f_esc~0.75 (independent of the QSO luminosity and/or redshift). Combining this f_esc estimate with the observed evolution of the AGN-LF, we compute the AGN contribution to the UV ionizing background (UVB) as a function of redshift. AGN brighter than one-tenth of the characteristic luminosity of the LF are able to produce most of it up to z~3, whereas at higher redshifts, a contribution of the galaxy population is required. Assuming an f_esc for star-forming galaxies between 5.5 and 7.6 per cent, independent of the galaxy luminosity and/or redshift, a remarkably good fit to the observational UVB data up to z~6 is obtained.

- **Speaker:** ***Elisabetta Lusso***

Affiliation: *Durham University*

Title: ***Discovery of a 4σ deviation from the Concordance Model of Cosmology using the Hubble Diagram of Quasars***

Abstract: The cosmological concordance model (ΛCDM) well accounts for a wealth of observations, from the existence of Cosmic Microwave background (CMB) to the discovery of the accelerated expansion of the universe from Type Ia supernovae. Yet, it assumes a still unknown form of dark energy and matter and some tensions arose recently as, for instance, the discovery of a 3.4σ discrepancy between the local (Riess et al. 2016) and Planck (Aghanim et al. 2016) measurement of H0. In addition, the ΛCDM model is poorly tested in the redshift interval between the farthest observed Type Ia supernovae (z~1.4) and that of the CMB (z~1100). We present new measurements of the expansion rate of the Universe in the redshift range z=0.5-5.5 based on a Hubble diagram of quasars. The distance of quasars has been estimated from the observed non-linear relation between the X-ray and ultraviolet emission, following a method developed by our group. The distance-redshift relation of quasars at z<1.4 is in agreement with that of supernovae and with the concordance model. Nonetheless, a deviation from the ΛCDM model emerges at higher redshift, with a statistical significance of ~4σ. We found that, if an evolution of the dark energy equation of state is allowed, our data suggest a dark energy density increasing with time.

- **Speaker:** ***Riccardo Nanni***

Affiliation: *Osservatorio di Astrofisica e Scienza dello Spazio di Bologna*

Title: ***The X-ray properties of z~6 quasars***

Abstract: More than 200 quasars (QSOs) with spectroscopic redshift z > 6 have been discovered so far. Multi-wavelength observations showed that these QSOs are evolved systems with large black hole masses (10^{8-10} solar mass), and their broad-band spectral energy distributions (SEDs) and rest-frame NIR/optical/UV spectra have not significantly evolved over cosmic time. The formation of their Super Massive Black Holes in less than 1 Gyr is still a challenge for theory, with many simulations claiming they formed at the center of primordial overdense regions. I report the study of all the 29 z~6 QSOs observed so far with X-rays, in which our group concluded that the X-ray spectral properties of high-z QSOs do not differ significantly from those of QSOs at lower-z. We also obtained a deep 500 ks Chandra observation to study the environment around the QSO J1030+0524, which shows the best evidence of an overdense region around a z~6 QSO. This is the deepest X-ray observation ever achieved for a z~6 QSO. Comparing our results with those from previous XMM observation we found a hardening of the X-ray spectrum and a decrease of the flux by a factor 2.5. This is the first evidence of a variable QSO at such high redshift. I also report the discovery of a diffuse X-ray emission southward the QSO, that could be linked to the feedback of the AGN.

- **Speaker:** ***Francesco Salvestrini***

Affiliation: *DIFA - Università di Bologna; INAF - Osservatorio di Astrofisica e Scienza dello Spazio di Bologna*

Title: ***Quasars as high redshift standard candles: the Lx-Luv relation at high redshift***

Abstract: A tight non-linear relation between the X-ray and the optical-ultraviolet luminosity has been observed in AGN over 5 orders of magnitude and up to high redshift. This suggests a coupling between the disk, emitting the primary radiation in the UV band, and the hot corona emitting in the X-ray. In this work, we have studied the L_X-L_{UV} relation for a sample of high-redshift ($z>4$) quasars, selected on the basis of their spectral properties and the quality of the available observations in both X-ray and optical/UV bands. The relation shows no-evidence of evolution with redshift, which indicates a universal physical mechanism regulating the energy transfer process in the

inner regions, and the observed dispersion is lower than in previous estimates. The non-linearity of the relation provides a new, powerful way to estimate the absolute luminosity, turning quasars into a new class of standard candles that can provide an important contribution in the determination of the cosmological parameters, probing cosmological time not achievable with other observational methods.

- **Speaker:** ***Tullia Sbarrato***

Affiliation: *Università degli Studi di Milano – Bicocca*

Title: ***How to assemble extremely massive black holes in a very short quasar life-time***

Abstract: The existence of extremely massive black holes at very high redshift is a true challenge to the commonly accepted black hole formation and evolution models. The quasars found at z>4 host extremely massive black holes, up to the case of a quasar found at z>6 with 11 billion solar masses. These objects are particularly problematic: there is not enough time to accrete such large masses in a standard scenario, and their disc emission seems consistent with sub-critical accretion. The presence of a jet could speed up the accretion process enough to build up 10^9Msun black holes before z~6 from a reasonable black hole seed. Studying the population of jetted quasars is hence necessary. The peculiar orientation of blazars (that have jets directed along our line of sight) makes them the most effective tracers of the whole population of jetted quasars. Do relativistic jets really have a role in the early formation of extremely massive black holes? Or a different accretion paradigm is required to justify the observed high-redshift population? We will explore the options, trying to draw conclusions about one of the most urgent questions on quasar physics: how could the first, most massive black holes form so fast in the early Universe?

- **Speaker:** ***Fabio Vito***

Affiliation: *Penn State University, Pontificia Universidad Catolica de Chile*

Title: ***The early growth of super-massive black holes as seen by Chandra***

Abstract: Deep X-ray surveys provide unprecedented access to the population of accreting super-massive black holes (SMBH) at high redshift. I will present our recent results (Vito et al. 2018) on the 3 < z < 6 AGN population in the 7 Ms CDF-S and 2 Ms CDF-N, the deepest X-ray surveys to date. We put tight constraints on quantities such as the obscured AGN fraction and the number density of z>3 AGN. In particular, we derived a large fraction (50-80%) of heavily-obscured (logNH>23) AGN, which does not evolve significantly from z=3 to 6 but shows a positive dependence on luminosity. Although this was already suggested by previous works, thanks to the use of the deepest X-ray data available we could investigate this behavior down to logL~42. I will show our findings on the high-redshift AGN X-ray luminosity function, focussing in particular on the slope of the faint end, accessible only by the deepest X-ray surveys. This is particularly important to assess the contribution of AGN to the cosmic reionization. All of these results will be placed in the context of SMBH seeds formation and growth. I will also discuss how future missions like Lynx, Athena and JWST will boost our knowledge of the SMBH formation and evolution in the early universe. Finally, I will present preliminary results on a sample of QSOs at z=6-6.8 with black-hole mass (2-40 x 10^8 Msun) estimated from near-IR spectroscopy observed with Chandra. Some of these are among the faintest optically-selected QSOs targeted in X-rays at z>6, lying a few times below the knee of the high-redshift QSO luminosity function.