ARE AGN SPECIAL?

The environmental dependence and global impact of AGN activity

Feeding black holes to the End of the Universe

PROGRAMME & ABSTRACTS

DARTMOUTH

Durham University

MNU MATARIKI NETWORK OF UNIVERSITIES

astro.dur.ac.uk/Are_AGN_Special

Contents

2 General Information
4 Oral Programme
9 Poster Programme

Oral Programme Abstracts
11 Monday 30th July
27 Tuesday 31st July
45 Wednesday 1st August
55 Thursday 2nd August
71 Friday 3rd August

83 Poster Programme Abstracts
109 Participant Directory
113 Extra Pages for Notes

Are AGN special? The environmental dependence and global impact of AGN activity

Durham–Dartmouth Extragalactic Workshop,

Durham, England 30 July–3 August 2018

http://astro.dur.ac.uk/Are_AGN_Special/

Powered by mass accretion onto super-massive black holes, Active Galactic Nuclei (AGN) are undoubtedly exotic phenomena. According to most theoretical models of galaxy formation, AGN have also had a profound impact on the way the Universe looks today. However, AGN activity is, in another sense, a common phenomenon: the finding that essentially all massive galaxies host a central supermassive black hole clearly indicates that these galaxies have all hosted AGN activity at some point during their lives. Are these AGN phases a special period in the lifetime of the galaxy that require specific environmental conditions, or are they simply a random event that can occur at any time in any galaxy?

The objective of this international workshop is to bring together observers and theorists to explore the environmental dependence and global impact of AGN activity. During the five days of the workshop we will investigate:

- What host-galaxy properties facilitate AGN activity?
- What larger-scale environments facilitate AGN activity?
- Is the high-redshift Universe a special environment for AGN activity?
- How do AGN shape the way the Universe looks?

The workshop is held in the historical city of Durham in England and includes a combination of review, invited, contributed, and poster talks, in addition to extended discussion sessions.

Scientific Organising Committee

David Alexander ● Ryan Hickox ● Richard Bower ● Marcella Brusa ● Alison Coil ● Sara Ellison ● Santiago Garcia-Burillo ● Ian McCarthy ● Adam Myers ● Priya Natarajan ● Debora Sijacki ● Thaisa Storchi-Bergmann ● Benny Trakhtenbrot

Local Organising Committee

David Rosario ● David Alexander ● Sotiria Fotopoulou ● Thomas Jackson ● Lizelke Klindt ● Elisabeta Lusso ● Jan Scholtz ● Mike DiPompeo ● Christopher Harrison ● Ryan Hickox ● George Lansbury ● Lauranne Lanz ● Allegra Santis

Venue and Locations

Oral presentations	Lecture theatre Ph8: Physics building (Rochester)
Posters and coffee	Astronomy building (Odgen Centre West)
Sunday evening buffet reception	Hatfield College Dining Hall from 6pm
Lunches	Astronomy building (Monday; Friday) Collingwood college (Tuesday; Thursday) No lunch provided on Wednesday except for Hadrians Wall excursion, where a packed lunch is given
Workshop photograph & dinner	Durham Castle from 7:15pm
Prince Bishop boat cruise	Meet at The Boathouse, Elvet Bridge at 7:15pm
Hadrians Wall excursion	Pick up outside Physics building before 1pm
Cathedral & Open Treasures	Meet at Cathedral visitor desk (guided tour starts 2:30pm)

Presentation Information

Talks – Review talks are 30+5 minutes and the invited and contributed talks are 17+3 minutes. Please check that there are no issues with your talk prior to your talk session.

Posters – Posters are displayed in the coffee area of the Astronomy building (Ogden Centre West). The poster boards allow up to standard-sized posters (A0 or 36 x 48 inches); because of limited space, standard-size posters must be orientated vertically. See the poster program for the poster identification codes. Everyone has the option to give a 1 min oral presentation of their poster.

Invited Speakers and Discussion Leaders

James Aird ● Rachael Alexandroff ● Almudena Alonso-Herrero ● Richard Bower ● Marcella Brusa ● Rebecca Canning ● Alison Coil ● Giovanni Cresci ● Colin DeGraf ● Yohan Dubois ● Sotiria Fotopoulou ● Ryan Hickox ● Stephanie LaMassa ● Debora Sijacki ● Vernesa Smolcic ● Thaisa Storchi-Bergmann ● Bram Venemans ● Benny Trakhtenbrot ● Nadia Zakamska

We encourage you to Tweet throughout the conference using #AGNSpecial18.
Our account is: @SpecialAGN18.

Workshop Programme

Sunday 29 July 2018

6.00–8.00 **Evening Reception (at Hatfield College)**

Monday 30th July 2018

8.00 **Registration (at astronomy building: OCW)**

9.00 **Welcome and Workshop Motivation (at Physics building: Ph8)**

Session 1: What host galaxy properties facilitate AGN activity?

9.20 **Session 1, block 1** – *Chair: Alexander*

Alonso-Herrero	The host galaxies of AGN [R]
Storchi-Bergmann	The feeding of supermassive black holes [I]
Hicks	How host galaxy and environment relate to the central 400 pc of local Seyfert galaxies

10.45 **Coffee Break and Poster Session**

11.25 **Session 1, block 2** – *Chair: Davies*

Habouzit	Properties of SMBH and their connection to galaxies in IllustrisTNG
Aird	Are the galaxies that host AGN special? The incidence of AGN and their distribution of accretion rates as a function of galaxy properties [I]
Jones(Mackenzie)	Does a universal mode of AGN accretion suggest AGN are not special?
Bernhard	Evidence for a mass-dependent AGN Eddington ratio distribution via the flat relationship between SFR and AGN luminosity

12.55 **Lunch (at astronomy building: OCW)**

2.00 **Session 1, block 3** – *Chair: Vestergaard*

Raimundo	The stellar and gas dynamics in the transition between black hole activity and quiescence
Whittam	Understanding the mechanical feedback from high- and low-accretion rate radio galaxies
Chang	Host galaxies of obscured AGNs and their environment
Zhao	The evolutionary link between Type 1 and Type 2 quasars by their host galaxies

3.30 **Coffee Break and Poster Session**

4.10 **Session 1, block 4** – *Chair: Lanz*

Kocevski	Elevated black hole growth in the progenitors of compact quiescent galaxies at $z = 2$ and future prospects with JWST
Klindt	The changing faces of quasars: what are the fundamental differences between blue and red quasars?
Assef	Hot dust obscured galaxies
Ginolfi	Observing the cold gas surrounding AGN-host galaxies with MUSE

5:40 **End**

7.30 **Prince Bishop Boat Cruise and Dinner**

Workshop Programme

Tuesday 31st July 2018

9.00 **Session 1, block 5** – *Chair: Rosario*

Poster talks (session 1)
Discussion session 1 (Chairs: Coil; LaMassa; Storchi-Bergmann)

10.20 **Coffee Break and Poster Session**

Session 2: What larger-scale environments facilitate AGN activity?

11.00 **Session 2, block 1** – *Chair: Burtscher*

Coil	AGN clustering and environment [R]
McAlpine	Connecting black hole and galaxy growth within the EAGLE simulation
Banerji	Are obscured quasars special? Host galaxies & environments from ALMA & JVLA
Hardcastle	The hosts and environmental impact of local radio-loud AGN

12.45 **Lunch (at Collingwood College)**

2.10 **Session 2, block 2** – *Chair: Villforth*

Smolcic	Black hole mass growth across cosmic time: insights from the VLA-COSMOS 3 GHz Large Project [I]
Steinborn	Do galaxy mergers make AGN special?
Barrows	The conditions of single and dual AGN in late-stage galaxy mergers
Jadhav	Monsters on the move: a search for supermassive black holes undergoing gravitational wave recoil

3.40 **Coffee Break and Poster Session**

4.20 **Session 2, block 3** – *Chair: Fotopoulou*

Powell	Clustering of hard X-ray-selected AGN
Noordeh	A spectroscopic study of AGN activity in massive galaxy clusters
Marshall	Ram pressure triggers AGN in galaxy clusters
Overzier	The complicated environments of the most powerful AGN at high redshift: progenitors of local brightest cluster galaxies or not?

5.50 **End**

Workshop Programme

Wednesday 1st August 2018

9.00 **Session 2, block 4** – *Chair: Rosario*

Poster talks (sessions 2 & 3)
Discussion session 2 (Chairs: Canning; Fotopoulou; Hickox)

10.20 **Coffee Break and Poster Session**

Session 3: Is the high-redshift Universe a special environment for AGN?

11.00 **Session 3, block 1** – *Chair: Lusso*

Sijacki	Supermassive black hole growth and feedback in the early Universe [R]
Nagamine	Formation of pre-AGN via direct collapse: cosmological zoom-in hydro simulation with radiation transfer
Ricarte	Modelling the black-hole-galaxy connection over cosmic time
Barger	Is AGN growth at the highest redshifts dominated by Compton-thick Sources?

12.45 **Free afternoon including organised activities**

7.15 **Conference drinks and group photo: Durham Castle**

8.00 **Conference dinner: Durham Castle**

Workshop Programme

Thursday 2nd August 2018

9.15 **Session 3, block 2** – *Chair: Brusa*

Venemans	The birth of giants: quasars and their host galaxies in the early universe [I]
Trakhtenbrot	The fastest growing SMBHs at $z \sim 5$: mapping their fast-growing hosts and their over-dense environments
Bischetti	Ionised outflows in $z \sim 6$ QSOs are there: investigating AGN-feedback and host galaxy properties in very luminous high-redshift QSOs
Ricci	The role of AGN in the reionization of the Universe

10.45 **Coffee Break and Poster Session**

11.25 **Session 3, block 3** – *Chair: Rosario*

Poster talks (session 4)
Discussion session 3 (Chairs: DeGraf; Trakhtenbrot)

12.45 **Lunch (at Collingwood College)**

Session 4: How do AGN shape the way the Universe looks?

2.10 **Session 4, block 1** – *Chair: Crenshaw*

Zakamska	Observations of quasar-driven galactic winds [R]
Cresci	An AGN special: feedback across cosmic epochs [I]
Harrison	The properties and prevalence of AGN-driven outflows during the peak of activity
Vietri	The WISSH survey: revealing ultra-massive black-holes and powerful winds in the most luminous quasars

3.55 **Coffee Break and Poster Session**

4.35 **Session 4, block 2** – *Chair: Alexandroff*

Dubois	How do AGN shape the way the Universe looks? [R]
Scholtz	The impact of AGN feedback on star formation inferred from ALMA and hydrodynamical simulations
Rosario	AGN feedback does not destroy cold molecular gas in local luminous Seyfert galaxies

6.00 **End**

Workshop Programme

Friday 3rd August 2018

9.00 **Session 4, block 3** – *Chair: Lansbury*

Bower	Black holes and the future of galaxy formation
Barnes	Improving AGN feedback for the next generation of cosmological simulations
Constantin	Near-IR and radio constraints of obscured AGN and their feedback in advanced mergers
Lanz	Do AGN lurk in special galaxies caught in the early stages of transition?

10.30 **Coffee Break and Poster Session**

11.10 **Session 4, block 4** – *Chair: Hickox*

Bourne	Simulation of AGN feedback in galaxy clusters
Terrazas	Supermassive black holes as the regulators of star formation in central galaxies
Talia	AGN-enhanced outflows of low-ionization gas in star-forming galaxies at $1.7 < z < 4.6$
	Discussion session 4 (Chairs: Alexandroff; Bower; Brusa)
	Workshop wrap up

1.00 **Lunch (at astronomy building: OCW)**

End of workshop

Poster Program

Posters are displayed on the middle floor of the Astronomy building (Ogden Centre West).
The poster identification codes refer to the board on which each poster is displayed.

Bessiere	1A	Towards an understanding of the duty cycle of AGN flickering using quasar light echoes
Birchall	1B	The prevalence of X-ray selected AGN in dwarf galaxies
Borkar	1C	The flaring activity of Sagittarius A at 3 mm observed with ATCA
Brumback	1D	Warped disks and super-Eddington flows in X-ray binaries as an analogue to AGN accretion physics
Burtscher	1E	AGNs are not special: stellar populations in the nuclei of ultra hard X-ray selected AGNs
Calistro Rivera	1F	The fraction of accreting black holes in dusty star-forming galaxies
Carraro	1G	Co-evolution of black hole accretion and star formation in galaxies
Carroll	1H	An extreme population of heavily buried AGN: identification and host galaxies
Davies	1I	Both sides of the coin: comparing the circumnuclear characteristics of active and inactive galaxies with LLAMA
del Moral-Castro	1J	Comparing isolated active and non-active galaxies from CALIFA survey
Ebrero	1K	Obscuration events in nearby AGN
Emig	1L	The first detection of radio recombination lines in AGN
Hsu	1M	Investigating the connection between AGNs and their host galaxy properties through SED decomposition
Kuraszkiewicz	1N	Obcuration/orientation effects in the sample of medium-redshift ($0.5 < z < 1$) 3CRR sources observed by Chandra
LaMassa	1O	The hunt for red quasars: unveiling luminous obscured black hole growth
Masini	1P	Are AGN special? The NuSTAR and Chandra point of view
Riffel(Rogemar)	1Q	Stellar and gas kinematics of the first 62 AGN observed with MaNGA
Riffel(Rogerio)	1R	First 62 AGN observed with SDSS-IV MaNGA - II: resolved stellar populations
Shimizu	1S	The special properties of molecular and ionized gas in the circumnuclear environment of AGN
Simmons	1T	Merger-Free Black Hole and Galaxy Growth
Vestergaard	1U	Swift X-ray to optical SEDs of $z \sim 2$ quasars
Xu	1V	A "Turn-on" Transition in "Changing-look" Quasar SDSS J141324.27+530527.0
Yan	1W	The most heavily obscured quasars: extreme obscuration in reddened hosts

Canning	2/3A	The CATS survey: AGN evolution in massive galaxy clusters
DeGraf	2/3B	Signatures of supermassive black hole seed formation over cosmic time
Efthymiadou	2/3C	The influence of galaxy mergers on the star formation history of luminous AGN
Foord	2/3D	Quantifying the rate of dual AGN
Fotopoulou	2/3E	AGN evolution in the mercy of the large scale enviroment

He	2/3F	Clustering of quasars over a wide luminosity range at $z \sim 4$ with Subaru Hyper Suprime-Cam wide field imaging
Hickox	2/3G	The dawn of black holes and their evolution in the early Universe: prospects for the future with Lynx
Jones(Kristen)	2/3H	SERVing up clustering around obscured and unobscured Quasars at $z \sim 2$
Kim	2/3I	Environmental dependence on AGN activity in the SDSS late-type galaxy sample
Krishnan	2/3J	Enhancement of AGN activity in a protocluster at $z = 1.6$
Loiseau	2/3K	AGN in a sample of nearby LIRG pairs: exploring the influence of a companion
Mazzucchelli	2/3L	A multiwavelength view on massive star forming companion galaxies to high-redshift quasars
Moravec	2/3M	Massive and distant clusters of the WISE survey: extended radio sources in massive galaxy clusters at $z \sim 1$
Weston	2/3N	Spectral energy distribution analysis of WISE-selected obscured AGNs in major mergers from the SDSS
Whalen	2/3O	Probing the difference between host halos for obscured and unobscured quasars

Alexandroff	4A	Peering deep in the radio to uncover the secrets of quasar feedback
Chen	4B	Extreme outflow in an AKARI-selected ULIRG at $z = 0.5$
Circosta	4C	The SUPER survey: exploring the impact of AGN outflows with SINFONI and ALMA
Crenshaw	4D	Resolving the mechanisms of feeding and feedback in nearby AGN
Fischer	4E	Spatially resolved AGN feedback in a lensed main-sequence galaxy at $z = 2.39$
Fritz	4F	Ram pressure feeding supermassive black holes?
Garcia-Lorenzo	4G	HARMONI view of high-redshift AGN
Gnilka	4H	Spatially resolved kinematics and morphology of Mrk 3
Jackson	4I	What makes AGN special? Testing AGN feedback in cosmological hydrodynamic simulations with a complete survey of local AGN
Lansbury	4J	The Teacup: a nearby quasar and superbubble seen in X-rays
Morabito	4K	AGN feedback from radio galaxies: when surveys and cosmological simulations meet
Ramasawmy	4L	Do black holes regulate the growth of massive galaxies?
Rivera	4M	Chandra/HST analysis of 25 SDSSRM quasars
Rodriguez-Ardila	4N	Feedback in low-luminosity active galactic nucleus
Sanmartim	4O	Star formation and gas kinematics in the central kiloparsec of post-starburst quasars
Talia	4P	ALMA view of a massive spheroid progenitor: a compact rotating core of molecular gas in an AGN host at $z = 2.226$
Temple	4Q	Outflow kinematics of obscured quasars at high redshift
Zovaro	4R	Catching sub-kpc scale AGN feedback in the act in the compact steep spectrum source 4C 31.04

Oral Programme Abstracts

Monday, 30th July 2018

The host galaxies of AGN

Dr Almudena Alonso-Herrero | Instituto de Fisica de Cantabria
aalonso@cab.inta-csic.es

Abstract

The AGN phenomenon is the phase of efficient feeding of a supermassive black hole and it is believed to be an intermittent process. Gas in the host galaxy disk needs to be transported to physical scales within the sphere of influence of the black hole. This involves triggering mechanisms that may operate on different physical scales and/or timescales. In this review I will discuss recent progress on the properties of the host galaxies of AGN. For the triggering mechanisms, there is no conclusive observational evidence that bars be more common in AGN than in non-active galaxies whereas major mergers might only dominate the fueling of the activity in the most luminous AGN. I will also discuss the properties of the circumnuclear/nuclear regions of moderate luminosity AGN which might provide some clues on the processes facilitating nuclear activity.

Notes

The feeding of Supermassive Black Holes

Dr Thaisa Storchi-Bergmann | Instituto de Fisica, Universidade Federal do Rio Grande do Sul, Porto Alegre, Brazil
thaisa@ufrgs.br

Abstract

The onset of nuclear activity depends on the availability of gas to feed Supermassive Black Holes in the center of galaxies. The way the gas reaches the nucleus depends on the environment, galactic and/or extragalactic. At high luminosities, mergers and interactions seem to be the main triggers of nuclear activity, although some controversies remain. Cooling flows in galaxy clusters seem to be the source of gas of massive central cluster galaxies generating radio-mode AGNs. At lower luminosities, minor mergers seem to play a role in early-type, gas-starving galaxies, while secular processes seem to dominate in later-type, gas-rich galaxies. I will briefly discuss all these processes and will focus in particular on the results obtained by our AGNIFS group via integral field observations of the inner few hundred parsecs of nearby AGN hosts in warm molecular and ionised gas. Besides ubiquitous outflows - although more compact than expected - we have found gas reservoirs in nuclear disks, as well as gas inflows along nuclear spirals and bars.

Notes

How host galaxy and environment relate to the central 400 pc of local Seyfert galaxies

Dr Erin Hicks | University of Alaska Anchorage
ekhicks@alaska.edu

Abstract

With the Keck OSIRIS Nearby AGN (KONA) survey we simultaneously probe the stellar, molecular gas, and ionized gas kinematics within the central 400 pc of a sample of 40 local, representative AGN. We present a study of how the integrated and spatially resolved properties within this circumnuclear region relate to those of the host galaxy and the galaxy environment on larger scales. The KONA sample is evenly split between type 1 and type 2 Seyferts, span over three orders of magnitude in hard X-ray and K-band luminosities, represent both late and early type host galaxies, and are found in a range of host galaxy environments. We consider trends with a range of integrated circumnuclear properties, including the distribution, velocity dispersion, and surface brightness of the stellar population and molecular hydrogen emission, as well as the relative AGN and stellar contributions to the K-band luminosity. The mechanism driving gas inward, as indicated by the measured molecular gas kinematics and traced out to kpc scales via V-H color and dust structure maps, is also considered in the context of the host galaxy properties and its environment.

Notes

Properties of SMBH and their connection to galaxies in IllustrisTNG

Dr Melanie Habouzit | Center for Computational Astrophysics
mhabouzit@flatironinstitute.org

Abstract

We study the population of supermassive black holes (BHs) and the connection between active galactic nuclei (AGN) and their host galaxies through cosmic time, in the large-scale cosmological hydrodynamical simulations IllustrisTNG. We first present BH properties (e.g., BH luminosity function, BH/AGN galaxy occupation fraction, distribution of BH Eddington ratios), and compare them to available observational constraints. We then study galaxy stellar mass and size distributions across cosmic time, and design redshift-dependent criteria to identify galaxy types (star-forming vs quiescent, and compact vs extended galaxies) in the simulations. We build a specific star-formation rate - stellar surface density diagram, and analyze how the simulated galaxies populate this diagram. There has been much debate in the literature about the physical processes that drive galaxys' evolution through this diagram, and the role of AGN feedback in quenching galaxies. For a large fraction of quiescent galaxies, we find that their star-forming progenitors first experienced a compaction event, forming the population of star-forming compact galaxies, and then a quenching event that brings these galaxies to the compact quiescent galaxy population. We measure the dependence of AGN fraction on a galaxy's location in the diagram, and find a high fraction of X-ray luminous AGN in the compact star-forming part of the diagram, and a low AGN fraction in the quiescent compact part, in good agreement with recent results from observational data of the CANDELS survey.

Notes

Are the galaxies that host AGN special? The incidence of AGN and their distribution of accretion rates as a function of galaxy properties.

Dr James Aird | University of Leicester
james.aird@leicester.ac.uk

Abstract

Determining whether certain conditions within a galaxy enhance or reduce the level of central black hole growth is challenging. Variability in AGN activity on short timescales compared to changes across the host galaxy can wash out underlying correlations between galaxy and AGN properties, resulting in a complex and biased observational picture. I will present work that starts from near-infrared selected samples of *galaxies*, directly measures the distribution of AGN accretion rates *within* such samples using deep X-ray data, and carefully traces how the incidence of AGN changes as a function of stellar mass and star formation rate over cosmic time ($z \sim 0.1-4$). We find a broad range of accretion rates within any given galaxy sample, reflecting the stochastic nature of AGN fuelling. The probability of a star-forming galaxy hosting an AGN increases with redshift and the overall distribution shifts towards higher accretion rates, likely due to the increased availability of cold gas at earlier cosmic times. However, the incidence of AGN is suppressed in lower mass star-forming galaxies, possibly due to the effects of supernova feedback. We also find significant differences in the incidence of AGN within star-forming galaxies depending on their star formation rates relative to the main sequence. Finally, the probability of a quiescent galaxy hosting an AGN is generally lower than that of a star-forming galaxy of equivalent mass and evolves differently with redshift. Overall, while AGN are found throughout the galaxy population, different physical conditions in different types of galaxies appear to play an important role in regulating AGN activity.

Notes

Does a universal mode of AGN accretion suggest AGN are not special?

Mackenzie Jones | Dartmouth College
Mackenzie.L.Jones.GR@Dartmouth.edu

Abstract

Observations of active galactic nuclei (AGN) allow us to trace the growth of black holes across cosmic time and investigate the impact of this growth on their host galaxies. Here we present results of modelling the underlying AGN population, accounting for observational biases and selection effects. First, I will present results showing that the Eddington ratio distribution for optically-selected AGN is consistent with a broad power-law, as seen in the X-rays (Jones et al. 2016). This suggests that a universal Eddington ratio distribution may be enough to describe the full AGN population, independent of host galaxy type or age. I will then describe our new semi-numerical galaxy formation simulation that includes this straightforward prescription for AGN accretion (Jones et al. 2017). We find that a simple model for AGN accretion can broadly reproduce the observed properties of host galaxies and halos of X-ray AGN. Furthermore, we find that the Eddington ratio distribution evolves with redshift, consistent with the behaviour predicted by hydrodynamic simulations and that different AGN selection techniques yield samples with very different host galaxy properties (Jones et al. 2018 in prep). Finally, I will point to future studies that will test whether our simple prescription for AGN accretion really is universal, or if further parameters are needed that would imply AGN are found in special host galaxies or environments.

Notes

Evidence for a mass-dependent AGN Eddington ratio distribution via the flat relationship between SFR and AGN luminosity

Dr Emmanuel Bernhard | The University of Sheffield
e.p.bernhard@sheffield.ac.uk

Abstract

The lack of a strong correlation between AGN X-ray luminosity ($L_{\rm X}$; a proxy for AGN power) and the star formation rate (SFR) of their host galaxies has recently been attributed to stochastic AGN variability. This is often incorporated in population synthesis models by assuming that the probability distribution of the AGN specific X-ray luminosity (i.e. the ratio between $L_{\rm X}$ and host stellar mass; a common proxy for Eddington ratio) is independent of any of their host galaxy properties, implying a decoupling between SFR and X-ray luminosity. Some recent studies have, however, demonstrated that a universal Eddington ratio distribution fails to reproduce key observed properties of the AGN and galaxy populations, not least the observed X-ray luminosity functions beyond $z \sim 1$. To investigate why this is the case, we developed a population synthesis model in which the Eddington ratio distribution differs between star-forming and quiescent hosts. We find that, although this model can reproduce the X-ray luminosity functions out to $z \sim 2$, it cannot simultaneously reproduce the observed flat relationship between SFR and X-ray luminosity. Introducing a mass dependency for the Eddington ratio distribution of AGNs in star-forming galaxies, in which there is a suppression of low Eddington ratios (i.e., $L_{\rm agn} < 0.1 L_{\rm Edd}$) in lower mass galaxies ($\log(M) < 10 M_{\odot}$), reproduces both the observed X-ray luminosity functions and the observed flat relationship between SFR and X-ray luminosity. Are AGN special? With our results demonstrating a fundamental conflict between an universal Eddington ratio distribution and observed AGN properties, we conclude: yes, they are.

Notes

The stellar and gas dynamics in the transition between black hole activity and quiescence

Dr Sandra Raimundo | Dark Cosmology Centre, University of Copenhagen
s.raimundo@dark-cosmology.dk

Abstract

Observations of the ionised and molecular gas dynamics in the nuclei of galaxies are essential to characterise AGN fuelling. Changing-look AGN show a dramatic transition in accretion rate (over a factor of 100) that occurs in only a matter of decades. They are a laboratory to study AGN fuelling and the onset of black hole accretion in a much shorter timescale than the thousands of years or more expected for the typical AGN on/off transitions. In this contribution I will present recent MUSE optical integral field observations of the gas and stellar dynamics in a changing-look AGN. We observe an interplay of inflow and outflow gas dynamics in the centre of the galaxy which suggests a cyclic nature for the fuelling of the AGN. We combined our new data with molecular gas observations to map the gas flow at different radii and characterise the AGN gas fuelling reservoir. I will discuss how changing-look AGN can be used as a tool to set constraints on the AGN fuelling process in general.

Notes

Understanding the mechanical feedback from high- and low-accretion rate radio galaxies

Dr Imogen Whittam | University of the Western Cape
iwhittam@uwc.ac.za

Abstract

I will discuss the properties of ∼1000 radio galaxies selected from a 1.4 GHz JVLA survey of Stripe 82. This survey covers 100 deg^2 and is a factor of five deeper than FIRST, allowing us to probe the fainter radio galaxy population (1.4 GHz luminosity $> 10^{21}$ W Hz^{-1}). Using optical spectra we have classified the sources as high-excitation (radiative mode) or low-excitation (jet mode) radio galaxies (HERGs and LERGs). We find that the HERGs tend to have higher Eddington-scaled accretion rates than the LERGs, but that there is more overlap between the two distributions than found by previous studies at higher radio luminosities. We show that the properties of the host galaxies (e.g. stellar mass and stellar age) vary continuously with accretion rate, with the most slowly accreting sources having the oldest stellar populations, consistent with the idea that these sources lack a supply of cold gas. We find that 84 per cent of our sample release more than 10 per cent of their accretion power in their jets, showing that mechanical AGN feedback is significantly underestimated in many hydrodynamical simulations. There is a scatter of ∼2 dex in the fraction of the accreted AGN power deposited back into the ISM in mechanical form, showing that the assumption in many simulations that there is a direct scaling between accretion rate and radio-mode feedback does not necessarily hold. We also find that mechanical feedback is significant for many of the HERGs in our sample as well as the LERGs. I will also discuss the influence of environment on the accretion rates and host galaxy properties of the radio sources in this sample. Finally, I will discuss plans to build on this work using the MeerKAT telescope here in South Africa.

Notes

Host galaxies of obscured AGNs and their environment

Dr Yu-Yen Chang | ASIAA
yuyenchang.astro@gmail.com

Abstract

I will present our recent results on mid-infrared selected active galactic nuclei (AGNs). We derived their stellar masses, star formation rates, dust properties, AGN contributions, as well as obscurations by fitting their optical to far-infrared photometry through the state-of-art spectral energy distribution (SED) technique. Our obscured AGNs by infrared selection are not significant different from the star-forming sequence. We confirm our previous finding about compact host galaxies of obscured AGNs at $z \sim 1$, and find that galaxies with 20-50% AGN contributions tend to have smaller sizes, by ∼25-50%. Besides, we show that high merger fraction up to 0.5 happens to the most luminous (log $L_{\rm IR} \sim 46$ ergs/s) AGN host and non-AGN galaxies, but not to the whole obscured AGN sample. Moreover, merger fraction has dependence on the total and star-forming infrared luminosity, rather than the decomposed AGN infrared luminosity. Our results suggest that major merger is not the main driver of AGN activities, and obscured AGNs might be triggered by internal mechanisms, such as secular process, disk instabilities, and compaction in a particular evolutionary stage. I will also discuss the role of environment on these obscured AGNs, based on the latest data from JCMT Large Programs and ALMA observations.

Notes

The evolutionary link between Type 1 and Type 2 quasars by their host galaxies

Dr Dongyao Zhao | Kavli Institute for Astronomy & Astrophysics, Peking University (KIAA)
zdymoon@pku.edu.cn

Abstract

One fundamental issue on clarifying the role of AGNs in galaxy growth and evolution is how AGNs were triggered. In simulations, gas-rich major merger is suggested as a promising mechanism to trigger luminous AGNs (quasars). Depending on this scenario, AGNs can be heavily obscured in the early phase appearing as type 2 quasars, then evolve into unobscured type 1 quasars that blows away gas and dust. With the aim of testing the role of major mergers in AGN activities and SMBH-galaxy coevolution in local universe, we conducted multi-wavelength HST WFC3 observations for matched sample of type 1 and type 2 quasars at $z \sim 0.1$ and carefully study the stellar properties of their host galaxies. Specifically, we rigorously analyse morphologies, structures (by 2D fits), colours, stellar masses and scaling relations of the host galaxies as well as their bulge components. We find that, for both type1 and type 2 quasars, minority of them ($<$35%) are hosted by galaxies with merging/disturbing morphologies, while majority of them ($>$50%) are hosted by regular disk galaxies (i.e., spiral, bar spiral, and lenticular galaxies). Moreover, we demonstrate that type 1 and type 2 quasars are indistinguishable in the properties of color and stellar mass, and they possess similar bulges whose sizes, concentrations, colours, stellar masses and scaling relations are statistically the same. Our results do not support the major merger scenario for luminous AGN in local universe and suggest the importance of secular processes. In contrast, studies on host galaxies of high$-z$ luminous AGNs have claimed the dominant role of major mergers. It implies that AGNs might be triggered by different mechanisms in different period of time. We will also compare our quasars with control sample of local normal galaxies to discuss whether the host galaxies of AGNs possess any specific properties.

Notes

Elevated Black Hole Growth in the Progenitors of Compact Quiescent Galaxies at $z = 2$ and Future Prospects with JWST.

Prof Dale Kocevski | Colby College
dale.kocevski@colby.edu

Abstract

I will present our recent finding that compact star-forming galaxies (cSFGs) at $z = 2$ host X-ray detected AGN at a rate five times greater than normal galaxies of similar mass and redshift. These cSFGs are likely the direct progenitors of the compact "red nuggets" observed at this epoch, which are the first population of passive galaxies to appear in large numbers in the early Universe. Our results are consistent with models in which cSFGs are formed through a dissipative contraction that triggers a compact starburst and concurrent growth of the central black hole. Our findings suggest that the first abundant population of quenched galaxies emerged directly following a phase of elevated supermassive black hole growth and further hints at a possible connection between AGN and the rapid quenching of star formation in these galaxies. I will also present an overview of the upcoming CEERS survey, which will observe the CANDELS-EGS field with JWST. CEERS will provide multi-band MIRI and NIRCam imaging, as well as NIRSpec spectroscopy that will enable the identification and study of AGN hosts beyond $z \sim 3$. CEERS is an ERS program and, as such, all data from the survey will be immediately available to the community.

Notes

The changing faces of quasars: what are the fundamental differences between blue and red quasars?

Lizelke Klindt | Durham University
lizelke.klindt@durham.ac.uk

Abstract

It has been proposed that luminous red quasars represent an evolutionary phase between starbursts and unobscured blue quasars, where energetic winds and radio jets are starting to drive gas and dust away from the nucleus. We can distinguish between an evolutionary or orientation-related explanation if red quasars differentiate themselves substantially from blue quasars in attributes that are related to their environments. To further explore the suggested models we used SDSS DR7 and WISE data to carefully select blue and red quasars from the redshift dependent $g-i$ distribution (in the redshift range $0.2 < z < 2.4$). From matching the subsets to FIRST we have found an enhanced radio-detection fraction of up to a factor of three for red quasars relative to blue quasars. This astonishing result is not driven by selection effects and demonstrates a clear connection between the radio-detection fraction and red quasars. The differences in the radio properties are not only restricted to the detection rate: red quasars have different radio-luminosity distributions and they appear to show differences in the broad morphological properties; e.g., a larger fraction of radio-detected red quasars lack strong radio lobes. The optical/MIR bolometric luminosity relations reveal either that the inferred optical luminosities are underestimated due to dust reddening, or that we observe an excess emission at 6 μm due to a larger dust covering factor in red quasars. Our results thus support the notion that red quasars are not compatible with just blue quasars reddened due to orientation.

Notes

Hot dust obscured galaxies

Dr Roberto Assef | Universidad Diego Portales
roberto.assef@mail.udp.cl

Abstract

The WISE mission has discovered a rare population of high-redshift, hyper-luminous infrared galaxies, all with bolometric luminosities above $\log L_{\rm Bol}/L_\odot > 13$, and many with $\log L_{\rm Bol}/L_\odot > 14$. Selected by their extremely red mid-IR colors and shown to have very hot dust temperatures, these hot, dust-obscured galaxies, or Hot DOGs for short, are dominated by the emission of a highly obscured, actively accreting supermassive black hole and may probe a key stage in galaxy evolution. I will present the latest results of our ongoing research to understand the nature of these enigmatic objects from the point of view of our extensive X-ray through radio photometric and optical spectroscopic follow-up observational campaigns, as well as our ALMA-based studies of their environments.

Notes

Observing the cold gas surrounding AGN-host galaxies with MUSE

Dr Michele Ginolfi | INAF-Observatory of Rome
michele.ginolfi@oa-roma.inaf.it

Abstract

Recent observations taken at the VLT-MUSE have revealed ubiquitous Lyman-alpha (Lyα) nebulae around bright QSOs at $z \sim 3-4$, extending up to 300 kpc. Such extended Lyα emission is mainly produced through circumgalactic gas "fluorescence" powered by the copious AGN-triggered UV radiation. Thanks to its Integral Field Unit (IFU), MUSE can provide information on the 3D-morphology and the kinematic of the cold gas distribution around bright QSOs; thus, these observations are precious for studying the interplay between AGN host galaxies and their surrounding environment. After briefly reviewing previous and current research on this topic, I will present new deep MUSE observations of a Broad Absorption Line (BAL) QSO at higher redshift, $z \sim 5$, revealing a Lyα nebula with a maximum projected linear size of $\sim$60 kpc around the QSO (Ginolfi+18,MNRAS). After correcting for the cosmological surface brightness dimming, we find that our nebula, at $z \sim 5$, has an intrinsically less extended Lyα emission than nebulae at lower redshift. However, such a discrepancy is greatly reduced when referring to comoving distances, which take into account the cosmological growth of dark matter (DM) haloes, suggesting an interesting positive correlation between the size of Lyα nebulae and the sizes of DM haloes/structures around QSOs. This conjecture is supported by a qualitative analysis of other observations of Lyα nebulae in a larger redshift range ($z \sim 2-7$). Differently from typical nebulae around radio-quiet non-BAL QSOs, in the inner regions ($\sim$10 kpc) of our nebula, the velocity dispersion of the Lyα emission is very high (FWHM$>$1000 km/s), suggesting that in our case the Lyα emission may trace outflowing material (associated with the BAL nature of the QSO) on 10 kpc-scales.

Notes

Oral Programme Abstracts

Tuesday, 31st July 2018

Review of AGN Clustering and Environment Results

Dr Alison Coil | UC San Diego
acoil@ucsd.edu

Abstract

I will review recent results on the clustering and environments of AGN, comparing results for AGN identified at different wavelengths, luminosities, and redshifts. I will also compare the clustering of AGN to galaxies in the same redshift and volume, taking into account AGN identification biases, and discuss the fundamental role that these biases play when interpreting AGN clustering and environment results.

Notes

Connecting black hole and galaxy growth within the EAGLE simulation

Stuart McAlpine | ICC, Durham University
s.r.mcalpine@durham.ac.uk

Abstract

I will present work investigating the link between galaxy and black hole growth within the hydrodynamical cosmological EAGLE simulations. Black holes within EAGLE transition through three evolutionary phases, linked to the mass of the host dark matter halo. This has natural consequences for globally linking properties of black holes and their host galaxies. For example, the correlation between star formation rate (SFR) and black hole accretion rate (BHAR), which forms a complex plane, and is able to explain the discrepancies between empirical studies that select on either BHAR or SFSR (McAlpine2017). I will also discuss the link between black hole activity and galaxy–galaxy mergers within EAGLE. We find that mergers (particularly major mergers) are important for producing the highest AGN luminosities (and Eddington rates) in the universe. I will discuss how we predict this link could best be seen observationally and the optimal selection methods (McAlpine in prep.).

Notes

Are obscured quasars special? Host galaxies & environments from ALMA & JVLA

Dr Manda Banerji | Institute of Astronomy, Cambridge
mbanerji@ast.cam.ac.uk

Abstract

Luminous, dust-obscured quasars have been hypothesized to represent the missing evolutionary link between starburst galaxies and unobscured quasars and are therefore an important transition population in galaxy evolution. This talk will present detailed observations of the host galaxies and environments of the most infrared luminous obscured quasars at $z = 2 - 3$ using data from SCUBA-2, ALMA and JVLA. Key results include: (i) the detection of multiple dusty star-forming galaxies around these quasars signalling the presence of significant over-densities (ii) evidence for gas-rich major mergers triggering star formation and accretion on to the supermassive black-hole in these systems (iii) constraints on the diverse interstellar medium properties of the population via observations of the CO(1–0), CO(3–2), CO(7–6) and CI(2–1) molecular line transitions and (iv) dynamical mass estimates for the quasar host galaxies via full dynamical modelling of the resolved velocity fields seen in molecular gas emission. I will draw comparisons to similar observations carried out for both the unobscured quasar and starburst galaxy populations in order to address the question: Are obscured quasars special in terms of their host galaxy properties and environments?

Notes

The hosts and environmental impact of local radio-loud AGN

Prof Martin Hardcastle | University of Hertfordshire
m.j.hardcastle@herts.ac.uk

Abstract

LOFAR surveys are giving us, for the first time, an unbiased view of the local radio-loud AGN population. The sensitivity and area coverage of LOFAR have enabled us to show that AGN activity at low luminosities is extremely common in massive galaxies; I will present the most recent results on the hosts and environments of the radio AGN population from the LOFAR survey of the 400-deg^2 HETDEX Spring field. However, it still appears to be the case that jet-related "feedback" activity in group/cluster environments is driven by rarer, more powerful AGN. Combining recent numerical and analytical modelling with observation, I will present estimates of the local jet kinetic luminosity function from which the overall energetic impact of the radio-loud AGN population may be estimated.

Notes

Black hole mass growth across cosmic time: Insights from the VLA-COSMOS 3 GHz Large Project

Dr Vernesa Smolcic | University of Zagreb
vs@phy.hr

Abstract

Understanding how galaxies form and evolve through cosmic time, and how these processes are influenced by active galactic nuclei (AGN) are important goals of modern astrophysics. In this context, "radio-mode AGN feedback" is a regular ingredient in cosmological models, yet from an observational perspective still rather poorly understood. It is considered to be a key feedback mechanism, related to central supermassive black hole mass growth, at work in the latest phases of massive galaxy formation, and controlling the galaxy's stellar mass build-up. Over the past decades our understanding of radio AGN was significantly advanced by panchromatic look-back sky surveys, and we have recently entered a "golden age" of radio astronomy thanks to upgraded and new facilities delivering now an order of magnitude increase in sensitivity. The VLA-COSMOS 3 GHz Large Project is based on 384 hours of observations with the upgraded, Karl G. Jansky Very Large Array (VLA) at 3 GHz (10 cm) toward the two square degree COSMOS field. The survey, reaching a median rms of 2.3 μJy/beam over the two square degrees at an angular resolution of 0.75 arcsec, contains 10,830 radio sources down to 5 times the rms. It simultaneously provides the largest and deepest radio continuum survey at such angular resolution to-date, bridging the gap between last-generation and next-generation radio surveys. These radio data, in conjunction with the panchromatic COSMOS data sets, allowed us to study the physical properties, composite nature (i.e., star-formation vs. AGN related contributions to the total radio emission of the sources), and cosmic evolution of radio AGN out to a redshift of about 6, which can directly be linked to the radio-mode feedback, as postulated in cosmological models.

Notes

Do galaxy mergers make AGN special?

Lisa K. Steinborn | University Observatory Munich
steinborn@usm.lmu.de

Abstract

We employ large-scale cosmological hydrodynamic simulations from the set of Magneticum Pathfinder Simulations with a volume large enough to allow for a statistical investigation of the most luminous AGN over cosmic time. The clustering properties of the simulated AGN, compared to all galaxies, reveal that AGN are indeed special. In particular, we find that the clustering strongly depends on the accretion mode, since the slope of the halo occupation distribution (HOD) is larger for inefficiently accreting AGN than for efficiently accreting ones. These results imply that AGN are not random events, but driven by certain fuelling mechanisms. One highly debated driving mechanism of AGN activity are galaxy mergers. Although simulations of isolated galaxy mergers strongly indicate that merger events increase AGN activity, their relevance for the overall AGN population is still a major unsettled question. In our simulations we find a clear connection between mergers and AGN activity. For AGN more luminous than 10^{45}erg/s, the fraction of AGN driven by minor and major mergers with respect to the total number of AGN strongly increases with AGN luminosity at $z = 2$, being largely consistent with recent observations. Thereby minor mergers play an equally important role as major mergers. However, we find that most AGN are not directly driven by merger events. Instead, the enhanced AGN fraction in mergers mainly reflects the intrinsic properties of the host galaxies (e.g. stellar mass, star formation activity), which are on average different for merging and non-merging galaxies. Instead of mergers, the gas supply and the properties of the gas surrounding the SMBH play a much more important role, independent of the recent merger history.

Notes

The conditions of single and dual AGN in late-stage galaxy mergers

Dr Scott Barrows | University of Colorado at Boulder
robert.barrows@colorado.edu

Abstract

It is currently unclear if powerful active galactic nuclei (AGN) are preferentially associated with galaxy mergers or if they are a more generic phase in all galaxies. Recent theoretical work suggests a more nuanced picture in which mergers are only important under specific conditions. In particular, AGN triggering may be dependent on the merger mass ratio, the gas fractions, and the AGN location within the merger. Thus far, these predictions have been difficult to test since the probability of AGN triggering in mergers likely peaks below 1 kpc. To overcome this observational hurdle, we have utilized the spatial resolution of the Chandra X-ray Observatory to develop a unique sample of AGN hosted by late-stage galaxy mergers. The spatial resolution of Chandra also allows us to determine the number of AGN and their spatial locations within each merging system. Moreover, we have recently acquired Hubble Space Telescope imaging to examine the role that their merger morphologies play in the formation of offset and dual AGN. We find that offset AGN are predominately found in minor mergers, whereas dual AGN are usually hosted by major mergers and galaxies with large morphological asymmetries. Furthermore, in both offset and dual AGN, the rate of SMBH growth increases toward more major mergers and larger morphological asymmetries. These results are the first to observationally confirm these theoretical predictions at small pair separations. Finally, we also see evidence that dual AGN are preferentially associated with relatively gas-rich systems while offset AGN are found in both gas poor and gas-rich systems. Overall, these results suggest that under the special conditions of major mergers, high gas fractions, and small nuclear separations galaxy mergers can elevate the frequency of AGN triggering beyond that of the non-merger population.

Notes

Monsters on the move: A search for supermassive black holes undergoing gravitational wave recoil

Yashashree Jadhav | Rochester Institute of Technology
ysj1195@rit.edu

Abstract

It has long been assumed that Active Galactic Nuclei reside at the centers of their host galaxies, but is this really true? A galaxy merger is expected to lead to the formation of an SMBH binary, which can shrink through dynamical processes until it eventually coalesces through the emission of gravitational waves. Such events fall outside the frequency range of the LIGO/VIRGO gravitational wave detectors and have not yet been detected through Pulsar timing arrays. However, numerical relativity simulations show that, depending on the initial spin-orbit configuration of the binary, the merged SMBH receives a gravitational recoil kick that may reach several 1000km/s. The kick causes the merged SMBH to oscillate for up to $\sim$1 Gyr in the gravitational potential well of the galaxy, during which, the recoiling SMBH may be observed as a "displaced" AGN. Displacements $\sim$10–100pc may be expected even in nearby elliptical galaxies and can be measured as spatial offsets in high resolution optical/infrared images. We present the results of a study of $\sim$100 early type active galaxies, in which isophotal analysis was conducted using Hubble Space Telescope archival and new optical/near-infrared images. We find evidence for significant spatial offsets between the position of the AGN and the photocenter of the galaxy in about 20% of the sample. We discuss our results in the context of the gravitational recoil hypothesis and also consider alternative displacement mechanisms. Establishing the distribution of displacement amplitudes of offset SMBH systems in the nearby universe will place constraints on the SMBH binary merger rate, galaxy merger rates (arguably one of the more uncertain quantities that determines the incidence of displaced SMBH) and provide new insights into the interactions between SMBH and their host galaxies.

Notes

Clustering of Hard X-ray-Selected AGN

Meredith Powell | Yale
meredith.powell@yale.edu

Abstract

I present recent results on the large-scale environments of X-ray-selected AGN via clustering analyses. By measuring the cross-correlation function of AGN from the Swift/BAT Spectroscopic Survey (BASS) with 2MASS galaxies, and modeling it via populating dark matter halos from the Bolshoi-Planck simulation with subhalo- and HOD-based models, we constrain their halo occupation statistics. I show that on average, the AGN occupy halos consistently with inactive galaxies of the same stellar mass distribution. However, when breaking up the sample in bins of column density, we find that obscured AGN reside in denser environments than unobscured AGN, despite no significant difference in their luminosity, redshift, stellar mass, or Eddington ratio distributions. We show there is a degeneracy between them residing in halos of different mass with distinct halo occupation distributions, or residing in halos of systematically different concentrations/assembly histories. Lastly, preliminary results on the clustering of the higher redshift AGN in the Stripe82X Survey are presented.

Notes

A spectroscopic study of AGN activity in massive galaxy clusters

Emil Noordeh | Stanford University
emiln@stanford.edu

Abstract

In galaxy clusters, environmental effects such as ram-pressure stripping, evaporation, and starvation can substantially impact galaxy gas reservoirs, changing the nature of the AGN-host galaxy connection. As such, clusters provide an exceptional laboratory to probe AGN fuelling processes as well as the connection between black hole and galaxy growth. At low redshifts, X-ray/optical AGN activity is observed to be suppressed in the cluster environment, but recently there has been intriguing evidence that this suppression reverses with redshift and that at $z > 1.5$ cluster AGN activity may be significantly enhanced with respect to the field. We have been undertaking spectroscopic observations of AGN in massive galaxy clusters in different redshift slices in order to probe this effect. I'll share our analysis of 7 clusters at $z \sim 0.4$ where we find evidence for a suppression of AGN activity towards the cluster core as well an inverse dependence of AGN activity with cluster mass, suggestive of merger driven triggering. I will also present new insight into AGN activity in the highest redshift, massive cluster known at $z \sim 2$. Preliminary analysis of our HST imaging and spectroscopy has unveiled a clear red sequence as well as evidence for a significant enhancement of AGN activity and star formation in confirmed cluster members.

Notes

Ram pressure triggers AGN in galaxy clusters

Madeline Marshall | University of Melbourne
madelinem1@student.unimelb.edu.au

Abstract

Active galactic nuclei (AGN) play an important role in the regulation of star formation in their host galaxies and the larger scale environment. To develop a full understanding of the role of AGN, it is important to know how they are triggered. Using a semi-analytic galaxy evolution model, I investigate the predicted spatial distribution of AGN in clusters under the assumption that they are triggered by ram pressure effects. By comparing these simulated AGN to SDSS observations of relaxed clusters, I find that the observed AGN distribution can be reproduced well by ram pressure triggering, with triggering ram pressures consistent with those found to trigger star formation in hydrodynamical simulations. These findings may assist in the interpretation of cluster observations including deep multi-wavelength and integral field surveys.

Notes

The complicated environments of the most powerful AGN at high redshift: progenitors of local brightest cluster galaxies or not?

Prof Roderik Overzier | National Observatory, Brazil
roderikoverzier@gmail.com

Abstract

It has been suggested that the most powerful AGN in the early universe, ranging from luminous radio galaxies at $z \sim 2$ to the brightest quasars at $z \sim 7$, are good signposts for the progenitors of today's massive central cluster galaxies and their supermassive black holes. Although spectacular cases of very strong galaxy clustering around various high redshift AGN has been found, the full story is rather more complex. In this talk, I will review our limited understanding of the possible links between powerful AGN and their larger-scale galaxy environments at high redshift. Based on the review paper by Overzier (2016) and more recent work.

Notes

Oral Programme Abstracts

Wednesday, 1st August 2018

Supermassive black hole growth and feedback in the early Universe

Dr Debora Sijacki | IoA, Cambridge
deboras@ast.cam.ac.uk

Abstract

In this talk I will review current theoretical efforts in understanding supermassive black hole formation, accretion and feedback in the early Universe. Specifically, I will discuss possible links between large scale cosmological environment and supermassive black hole assembly and highlight key ingredients needed to power luminous high redshift quasars. Furthermore, I will outline several possible interaction channels between these luminous quasars and their host galaxies in view of a mounting observational evidence of large scale, multiphase AGN-driven outflows.

Notes

Formation of pre-AGN via Direct Collapse: cosmological zoom-in hydro simulation with radiation transfer

Prof. Ken Nagamine | Osaka Univ. / UNLV
kn@vega.ess.sci.osaka-u.ac.jp

Abstract

Direct collapse of a gas sphere is an attractive scenario for the formation of pre-AGN (i.e. massive black hole seed). We model collapse of a primordial gas within dark matter halos using high-resolution cosmological zoom-in hydro simulations with flux-limited diffusion (FLD) approximation for radiation transfer. Collapse is followed down to the formation of photosphere, and adiabatic models have been run for comparison. We find that (1) the FLD flow forms an irregular central structure with dynamically insignificant rotation, and does not exhibit fragmentation. This is contrary to adiabatic model which forms an asymmetric, geometrically-thick disk that drives a pair of strong spiral shocks, subject to Kelvin-Helmholtz shear instability, forming fragments; (2) the growing central core in the FLD flow quickly reaches a core mass of $\sim$10 $M_\odot$ and a highly variable luminosity of order of $10^{38} - 10^{39}$ erg/s, comparable to the Eddington luminosity. It experiences massive recurrent outflows driven by radiation force and thermal pressure gradients, which form dense expanding shells, mixing with the accretion flow and transferring the angular momentum outwards; and (3) the interplay between radiation and thermal pressure gradients and gravity, subject to the massive accretion rate, results in photosphere of radius $\sim$10 AU, much larger than that of a protostar. Overall, the inclusion of radiative transfer reveals complex early stages of formation and growth of the central structure in direct collapse scenario of massive black hole formation. For more details, please see arXiv:1803.03278 and 1801.08545.

Notes

Modelling the Black Hole-Galaxy Connection Over Cosmic Time

Angelo Ricarte | Yale University
angelo.ricarte@yale.edu

Abstract

We have developed a semi-analytic model (SAM) which can reproduce the properties of accreting black holes from $z = 6$ to the present. This model begins at the seeding epoch, $15 < z < 20$, and evolves forward the black hole population using simple prescriptions for accretion and dynamics that are linked to the state of the host galaxy. We find that merger-triggered bursts of accretion are sufficient to explain black hole assembly for $z > 2$. Yet at later times, a secondary steady mode of accretion must take over to explain both low-redshift luminosity functions and the assembly of low-mass black holes. We also explore the consequences of different black hole seeding mechanisms, and we find observational signatures in luminosity functions just beyond our high-redshift frontier as well as in the mass distributions of gravitational wave events.

Notes

Is AGN Growth at the Highest Redshifts Dominated by Compton-thick Sources?

Prof. Amy Barger | University of Wisconsin-Madison
barger@astro.wisc.edu

Abstract

We have used SCUBA-2 and ALMA to detect 75 sources in 100 square arcminutes of the Chandra Deep Field-South, by far the largest sample of faint 870 micron sources yet obtained. The high spatial positional accuracy of these ALMA data allows a detailed comparison with the X-ray, optical, and infrared data. We used the combined data set to search for very high-redshift Compton-thick AGNs and found several candidates at $z >> 4$. It is possible that this type of source may dominate the AGN population at the highest redshifts and hence the growth of supermassive black holes at this time. These sources also contain large amounts of star formation, suggesting a strong coupling between the black hole growth and the galaxy growth.

Notes

Oral Programme Abstracts

Thursday, 2nd August 2018

The birth of giants: quasars and their host galaxies in the early universe

Dr Bram Venemans | MPIA Heidelberg
venemans@mpia.de

Abstract

Quasars are the brightest, non-transient objects observed at the highest redshifts, $z > 7$, which makes them unique probes of the evolution of black holes, massive galaxies and the intergalactic medium: the density of high redshift quasars puts powerful constraints on the mechanisms that are required to seed and grow supermassive, $> 10^9$ solar mass black holes less than a Gyr after the Big Bang. Observations in the (sub)millimeter can constrain the gas and dust content, star formation rate and masses of the galaxies hosting these luminous quasars. In this talk I will focus on the recent progress made in locating luminous quasars in the early universe using very wide field optical and near-infrared surveys and present the results of various multi-wavelength follow-up programmes, in particular the recent ALMA observations of the quasar host galaxies and their environment. I will discuss the implications of these findings on massive galaxy and black hole formation.

Notes

The Fastest Growing SMBHs at $z \sim 5$: Mapping their Fast-Growing Hosts and their Over-Dense Environments

Benny Trakhtenbrot | ETH Zurich
benny.trakhtenbrot@phys.ethz.ch

Abstract

I will present new ALMA and HST data that are part of a multi-wavelength, multi-scale project to understand the epoch of fastest growth of the most massive black holes, and their host galaxies, at $z \sim 5$. These luminous quasars accrete close to their Eddington limit, and have black hole masses of $M_{\rm BH} \sim 10^9 M_{\odot}$. Our dedicated ALMA campaigns show that a high fraction of these systems are related to major galaxy mergers, over-dense environments, and/or extremely intense star formation activity. The new HST data probe the stellar content of the quasars' hosts and of the interacting companion galaxies seen by ALMA, as well as the larger-scale environments. The HST non-detections of the companion sub-mm galaxies suggest that fast SMBH growth is related to extremely gas- and dust-rich star forming environments. Our HST data, which covers scales of ∼1-100 kpc, may ultimately trace the origins of the well-known relations between BH and stellar mass, and whether early, fast SMBH growth occurs preferentially in over-dense large scale environments (i.e., proto-clusters), as suggested by recent simulations. I will finally mention the forthcoming steps in this long-term project.

Notes

Ionised outflows in $z \sim 6$ QSOs are there. Investigating AGN-feedback and host galaxy properties in very luminous high-redshift QSOs

Manuela Bischetti | INAF OAR, Università degli Studi di Roma Tor Vergata
manuela.bischetti@oa-roma.inaf.it

Abstract

I will present evidence of AGN-driven outflows in the early Universe, resulting from the stacking analysis of ALMA [CII] observations of a sample of ∼50 QSOs at $z \sim 5 - 7$. Very broad [CII] wings are on average present, and extend beyond velocities of 1000 km/s in systems with low and high SFR. Such wings are therefore revealing AGN-driven [CII] outflows, with associated mass outflow rates of 500-1500 $M_{\odot}$/yr. I will discuss how these outflows relate to those observed in lower$-z$ AGNs and give an estimate of their spatial extension. Thanks to sub-mm 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 $M_{\odot}$/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 take place in the companion galaxies.

Notes

The role of AGN in the reionization of the Universe

Dr. Federica Ricci | PUC
fed.ricci89@gmail.com

Abstract

The cosmological process of hydrogen (H I) reionization in the intergalactic medium is thought to be driven by UV photons emitted by star-forming galaxies and ionizing active galactic nuclei (AGN). The contribution of quasars (QSOs) to H I reionization at $z > 4$ has been traditionally believed to be quite modest. However, this view has been recently challenged by new estimates of a higher faint-end UV luminosity function (LF). To set firmer constraints on the emissivity of AGN at $z < 6$, we here make use of complete X-ray-selected samples including deep Chandra and new Cosmic Evolution Survey data, capable to efficiently measure the 1 Ryd comoving AGN emissivity up to $z \sim 5 - 6$ and down to 5 mag fainter than probed by current optical surveys, without any luminosity extrapolation. We find good agreement between the log $N_H \simeq 21 - 22$ cm^{-2} X-ray LF and the optically selected QSO LF at all redshifts for M1450$\simeq$-23. The full range of the log $N_H < 21 - 22$ cm^{-2} LF (M1450< -17) was then used to quantify the contribution of AGN to the critical value of photon budget needed to keep the Universe ionized. We find that the contribution of ionizing AGN at $z = 6$ is as small as 1-7 per cent, and very unlikely to be greater than 30 per cent, thus excluding an AGN-dominated reionization scenario.

Notes

Observations of quasar-driven galactic winds

Dr Nadia Zakamska | Johns Hopkins University
zakamska@jhu.edu

Abstract

Feedback from supermassive black holes is now thought to be one of the key components of galaxy formation. It is well known that active nuclei are capable of launching powerful winds and jets, but until recently the impact of these phenomena on galactic scales was poorly measured and poorly understood. A major difficulty is that quasar-driven winds are multi-phase phenomena, and different phases require observations using different tracers. It is not yet known which phase dominates the energy and the momentum of quasar-driven winds on galactic scales. I will review observational techniques used in measuring winds from active galactic nuclei and in measuring their impact on galactic scales, summarize exciting new results and discuss unsolved problems and outstanding issues.

Notes

An AGN special: feedback across cosmic epochs

Dr Giovanni Cresci | INAF – Osservatorio di Arcetri
gcresci@arcetri.astro.it

Abstract

Galaxy-scale outflows powered by actively accreting supermassive black holes are now routinely detected, and they have been associated with both the suppression and triggering of star formation. I will present results on both high$-z$ and local AGNs, discussing the different properties and impact of AGN outflows on their host galaxies at different cosmic epochs, and showing signatures of both positive and negative feedback.

Notes

KASHz: The properties and prevalence of AGN-driven outflows during the peak of activity

Dr Chris Harrison | ESO
charriso@eso.org

Abstract

There is now wide observational support that AGN drive outflows into their host galaxies and beyond. For low-redshift systems ($z < 0.5$) optical spectroscopic surveys, such as SDSS, have played a key role in determining the prevalence of ionized outflows in AGN and non-AGN host galaxies. Consequently, follow-up spatially-resolved spectroscopy (i.e., IFU observations) means that detailed measurements of the properties of these outflows can placed into context of the overall population. However, for systems during the peak epoch of black hole and galaxy growth ($z \sim 1 - 3$) IFU constraints of AGN outflows have typically been of rare, extreme objects. To overcome these limitations, we have utilised KMOS to create a sample of 250 $z \sim 0.5 - 3$ AGN with IFU observations to search for and to characterise ionised outflows. In combination with follow-up AO-assisted IFU observations and high-resolution ALMA observations of subsets of our targets, we are creating a detailed picture of how typical AGN impact upon the star formation in their hosts. Furthermore, by comparing to IFU observations of 100s of non-active high$-z$ galaxies we can address the question: Are AGN Special?

Notes

The WISSH survey: Revealing ultra-massive black-holes and powerful winds in the most luminous quasars.

Dr. Giustina Vietri | ESO/Excellence Cluster Universe
Giustina.Vietri@eso.org

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 ($L_{\rm bol} > 10^{14} L_{\odot}$) and at the peak of their number density ($z \sim 2.5 - 3.5$). We found that WISSH quasars are typically powered by highly accreting (0.3–3 $L_{\rm edd}$), 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 $L_{\rm bol}$ 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.

Notes

How do AGN shape the way the Universe looks?

Dr Yohan Dubois | IAP
dubois@iap.fr

Abstract

Notes

The impact of AGN feedback on star formation inferred from ALMA and hydrodynamical simulations.

Jan Scholtz | Durham University/ESO
honzascholtz@gmail.com

Abstract

AGN are expected to have an impact upon the star formation in their host galaxies; however, there has been confusing and contradictory results in the literature on the observational evidence for or against this prediction. By utilising the largest set of X-ray AGN observed at 870 microns with ALMA, in combination with archival UV through FIR data, we have constructed star formation rate and specific star formation rate distributions of $z \sim 1-3$ AGN - a substantial step forward from the average (mean) values that are usually adopted at these redshifts. In combination with model predictions we demonstrate that, taken at face value, the observational results may be miss-interpreted as providing evidence against AGN feedback. By utilising the EAGLE simulations with and without the AGN feedback, we identified the predicted observational signatures of AGN feedback on the (specific) star formation rates of massive galaxies. As well as lowering the typical star formation rates of massive galaxies, we find that the AGN are responsible for broadening the distribution of the sSFR distribution in the overall galaxy population for galaxies. Our work demonstrates that these distributions are key observational tests for feedback models and that understanding the role of AGN feedback in galaxy evolution comes from combining cutting edge observations with strong theoretical predictions.

Notes

AGN feedback does not destroy cold molecular gas in local luminous Seyfert galaxies

Dr. David Rosario | Durham University
david.rosario@durham.ac.uk

Abstract

The properties of cold molecular gas in galaxies are sensitive to the nature and efficiency of star formation within molecular clouds. I will report on a carefully controlled CO spectroscopic study of a complete volume-limited set of the most luminous nearby ($D < 40$ Mpc) Seyfert galaxies, designed to understand whether the gas fractions and star formation efficiencies are influenced by the presence of the AGN. Despite several advances over earlier studies of this kind, we find no differences between AGN and inactive galaxies: indeed, the star formation efficiencies in the centres of Seyferts are consistent with their larger-scale discs. This highlights the resilience of star forming molecular gas against the effects of AGN feedback.

Notes

Oral Programme Abstracts

Friday, 3rd August 2018

Black Holes and the Future of Galaxy Formation

Prof. Richard Bower | ICC, Durham
R.g.bower@durham.ac.uk

Abstract

Galaxies fall into two clearly distinct types: "blue-sequence" galaxies that are rapidly forming young stars, and 'red-sequence' galaxies in which star formation has almost completely ceased. In my talk, I'll argue that these sequences are created by a competition between star formation-driven convection and gas accretion on to the supermassive black hole at the galaxy's centre. The transition between galaxy types occurs as the hot gas corona become hot enough to trap star formation buoyant gas that would otherwise boil off the galaxy. This picture explains a remarkable range of the observed properties of the Universe, from the host halo masses of luminous quasars to the transformation of galaxy morphologies. I'll follow-on by looking at the implications of this model for the future star formation history of the Universe.

Notes

Improving AGN feedback for the next generation of cosmological simulations

Dr. David Barnes | MIT
djbarnes@mit.edu

Abstract

Feedback from active galactic nuclei (AGN) is now a cornerstone upon which theories of galaxy and structure formation are built. AGN feedback is thought to be the mechanism that establishes the observed scaling relations between integrated galaxy properties and black hole properties, creates the observed population quiescent massive galaxies and regulates strong cooling flows and the baryonic content of galaxy groups and clusters. However, as the numerical resolution and structure formation models of cosmological simulations improve it is becoming clear that current AGN models are no longer sufficient (Rosas-Guevara et al. 2016, Barnes et al. 2017b,c, Weinberger et al. 2017b). In this talk, I will explore how fair comparisons between current and impending observational data and numerical simulations can place tighter constraints on models of AGN feedback. I will then use the IllustrisTNG simulations (Weinberger et al. 2017a, Pillepich et al. 2018a) to examine if the modelling feedback can be improved by including additional physical processes, like anisotropic thermal conduction, by studying the fraction of galaxy clusters that host a cool-core (Barnes et al 2017c, in prep.). Finally, I will explore how the impact of "quasar mode" feedback changes when the radiation, and its resulting dust pressure, is modelled directly in radiation hydrodynamical simulations compared to current AGN feedback models (Barnes et al. in prep., Vogelsberger in prep.).

Notes

Near-IR and Radio constraints of Obscured AGN and their Feedback in Advanced Mergers

Prof. Anca Constantin | James Madison University
constaax@jmu.edu

Abstract

Close separation dual AGNs provide unambiguous confirmation of ongoing mergers where the black holes experience their most rapid growth. However, most of these systems have been discovered serendipitously, and confirmed cases remain extremely rare. We present here the results of the analysis of new Jansky Very Large Array radio continuum observations and Large Binocular Telescope near-IR spectroscopy of advanced merger systems that display mid-IR colors suggestive of AGNs while lacking signatures of activity in the optical. We confirm the presence of broadened and/or high-excitation lines indicative of powerful AGN, reveal signs of hidden AGN feedback in the form of kinematic outflows, and begin to probe the multi-phase properties of their ISM. We give special attention to the morphology and the kinematic modeling of the molecular and high-ionization gas, as well as to the physical mechanisms leading to this emission. Our results yield critical evidence that the epoch of peak black hole growth in mergers occurs in a highly obscured phase, consistent with theoretical predictions. This is one of the first detailed investigations into the physical environment of optically obscured dual AGNs, and provides key indications for finding and characterizing elusive black hole accretion, with strong implications for the global accounting of feedback energy driven by low-luminosity AGNs into the circumnuclear medium.

Notes

Do AGN Lurk in Special Galaxies Caught in the Early Stages of Transition?

Dr. Lauranne Lanz | Dartmouth College
lauranne.lanz@dartmouth.edu

Abstract

The role of AGN in the transition of galaxies from actively star forming to quiescence is still not fully understood, and is particularly challenging to study for AGN that are weak or hidden by obscuration or host dilution. The Shocked Post-starburst Galaxy Survey (SPOGs) selects quenching galaxies that contain shocks based on their optical line diagnostics as well as molecular gas. SPOGs catches galaxies at an earlier stage of transition than classical post-starburst selection criteria, providing a crucial window into the role of AGN in this special early phase of transformation. We recently completed a pilot survey using Chandra to look for AGN in a set of SPOGs showing enhanced IR emission relative to their molecular content. I will discuss the insights obtained about the characteristics of AGN in SPOGs and the implications on the role of AGN in galaxy transitions.

Notes

Simulation of AGN feedback in galaxy clusters

Dr. Martin Bourne | IoA/KICC, University of Cambridge
mabourne@ast.cam.ac.uk

Abstract

AGN feedback plays an important role in galaxy evolution, particularly in high mass galaxies. One channel of feedback occurs through powerful jets that inflate large cavities of relativistic plasma and is critical in regulating the heating of the intracluster medium (ICM). However, how the mechanical energy of the jets is isotropically communicated to the ICM remains an open question. Given the large dynamic range in the processes governing AGN feedback and its interaction with the ICM, attempting to simulate all of the relevant scales is a formidable task. I will present simulations of jet feedback using the moving mesh code AREPO. The method relies upon a super-Lagrangian refinement technique that provides vastly improved resolution close to the SMBH while still allowing courser resolution on larger scales. The technique allows us to launch high-resolution jets on relatively small scales and capture its propagation and evolution to large distances ($\sim$100 kpc). We study the lobe inflation process, its interaction with the ICM, including turbulence generation (or lack thereof). Further, we investigate jet evolution in more realistic cluster environments, for example by including sub-structure driven motions in the ICM, which are able to reproduce line-of-sight kinematics consistent with Hitomi observations of the Perseus cluster.

Notes

Supermassive black holes as the regulators of star formation in central galaxies

Bryan Terrazas | University of Michigan
bterraza@umich.edu

Abstract

Cavities and bubbles in the extended X-ray emission from massive galaxies demonstrate that feedback from supermassive black holes can have a profound effect on the hot gaseous atmospheres that surround these systems. The consequences of these effects result in dramatic changes with respect to how the baryon cycle works and whether new stars are able form within these galaxies. With this concern in mind, we present a relationship between the black hole mass, stellar mass, and star formation rate of a diverse group of 91 local galaxies with dynamically-measured black hole masses. For our sample of galaxies with a variety of morphologies and other galactic properties, we find that the specific star formation rate is a smoothly decreasing function of the ratio between black hole mass and stellar mass. We propose a physical framework where galaxies are in equilibrium with their hot gas atmospheres: we argue that the amount of sustained heating from low-accretion rate black hole feedback suppresses a certain amount of cooling onto the galaxy and results in a corresponding rate of star formation. With respect to galaxy formation models, our results present a powerful diagnostic with which to test various prescriptions of black hole feedback and its effects on star formation activity. Using the new IllustrisTNG simulation, we compare our observational results with simulation data and test whether our physical interpretation holds true in a state-of-the-art model. In addition, we use the fiducial IllustrisTNG run and dozens of other TNG runs with varying physics implementations to show how observable galaxy trends and correlations are affected by changes in the black hole feedback physics, thereby providing a pathway to physically interpret observations.

Notes

AGN-enhanced outflows of low-ionization gas in star-forming galaxies at $1.7 < z < 4.6$

Dr Margherita Talia | University of Bologna
margherita.talia2@unibo.it

Abstract

Fast and energetic winds are invoked by galaxy formation models as essential processes in the evolution of galaxies. These massive gas outflows can be powered either by star-formation and/or AGN activity, but the relative dominance of the two mechanisms is still under debate. In this work we use spectroscopic stacking analysis to study the properties of the low-ionization phase of the outflow in a sample of 1332 star-forming galaxies (SFGs) and 62 X-ray detected ($L_X < 10^{45}$ erg $s-1$) Type 2 AGN at 1.7<z<4.6 selected from a compilation of deep optical spectroscopic surveys (mostly from zCOSMOS-Deep and VUDS). We measure velocity offsets of ∼-150 km/s in the SFGs while in the AGN sample the velocity is much higher (∼-800 km/s), suggesting that the AGN is boosting the outflow up to velocities that could not be reached only with the star-formation contribution. The sample of X-ray AGN has on average a lower SFR than non-AGN SFGs of similar mass: this, combined with the enhanced outflow velocity in AGN hosts, is consistent with AGN feedback in action. We further divide our sample of AGN into two X-ray luminosity bins: we measure the same velocity offsets in both stacked spectra, at odds with results reported for the highly ionized phase in local AGN, suggesting that the two phases of the outflow are mixed only in low-velocity outflows.

Notes

Poster Programme Abstracts

Monday, 30th July to Friday, 3rd August 2018

1A Towards an understanding of the duty cycle of AGN flickering using quasar light echoes

Dr. Patricia Bessiere | Pontifica Universidad Catolica de Chile
patricia.bessiere.astro@gmail.com

Abstract

Although our current understanding of galaxy evolution strongly suggests that active galactic nuclei (AGN) play a key role, the fundamental question of how they are triggered remains unanswered. It has been suggested that the trigger may be major galaxy mergers, but although many telescope hours have been expended on this topic, the answer remains elusive. Therefore, we have taken a novel approach to determining the significance of mergers in triggering AGN. We have utilise the recently discovered phenomenon of quasar light echoes, along with the dawning realization that AGN activity is most likely episodic, switching on and off many times throughout the whole accretion episode, to make a systematic search for evidence of such light echoes around merging but non-active galaxies. In this talk, I will outline the promising initial results of our imaging campaign, in which we find $\sim$ 10% of our sample show evidence of light echoes. I will also discuss the next steps towards observationally quantifying the duty cycle of AGN, and thus gain fundamental new insights into how AGN drive galaxy evolution.

1B The prevalence of X-ray selected AGN in dwarf galaxies

Keir Birchall | University of Leicester
klb64@leicester.ac.uk

Abstract

Black holes are near ubiquitous higher up the galactic mass scale so AGN activity is inevitable at some point in the host's lifetime, but how prevalent are AGN in the regime of dwarf galaxies and is there anything special about these objects? Dwarf galaxies are orders of magnitude less massive, generally have lower metallicities than their high mass counterparts and rarely interact with their neighbours; for these reasons they can also be considered an analogue for the high redshift Universe. Thus, determining the occupation fraction of AGN within dwarf galaxies gives us an insight not only into the low mass environments that can trigger such activity, but also into the mechanisms by which black hole seeds form and develop. Focusing on the nearby universe ($z < 0.25$), we present results from one of the first robust and large-scale quantifications of X-ray selected AGN in this redshift and mass regime. Starting from a parent sample of 835,861 galaxies, we combined data from the MPA-JHU catalogue (based on SDSS DR8) and 3XMM DR7, performed a careful review of the data to remove misidentifications and produced a sample of ∼70 dwarf galaxies ($M_* < 3 \times 10^9 M_\odot$) that exhibit nuclear X-ray activity indicative of an AGN. After carefully considering the varying sensitivity of the 3XMM survey, we quantify the occupation fraction in the low redshift regime and speculate about the implications for black hole formation models. In addition, we compare the results of BPT diagnostics and show that this selection method misses a high fraction of our AGN population.

1C The flaring activity of Sagittarius A* at 3mm observed with ATCA

Dr. Abhijeet Borkar | Astronomy Institute of the Czech Academy of Sciences
borkar@asu.cas.cz

Abstract

The center of the Milky Way harbours a 4 million $M_\odot$ supermassive black hole (SMBH), Sagittarius A* (Sgr A*). It is extremely underluminous with bolometric luminosity several orders of magnitude less than its corresponding Eddington luminosity, and exhibits properties similar to the comparatively higher luminous low luminosity active galactic nuclei. Its immediate proximity enables us to study the physics of the accretion processes in galactic nuclei with great detail. Sgr A* undergoes regular flaring activity which is thought to arise from the innermost region of the accretion flow. This strong flux variability has been observed across different wavelengths, from NIR & X-ray to radio and submillimeter. Multiwavelength observations have shown that the NIR & X-ray flares occur simultaneously, and are followed by the submm & radio flares. The study of the flux variability provides indirect constraints on the details of the emission mechanism and allows us to investigate the accretion around a low-luminosity SMBH. Here we present the results of our observations of the Galactic Center at 3 mm wavelength using the Australia Telescope Compact Array, taken between 2010 and 2014. We use structure function analysis and Bayesian blocks representation to detect the flaring events. From this, six instances of flaring activity were detected, lasting 1.5 - 3 hours. The adiabatically expanding plasmon model was used to describe the flares and derive the physical properties of the source responsible for the variability.

1D Warped disks and super-Eddington flows in X-ray binaries as an analogue to AGN accretion physics

McKinley Brumback | Dartmouth College
mckinley.c.brumback.gr@dartmouth.edu

Abstract

AGN display a range of interesting accretion phenomena, including super-Eddington accretion rates and the formation of accretion disks with complex geometry. These same characteristics can also be found in X-ray binaries, which offer an opportunity to study accretion physics in greater detail because of their proximity and shorter accretion time scales. Here, we present a multi-epoch timing and spectral analysis of the luminous neutron star binary LMC X-4. LMC X-4 displays periodic changes in luminosity that are attributed to the precession of a warped inner accretion disk. Analogous disks have been found in nearby AGN such as NGC 4258 and the Circinus galaxy. In order to examine the kinematics and geometry of warped accretion disks, we use joint observations with NuSTAR and XMM-Newton to perform pulse phase spectroscopy, and we observe the complete precession of the warped accretion disk around the neutron star for the first time. Additionally, we use a careful timing analysis to demonstrate a dramatic "turn-on" in pulsations from this source in association with a super-Eddington accretion flare. Understanding the effects of accretion disk geometry and super-Eddington accretion on X-ray binaries can shed light on accretion onto other types of compact objects, including AGN.

1E AGNs are not special: Stellar populations in the nuclei of ultra hard X-ray selected AGNs

Dr. Leo Burtscher | Leiden Observatory
burtscher@strw.leidenuniv.nl

Abstract

We present the nuclear (R ≈ 100 pc) star formation histories of a complete, ultra-hard-X-ray selected sample of luminous local AGNs and a matched sample of inactive galaxies (the LLAMA sample). Using VLT/X-SHOOTER spectroscopy, we performed stellar population synthesis of ten AGNs and 17 inactive control galaxies. We find that the nuclear star formation histories of AGNs are very similar to the star formation histories of inactive galaxies with nuclear star-formation, suggesting that AGNs are not special, but perhaps an inevitable consequence of a certain circum-nuclear environment.

1F The fraction of accreting black holes in dusty star-forming galaxies

Gabriela Calistro Rivera | Leiden Observatory
gcalistrorivera@gmail.com

Abstract

Although AGN do not typically dominate the bolometric emission of dusty star forming galaxies, large AGN fractions (sometimes >40%) have been observed in various sub-millimeter surveys. These diagnostics have been however mostly based on X-ray counterpart selections and a complete multiwavength census of the fraction of AGN hosts is needed. I will present our results on a multiwavelength characterisation of the AGN contribution to the bolometric emission in dusty star forming galaxies in the ALESS submillimeter survey. Using mid-infrared spectroscopically estimated AGN fractions in ULIRGs we have calibrated our method based on SED modelling, enabling us to return robust estimates of AGN fractions till ∼30%. Our method reveals a significantly larger contribution of AGN activity buried in star formation than previously expected and represents a unique tool to potentially characterise an unbiased accretion history of the Universe when applied to larger populations of star-forming galaxies.

1G Co-evolution of black hole accretion and star formation in galaxies

Rosamaria Carraro | Universidad de Valparaiso
rosamaria.carraro@postgrado.uv.cl

Abstract

We investigate the co-evolution between black hole accretion rate (BHAR) and star formation rate (SFR). We take advantage of new Chandra X-ray COSMOS-Legacy survey which allows to exploit the unique depth/area combination of the COSMOS field in its entirety in combination with the new COSMOS2015 catalog, comprising the new UVista Ultra-deep observations in COSMOS. This allows to make an X-ray stacking analysis in a very broad redshift interval (0.1<z<3.5) with great statistics for normal star forming, quiescent and starburst galaxies. We estimate the SFR from the far-IR and study the average SFR-stellar mass (M*) relation and compare it with the BHAR-M* relation. We also study the specific SFR and specific BHAR evolution with redshift. Our results support the idea that the same secular processes feed and sustain both star formation and black hole accretion in normal star-forming galaxies while starburst and quiescent galaxies show an average higher and lower BHAR respectively. We find evidence of downsizing for both star formation and black hole accretion, and a higher efficiency in the black hole accretion process than in the star formation.

1H An extreme population of heavily buried AGN: Identification and host galaxy characteristics

Christopher Carroll | Dartmouth College
christopher.m.carroll.gr@dartmouth.edu

Abstract

Obscured quasars represent a large fraction of the total number of powerful active galactic nuclei (AGN). Understanding the complete quasar population requires a full accounting of these sources, which is difficult in the presence of complex selection effects. Additionally, dust extinction in obscured quasars allow us to observe their host galaxies and make connections between AGN emission and physical properties of their hosts. Using optical to mid-IR broadband photometry from SDSS, UKIDSS, and *WISE*, we model the spectral energy distributions (SEDs) for these systems with no prerequisite AGN selection and uncover dozens of powerful obscured quasars which lack hard X-ray counterparts in *NuSTAR* survey and serendipitous fields. At the *NuSTAR* flux limits, a lack of detection indicates extremely heavy obscuration with hydrogen column densities beyond 10^{25} cm^{-2}. This points to a population of very deeply buried AGN. We explore the host galaxy properties of these AGN and compare to similar samples with lower obscuration to investigate connections between level of obscuration, host galaxy environment, and AGN fueling.

1I Both sides of the coin: comparing the circumnuclear characteristics of active and inactive galaxies with LLAMA

Dr Richard Davies | MPE
davies@mpe.mpg.de

Abstract

LLAMA is a comprehensive study of a complete volume limited sample of very hard X-ray selected AGN at <40Mpc with luminosities log $L_{\rm bol}(erg/s) = 43.1 - 44.5$, as well as a matched sample of inactive galaxies. By comparing their spatially resolved kinematics and high resolution spectra, we aim to understand the physical processes regulating the inflow and outflow of gas in the circumnuclear region, and provide guidance for higher redshift galaxies where co-evolution primarily occurs but the central kiloparsec is barely resolved. Using the LLAMA sample, I will suggest that the answer to whether AGN are special depends on how and where one looks. I will discuss how the role of environment in fuelling AGN is linked to the host galaxy; that while the molecular gas on scales of kiloparsecs is similar in active and inactive galaxies, there are striking differences on scales of tens of parsecs; and that a wider range of central stellar surface brightnesses is found among inactive galaxies than AGN. Together, these effects suggest that the specialness of AGN can be an elusive characteristic.

1J Comparing isolated active and non-active galaxies from CALIFA survey.

Ignacio Del Moral-Castro | Instituto de Astrofisica de Canarias
imoralc@iac.es

Abstract

Unveil the mechanisms that trigger active galactic nuclei is crucial for our understanding of the formation and evolution of galaxies. Mergers, especially the major ones, seem to be connected to most of the luminous AGN, while less luminous AGNs would be driven by secular processes, like disk instabilities or bars. Taking advantage of recent integral spectroscopic surveys (e.g. CALIFA, MANGA and SAMI), we selected a sample of isolated active and non-active galaxies (barred and unbarred) matched in mass, redshift and morphology. We analyze the spatially resolved properties of the stellar and ionized gas to study the influence of secular processes (e.g. bars) in AGN triggering. In this contribution, we will present our findings on a pilot study of low-luminosity AGN and their almost-twin non-active galaxies selected from the CALIFA.

1K Obscuration events in nearby AGN

Dr. Jacobo Ebrero | European Space Astronomy Centre (ESAC)
jebrero@sciops.esa.int

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 NGC 985 to be 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). Reanalysis 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 between our two observations in 2015, and up to the many-year timescales probed by prior HST observations in 2013 and 1999. 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.

1L The first detection of radio recombination lines in AGN

Kimberly Emig | Leiden Observatory
emig@strw.leidenuniv.nl

Abstract

Atomic gas has proven difficult to probe past redshifts of $z > 0.5$, severely limiting our knowledge of its influence on galaxy and AGN evolution. Low-frequency radio ($<$ 500 MHz) recombination lines provide a means to uncover the presence of cold, neutral gas and furthermore determine its physical properties (such as temperature and density) out to high redshifts. Only now, thanks to the enhanced sensitivity, resolution, and wide bandwidths of telescopes like LOFAR, can low-frequency recombination lines be explored outside of our Galaxy. We have achieved the first detections of radio recombination lines in AGN, demonstrating their capacity as a probe of cold, diffuse gas clouds at z > 1. In our initial searches, we have targeted bright sources with known HI absorption features, which are typically compact, steep-spectrum AGN. We present the resulting detections of these searches and the unique science it is uncovering.

1M Investigating the connection between AGNs and their host galaxy properties through SED decomposition

Dr. Li-Ting Hsu | Academia Sinica Institute of Astronomy and Astrophysics
lthsu@asiaa.sinica.edu.tw

Abstract

Many studies propose that the evolution of the galaxy is related to the growth of the central supermassive black hole (SMBH). One way to study the AGN-galaxy coevolution is to investigate the AGN impacts on their host galaxies. In our work, we present the study of the host galaxy properties of the X-ray selected AGNs in the Chandra Deep Field South and North. We did the AGN/host galaxy decomposition based on the SED fitting results of our well-trained AGN-galaxy hybrids, and made corrections for the dust extinction and AGN contribution to get more accurate AGN host fluxes. For the AGN-dominated type 1 AGNs, it is not surprising to find that their host are strongly effected by the AGN contribution rather than the dust extinction. While for the host-dominated type 2 AGN, the correction for the dust extinction is larger than the correction for the AGN contribution. Similar to normal galaxies, AGN host colors also present bimodality in the color-magnitude diagram. However, there are more AGN hosts appear in the green valley. This shows that the green-valley objects could be in the evolutionary stage between star-forming (blue cloud) and passive (red sequence) galaxies, undergoing the quenching of star formation. I will present the stellar mass to star formation rate relation for the AGN hosts to further study the AGN impact on the host galaxy evolution.

1N Obcuration/orientation effects in the sample ofmedium-redshift ($0.5 < z < 1$) 3CRR sources observed by Chandra.

Dr. Joanna Kuraszkiewicz | Harvard-Smithsonian Center for Astrophysics
jkuraszkiewicz@cfa.harvard.edu

Abstract

The level of accretion power in the Universe has fundamental implications both for cosmology and the physics of active galactic nuclei (AGN). Despite their intrinsically bright, multi-wavelength emission, an unknown AGN fraction remain obscured, their nuclei invisible due to orientation-dependent obscuration by massive amounts of material. One way to select AGN samples that are orientation-unbiased (although limited to radio-loud sources) is low frequency radio, where the selection is based on extended radio lobes. The radio data also provide an independent estimate of orientation via the radio core fraction. We extend our studies of a complete, 178 MHz radio flux-limited, Chandra observed sample of high-redshift ($1 < z < 2$) 3CRR sources (Wilkes et al. 2013) to medium redshifts ($0.5 < z < 1$). This medium-redshift, flux-limited and orientation unbiased sample includes: 13 quasars, 22 narrow-line radio galaxies (NLRGs) and one low-excitation radio galaxy (LERG), with matched radio luminosities (log $L_r(178MHz) \sim 44-45$). The quasars have high X-ray luminosities $L_x(0.3-8keV) \sim 45-46$, soft hardness ratios (HR<0), and high radio core fraction, indicating low obscuration (log $N_{\rm H} < 22$) and face-on inclination. NLRGs, have lower observed X-ray luminosities ($L_x \sim 43-45$), a wide range of hardness ratios, and lower radio core fraction, indicating a range of obscuration (log $N_{\rm H} > 21$) and edge-on inclinations. These properties together with the observed trend of increasing NH with decreasing radio core fraction are roughly consistent with orientation-dependent obscuration as in Unification models. This sample includes a new population, not seen at high redshift: five of the NLRGs have extremely low NH (log $N_{\rm H} < 22$, i.e. X-ray Type1), show high quasar-like L_x/L_r ratios, soft hardness ratios, and weak near-to-mid-IR emission and require an extremely thin and cool torus or low $L/L_{\rm edd}$ ratio. At least 6 NLRGs (∼17% of sample) are Compton-thick.

1O The Hunt for Red Quasars: Unveiling Luminous Obscured Black Hole Growth

Dr. Stephanie LaMassa | Space Telescope Science Institute
slamassa@stsci.edu

Abstract

The obscured AGN phase may represent a critical stage in supermassive black hole and galaxy co-evolution, where powerful winds from the AGN accretion disk shapes the environment, perhaps regulating host galaxy star formation. Since this phase is short-lived, wide-area surveys are required to identify such systems. I will report on an ongoing program to follow-up obscured AGN candidates in the 31 deg^2 Stripe 82 X-ray survey using two complementary selection methods. Our red $R-K$ sample ($R-K > 4$, Vega) is nearly complete to $K < 16$, where we identify outflow signatures in half of the sample, perhaps indicative of feedback affecting the host galaxy. We completed a pilot program of our fainter optical dropout fainter ($K > 17$, Vega), demonstrating proof of concept that we recover luminous, high-redshift quasars missed from optical surveys with this selection. We plan to push the $R-K$-selected sample to fainter magnitudes ($K = 17$) and complete the optical dropout sample to recover obscured AGN missing from our optical census (thereby achieving a more comprehensive view of supermassive black hole growth) and search for spectroscopic kinematic signatures of outflows in our samples to test whether the feedback hypothesis is accurate.

1P Are AGN special? The NuSTAR and Chandra point of view

Dr. Alberto Masini | Dartmouth College
alberto.masini@dartmouth.edu

Abstract

In order to answer the question “Are AGN special?”, we need to identify and study “normal” and “special” AGN, with both deep and wide X-ray surveys, which are one of the least-biased ways to blindly detect AGN and perform statistically meaningful population studies, in conjunction with multiwavelength data. After discussing the observed Compton-thick fraction at $z \sim 1$ in the CANDELS UDS field with the hard X-ray focusing telescope NuSTAR, I will present two rare and peculiar buried sources detected above 8 keV and missed by previous deep X-ray surveys. In addition, a new Chandra legacy survey of the XBootes field (the CDWFS survey) will be delineated. CDWFS will detect thousand of AGN and will allow to study in detail the connection of AGN activity with environment across a large range of redshifts and luminosities.

1Q Stellar and gas kinematics of the first 62 AGN observed with MaNGA

Dr. Rogemar A. Riffel | Universidade Federal de Santa Maria - UFSM
rogemar@ufsm.br

Abstract

We investigate the effects of Active Galactic Nuclei (AGN) outflows on the kinematics of their host galaxies, using a sample of AGN already observed in MaNGA survey and a control sample (inactive galaxies). We compare the gas and stellar velocity fields for the two samples and do not find any difference in the Position Angle (PA) offsets between the line of nodes of gas and stars for AGN and control galaxies. However, we note that AGN have larger fractional σ differences [$\sigma_{\rm frac} = (\sigma_{\rm gas} - \sigma_{\rm stars})/\sigma_{\rm stars}$] when compared to their controls, as obtained using velocity dispersion values of the inner 25 arcsec diameter. AGN show median $\sigma_{\rm frac}$ value of $< \sigma_{\rm frac} >_{\rm AGN} = 0.04$, while the the median value for control galaxies is $< \sigma_{\rm frac} >_{\rm CTR} = -0.23$. 75 % of the AGN show $\sigma_{\rm frac} > -0.13$, while 75 % of the normal galaxies show $\sigma_{\rm frac} < -0.04$, thus we suggest that the parameter $\sigma_{\rm frac}$ can be used as an indicative of AGN activity. We find a correlation between the [O iii]λ5007 luminosity and $\sigma_{\rm frac}$ for our sample. Our main conclusion is that the AGN already observed with MaNGA are not powerful enough to produce important outflows at large scale, but at small scales ($\sim$2 kpc) the AGN feedback has an important effect on the gas kinematics of host galaxies.

1R The first 62 AGN observed with SDSS-IV MaNGA - II: resolved stellar populations

Dr. Rogerio Riffel | UFRGS
riffel@ufrgs.br

Abstract

We present spatially resolved stellar population age maps, average radial profiles and gradients for the first 62 Active Galactic Nuclei (AGN) observed with SDSS-IV MaNGA to study the effects of the active nuclei on the star formation history of the host galaxies. These results, derived using the STARLIGHT code, are compared with a control sample of non-active galaxies matching the properties of the AGN hosts. We find that the fraction of young stellar populations (SP) in high-luminosity AGN is higher in the inner ($R \leq$ 0.5 R_e) regions when compared with the control sample; low-luminosity AGN, on the other hand, present very similar fractions of young stars to the control sample hosts for the entire studied range (1 R_e). The fraction of intermediate age SP of the AGN hosts increases outwards, with a clear enhancement when compared with the control sample. The inner region of the galaxies (AGN and control galaxies) presents a dominant old SP, whose fraction decreases outwards. We also compare our results (differences between AGN and control galaxies) for the early and late-type hosts and find no significant differences. In summary, our results suggest that the most luminous AGN seems to have been triggered by a recent supply of gas that has also triggered recent star formation (t $\leq$ 40 Myrs) in the central region.

1S The Special Properties of Molecular and Ionized Gas in the Circumnuclear Environment of AGN

Dr. Taro Shimizu | Max Planck Institute for Extraterrestrial Physics
shimizu@mpe.mpg.de

Abstract

While a comparison between the global properties of AGN and inactive galaxies seem to indicate AGN are not particularly special, a close look on small scales reveal an intricate web of molecular and ionized gas in the central regions of AGN. With the Local Luminous AGN with Matched Analogues (LLAMA) sample, we have obtained SINFONI H and K band IFU observations for 17nearby (D < 40 Mpc), hard X-ray (14 - 195 keV) selected AGN and 10 inactive galaxies matched to the AGN in their global properties (i.e. stellar mass, inclination, distance). These observations probe the inner 200 pc of each galaxy with at a spatial resolution of 10 pc. In this talk, I will detail our analysis of the NIR line emission detected in the SINFONI cubes including the spatial distribution, kinematics, and excitation mechanism for each gas tracer (H2, [FeII], Br-gamma, and [SiVI]) and how they relate to the stellar distribution and kinematics. We find that in general AGN contain at least an order of magnitude higher H2 surface brightness compared to inactive galaxies that is largely tracing a massive rotating nuclear disk. Matched inactive galaxies are nearly completely deficient of ionized gas which is tracing primarily AGN driven outflows and shocks in the AGN. I will discuss the prevalence and mass loss rate of these outflows and there possible role in the evolution of their host galaxies. Our LLAMA studies with SINFONI suggest that AGN are indeed special but perhaps only in very central regions of galaxies where the AGN has the greatest effect.

1T Merger-Free Black Hole and Galaxy Growth

Dr. Brooke Simmons | UC San Diego
bdsimmons@ucsd.edu

Abstract

Recent results, both observational and theoretical, indicate that merger-free evolution contributes roughly equally to the overall growth of black holes in the Universe and is also responsible for a significant amount of galaxy growth over cosmic time. Black holes hosted in unambiguously disk-dominated galaxies with merger-free histories since $z \sim 2$ can reach quasar-like luminosities and black hole masses typical of those hosted in galaxies with more merger-driven evolutionary histories and a similar rate of outflows. Moreover, the fitted correlation between black hole mass and total galaxy stellar mass in these merger-free systems appears to be fully consistent with the canonical relationship based on merger-driven systems. The same correlation between black hole & galaxy in merger-free systems indicates the black hole-galaxy connection must originate with a process more fundamental than the dynamical configuration of a galaxy's stars.

1U Swift X-ray to optical SEDs of $z \sim 2$ quasars

Prof. Marianne Vestergaard | Niels Bohr Institute, University of Copenhagen
mvester@nbi.ku.dk

Abstract

We have observed a sample of ~ 140 radio-loud and radio-quiet quasars at redshifts between 1.5 and 3.5 with the Swift satellite in order to characterize their optical-UV-X-ray SEDs. This study is part of a larger program aimed to investigate the inter-relationships between the accretion disk, X-ray emitting components and the broad line region. In this poster we describe our data analysis and present the observed sample properties. We find that the quasar sample is well representative of the commonly observed radio-loud and radio-quiet quasar populations and thus suitable for the aimed follow-up studies. This work is being prepared for publication as Lawther et al. 2018.

1V A "Turn-on" Transition in "Changing-look" Quasar SDSS J141324.27+530527.0

Dr. Dawei Xu | National Astronomical Observatories of China
dwxu@nao.cas.cn

Abstract

We here report an identification of SDSS J141324+530527.0 at $z = 0.456344$ as a new "changing-look" quasar with a "turn-on" spectral type transition from Type-1.9/2 to Type-1 within a rest frame time scale of 1-10 yr by a comparison of our new spectroscopic observation and the SDSS archive data base. The SDSS DR7 spectrum taken in 2003 is dominated by a starlight emission from host galaxies redward of the Balmer limit, and has non-detectable broad Hβ line. The new spectrum taken by us on 2017 June 1 and SDSS DR14 spectrum taken on 2017 May 29 indicate that the object is of a typical quasar spectrum with a blue continuum and strong Balmer broad emission lines. In addition, an intermediate spectral type can be identified in the SDSS DR13 spectrum taken in 2015. The invariability of the line wing of Mg IIλ2800 emission and time scale argument (The invariability of [O III]λ5007 line blue asymmetry) suggests that a variation of obscuration (an accelerating outflow) is not a favourable scenario. The time scale argument allows us to believe the type transition is possibly caused by either a viscous radial inflow or a disk instability around a $M_{\rm BH} = 5 - 9 \times 10^7\ M_\odot$ black hole.

1W The most heavily obscured quasars: Extreme obscuration in reddened host galaxies

Wei Yan | Dartmouth College
wei.yan.gr@dartmouth.edu

Abstract

New infrared and hard X-ray observations are allowing us to probe a population of extremely heavily obscured, powerful AGN that were previously inaccessible in X-ray surveys. Here we report NuSTAR observations of four WISE-selected heavily obscured quasars for which we have optical spectroscopy from the Southern African Large Telescope and W. M. Keck Observatory. Three of the four objects are undetected with NuSTAR at 3-24 keV, while the fourth has a marginal detection. We compare X-ray and IR luminosities to obtain estimates of the hydrogen column densities (N_H) that are at or greater than 10^{25} cm^{-2}. Thus we confirm that WISE and optical selection can identify very heavily obscured quasars that may be missed in X-ray surveys, and do not contribute significantly to the cosmic X-ray background. From the optical Balmer decrements obtained from Keck spectra, we found that our three extreme obscured targets lie in highly reddened host environments. This galactic extinction is not adequate to explain the more obscured AGN, but it may imply a different scale of obscuration in the galaxy.

2/3A The CATS survey: AGN evolution in massive galaxy clusters

Dr. Rebecca Canning | Stanford University
rcanning@stanford.edu

Abstract

A critical prerequisite for both AGN activity, and the formation of new stars in host galaxies, is the availability of gas. Environmental processes in dense environments affect gas reservoirs in ways that are different to the field. The density of cluster members and their relative velocities also depend on the cluster mass. As such, the rates of violent processes will differ in clusters and the field. The relative importance of these processes depends on both the position within, and the mass of, the host galaxy cluster. We recently undertook a survey of X-ray AGN in the fields of 135 of the most massive clusters between $0.2 < z < 0.8$. We find no significant redshift dependent evolution of the cluster and field populations and the radial distribution scales self-similarly, however, we find a strong dependence of the overdensity of X-ray AGN on the host cluster mass, scaling as M^{-1}. This non self-similar scaling is similar in form to that of the galaxy merger rate in clusters suggesting that galactic mergers and interactions are important for the triggering of cluster X-ray AGN. We have now increased our statistical study to >500 massive galaxy clusters from $z = 0$ to $z \sim 2$ and multi wavelength AGN identification. I will share new results of the X-ray and Radio AGN distribution in the highest$-z$ clusters and detail our survey which will identify ∼40,000 AGN and aims to trace the evolution of AGN in dense environments from early-times, through the peaks of AGN and SF activity, to the present day.

2/3B Signatures of supermassive black hole seed formation over cosmic time

Dr. Colin DeGraf | University of Cambridge
cdegraf@ast.cam.ac.uk

Abstract

Although well understood that supermassive black holes are found in essentially all galaxies, the mechanisms by which their seeds originally form remain highly uncertain, despite the importance the formation pathway can have on AGN and quasar behavior at all redshifts. Using a combination of cosmological simulations and analytic modeling, I will discuss how varying the conditions under which supermassive black hole seeds form leads to changes in AGN populations. In particular, I will discuss the moderate impact on the black hole mass function and the mid- and faint-end of the luminosity functions, and the strong impact on both merger rates and AGN accretion efficiencies. In addition to demonstrating the importance of initial seed formation on our understanding of long-term black hole behavior, we also show that the signatures of seed formation suggest multiple means by which upcoming observational surveys (at both high- and low-redshifts) can provide the data required to constrain the way in which supermassive black hole seeds initially form.

2/3C The influence of galaxy mergers on the star formation history of luminous AGN

Anastasia Efthymiadou | University of Bath
a.efthymiadou@bath.ac.uk

Abstract

The evolution of massive galaxies and that of the supermassive black holes at their centres are believed to be linked. Dense cold gas transferred to the central region of a galaxy fuels and triggers both a starburst phase and the black hole growth. Galaxy mergers constitute a potential candidate for providing this cold dense gas and, therefore, triggering both circumnuclear star formation and AGN activity. We study the connection between star formation and black hole growth in luminous AGN involved in galaxy mergers. To this end, we investigate the stellar population properties of AGN host galaxies ($z \sim 0.3$) that show neighbouring galaxies using SDSS data. We present spectroscopic analysis results on the comparison of star formation histories between the central AGN and their neighbours as a function of projected distance. We witness an enhancement in star formation with decreasing distance for the case of neighbours, confirming the mergers-starburst correlation, while the AGN host galaxies do not reveal a similar increase. Although the activity of the central AGN does not show to be directly driven by the merger, our results support the starburst-AGN activity connection.

2/3D Quantifying the Rate of Dual AGN

Adi Foord | University of Michigan
foord@umich.edu

Abstract

Despite the importance of dual active galactic nuclei to wide-ranging astrophysical fields such as galaxy formation and gravitational waves, the rate of dual AGNs has yet to be accurately measured. The most direct method of detecting dual AGN is finding spatially resolved unambiguous evidence of AGN, thus X-ray observations are crucial and high spatial resolution is necessary. However, while sources that are widely separated relative to the instrument Point Spread Function (PSF) are easy to identify, dual AGNs with smaller separations can only be distinguished from a single AGN with statistical analysis. Thanks to event repositioning algorithms, it is possible to achieve sub-pixel resolution with Chandra, however, it can only be used to make images and subjectively analyze them for dual point sources – leading to to both to false negatives and false positives. I will present our early results from BAYMAX, (Bayesian AnalYsis of Multiple AGN in X-rays), a tool that uses a Bayesian framework to quantitatively evaluate whether a given source in a Chandra observation is actually a single or dual point source. Using BAYMAX on both new and archival data will allow us to quantify the true dual fraction across the visible universe, and I will give an update regarding our efforts on this task.

2/3E AGN evolution in the mercy of the large scale enviroment

Dr. Sotiria Fotopoulou | Durham University
sotiria.fotopoulou@durham.ac.uk

Abstract

Previous analyses of X-ray emitting galaxy clusters have shown that X-ray AGNs tend to be abundant in the outskirts of clusters, and their surface density drops towards the centers of galaxy clusters. This observation is similar to the transition galaxies undergo as they fall into clusters. Namely, processes such as tidal stripping remove effeciently the cold gas reservoir essential for star-formation resulting into an increased number of passive galaxies deep in the potential well of galaxy clusters. This phenomenon is imprinted on the galaxy luminosity function. This work is designed to harness the wealth of modern wide extragalactic X-ray surveys and determine for the first time the X-ray luminosity function of AGN inside clusters and the field. With a combined 60 sq. deg. sky coverage and X-ray flux limit of about 10^{-15}erg/s/cm^2 the XXL and the X-COP surveys are unique laboratories to assess the transformation of AGN. Due to the large collecting area of XMM-Newton, ideal for providing extended sky coverage, and the ancillary multiwavelength photometric and spectroscopic data we are in position to probe the AGN population across different environments, from the field all the way into galaxy cluster cores. Our sample consists of about 200 clusters with masses $10^{14} - 10^{15}$ solar masses up to redshift of one and more than ten thousand AGN. I will present the first direct determination of the X-ray luminosity function of AGN inside clusters and the field up to redshift of one and discuss the implications on the unified model of AGN.

2/3F Clustering of quasars over a wide luminosity range at $z \sim 4$ with Subaru Hyper Suprime-Cam wide field imaging.

Wanqiu He | Astronomical institute, Tohoku University, Japan
he_wanqiu@astr.tohoku.ac.jp

Abstract

Clustering analysis for quasars/galaxies at high redshifts could help understand the evolution of super massive black holes (SMBHs) in the early universe. The wide and deep imaging of Subaru Hyper Suprime-Cam Strategic Survey Program (HSC-SSP) is very powerful to investigate the clustering of quasars over a wide luminosity range at $z \sim 4$. Based on the internal data release S16A with a wide survey region of 172 sq.deg, we photometrically selected a large sample (901) of low-luminosity quasars at $z \sim 3.8$ with $-24.73 < M_{1450} < -22.23$ for the first time. We examined their clustering by the cross-correlation function (CCF) with LBGs. By comparing their clustering to that of luminous SDSS quasars at $3.4 < z < 4.6$ with $-28.0 < M_{1450} < -23.95$, we found no significant luminosity dependence of quasar clustering at $z \sim 4$, indicating both of the high- and low-luminosity quasars reside in halos with $\sim 10^{12}$ solar mass. We noted that the clustering of luminous quasars estimated by the CCF is smaller than that estimated by the auto-correlation function (ACF) over a similar redshift range, especially on scales below 40 arcsec. This deficit of luminous quasar-LBG pair on the small scales may indicate the effect of feedback from the luminous quasars.

2/3G The dawn of black holes and their evolution in the early Universe: Prospects for the future with Lynx

Prof. Ryan Hickox | Dartmouth College
ryan.c.hickox@dartmouth.edu

Abstract

In recent years, extragalactic surveys have made great strides in tracing the growth of black holes and their connections to galaxies and halos over most of cosmic history, from the local Universe to $z = 2$ and beyond. However, the deepest, distant Universe remains relatively unexplored, and important questions remain about the emergence of "seed" black holes at $z > 6$, and their evolution over the first few Gyr up to the epoch of peak activity at $z \sim 2$. I will give a brief overview of our current understanding of distant AGN, and discuss prospects for the future with upcoming facilities such as *JWST*, *WFIRST*, and *Athena*. I will focus particularly on how the high throughput and exceptional angular resolution of NASA's *Lynx* X-ray concept mission can revolutionize our understanding of the growth of black holes, their host galaxies, and environments the early Universe.

2/3H SERVing up Clustering around Obscured and Unobscured Quasars at $z \sim 2$

Dr Kristen Jones | Arecibo Observatory
kjones@naic.edu

Abstract

We analyze matched samples of obscured and unobscured quasars to characterize the megaparsec-scale environment of a previously unexplored sample of high redshift ($1.3 < z < 2.5$) SIRTF Wide-field Infra-Red Extragalactic Survey (SWIRE) quasars. Optically obscured quasars are compared to a control sample of optically-bright quasars identified via selection in the mid-infrared using Spitzer color cuts as described in Lacy et al. (2007). The SERVS data fields were observed at 3.6 and 4.5 μm to a depth of $\sim$2μJy (AB = 23.1). The final high-z sample of 42 quasars (18 Type 1, 17 Type 2, and 7 Type 1R) is cross-correlated with the ~ 4 million galaxies from the Spitzer Extragalactic Representative Volume Survey (SERVS) filtered using color-color cuts to remove low-redshift ($z < 1.5$) or foreground objects. Recent work has found diverse results in such studies, with variation of environmental richness by redshift, level of obscuration, sample selection, and luminosity of source. For this sample of quasars we find mean scale lengths $\langle r_o \rangle = 26.0 \pm 8.36$ and 18.0$\pm$7.12 Mpc for Type 1 and Type 2 quasars, respectively. For the smaller sample of Type 1R we calculate $\langle r_o \rangle = 21.2 \pm 12.4$ Mpc. Overall we find no significant statistical distinction between the level of clustering for these different types of objects. Clustering amplitude also remains relatively independent of redshift within the range of the sample, indicating a consistent halo mass for quasar presence, which coincides with the findings of much recent work. I compare our results with diverse recent studies and investigate the significance of selection criteria for future clustering research.

2/3I Environmental dependence on AGN activity in the SDSS late-type galaxy sample

Minbae Kim | Kyung Hee University
mbkim@khu.ac.kr

Abstract

We explore the role of various environments in triggering star formation (SF) and narrow-line active galactic nucleus (AGN) in SDSS spiral galaxies and the SF-AGN connection, using a volume-limited sample with $M_r < -19.5$ and $0.02 < z < 0.055$ selected from the SDSS Release 7. To avoid the dependency of AGN activity on bulge mass, the central velocity dispersion of the sample galaxies is limited to have a narrow range of $130 \leq \sigma \leq 200$km s^{-1}. We note that in gas sufficient galaxies, AGN feeding lags behind starburst, whereas as the gas exhausts, the SF slows down and AGN seems to even prevent the SF, and thus divide the high-σ sample into two subsamples according to their cold gas content at central region traced by fiber star formation rate, SFR$_{\rm fib}$. We find that a high density (cluster) environment causes a significant increase in AGN activity as well as gas depletion in host galaxies. However, the finding is only noticeable in the high-σ and low SFR$_{\rm fib}$ sample. It seems that a galaxy interaction with the nearest neighbor directly affects the SF of the central region. However, it is unclear whether it directly affects AGN activity.

2/3J Enhancement of AGN activity in a protocluster at z=1.6

Charutha Krishnan | University of Nottingham
charutha.krishnan@nottingham.ac.uk

Abstract

I will present our recent study of the prevalence of X-ray AGN in the high-redshift protocluster Cl 0218.3-0510 at $z = 1.62$, and review the implications for our understanding of galaxy evolution. There has long been a consensus that X-ray AGN avoid clusters in the local universe, particularly their cores. The high-redshift universe appears to not follow these trends, as there is a reversal in the local anti-correlation between galaxy density and AGN activity. In this z=1.62 protocluster, we find a large overdensity of AGN by a factor of 23, and an enhancement in the AGN fraction among massive galaxies relative to the field by a factor of 2. I will discuss the comparison of the properties of AGN in the protocluster to the field, and explain how our results point towards similar triggering mechanisms in the two environments. I will also describe how our study of the morphologies of these galaxies provide tentative evidence towards galaxy mergers and interactions being responsible for triggering AGN, and explain the reversal of the local anti-correlation between galaxy density and AGN activity.

2/3K AGN in a sample of nearby LIRG pairs: exploring the influence of a companion

Dr. Nora Loiseau | XMM-Newton SOC, ESAC/ESA
nloiseau@sciops.esa.int

Abstract

In order to investigate if AGNs are a special period in the galaxies lives, and if yes, if this is related to the interaction with a companion galaxy, or just an evolutionary state of the galaxies, we analyse the X-ray emission in a sample of 143 LIR galaxies in pairs or triplets. X-rays is probably the best tool for studying the properties of AGN in the centre of galaxies, except if they are heavily obscured, which seems to be the case for many interacting galaxies. We study the properties of our sample of nearby major mergers comparing our and catalogue X-ray data with available information in other wavelengths.

2/3L A Multiwavelength View on Massive Star Forming Companion Galaxies to High-Redshift Quasars

Chiara Mazzucchelli | Max Planck Institute for Astronomy
mazzucchelli@mpia.de

Abstract

Luminous, high redshift ($z > 6$) quasars are formidable probes of the early universe, and they are thought to reside in large galactic overdensities. However, previous UV-based observational studies did not uniquely detect these rich environments. Recently, our ALMA survey of cool gas and dust in the host galaxies of 27 $z > 6$ quasars unveiled the presence of bright, massive, gas rich companion galaxies in 20% of the cases. These fields are among the most overdense in the first Gyr of the universe. Here, I will show recent deep HST/WFC3 and Spitzer/IRAC follow-up observations of the rest-frame UV/optical emission from these companion galaxies. Considering all the data at hands, I will model their spectral energy distributions, derive limits on their physical properties (e.g. star formation rates, gas and stellar masses), and I will place them in the context of the observed galaxy population at $z \sim 6$.

2/3M Massive and Distant Clusters of the WISE Survey: Extended Radio Sources in Massive Galaxy Clusters at $z \sim 1$

Emily Moravec | University of Florida
emoravec@ufl.edu

Abstract

Observations indicate that active galactic nuclei play a role in galaxy and cluster evolution. We examined the radio morphologies of extended radio sources and the properties of their host-galaxies in massive galaxy clusters at z $\sim$ 1, an epoch in which clusters are assembling rapidly. We cross-correlated a parent sample of massive galaxy clusters with the VLA Faint Images of the Radio Sky at Twenty-Centimeters (FIRST) survey to identify extended radio sources within 1′ of the cluster center. We present the results from a pilot study with the Jansky Very Large Array to determine the typical physical characteristics of the extended radio sources in 10 galaxy clusters. Out of the ten target sources, there are six FR II sources, one FR I source, and three sources with other morphologies. Using *Spitzer* data, we find that six radio sources out of the eight have infrared counterparts. A majority of these counterparts are consistent with being massive, elliptical galaxies, but only one is consistent with being a brightest cluster galaxy. Finally, we find a surprisingly tight correlation between the largest angular extent of the FR sources and cluster centric distance. We discussion potential interpretations of this correlation.

2/3N Spectral Energy Distribution Analysis of WISE-Selected Obscured AGNs in Major Mergers from the SDSS

Madalyn Weston | University of Missouri - Kansas City
mew9bc@mail.umkc.edu

Abstract

We use the Wide-field Infrared Survey Explorer (WISE) and the Sloan Digital Sky Survey (SDSS) to confirm a connection between dust-obscured active galactic nuclei (AGNs) and galaxy merging. Using a catalog of visually-selected major mergers and interactions from the SDSS, with stellar masses above $2 \times 10^{10} M_{\odot}$ and redshifts $z \leq 0.08$, we find that major mergers (interactions) are 5–17 (3–5) times more likely to have red [3.4]-[4.6] colors associated with dust-obscured AGNs when compared to non-merging control galaxies with similar masses. We find that AGNs are five times more likely to be obscured when hosted by a merging galaxy, half of AGNs hosted by a merger are dusty, and we find no enhanced frequency of optical AGNs in merging over non-merging galaxies. Most mergers and interactions hosting dusty AGNs are star-forming. Therefore, quantifying the amount of buried SF and AGN activity in these systems is key to understanding the major merger-induced growth of stellar mass and central supermassive black holes. In our ongoing research, we use spectral energy distribution (SED) analysis to quantify the amount of buried SF and AGN activity in our sample of merging galaxies, and a sample of statistically-matched control galaxies. We will use the results of SED analysis to answer the following research questions: (1) Do all merging galaxies host an AGN that contributes significantly to the IR energy output (20% of the total IR light or more), regardless of optical emission type? (2) Do mergers identified as Seyfert or dusty AGNs by Weston et al. (2017) host more SF or AGN activity than those classified as non-AGNs? (3) Are previously selected AGNs in mergers different than those in non-merging galaxies? (4) Does the amount of AGN activity found through SED analysis scale with the [OIII] luminosity (a proxy for AGN power) of the host galaxy?

2/30 Probing the Difference between Host Halos for Obscured and Unobscured Quasars

Kelly Whalen | Dartmouth College
kelly.e.whalen.gr@dartmouth.edu

Abstract

Wide-field infrared surveys have allowed us to better understand obscured quasars. Recent cross-correlation and clustering measurements of obscured and unobscured quasars have shown us that obscured quasars preferentially inhabit more massive parent dark matter halos than their unobscured counterparts, in direct opposition to simple unified ("torus") models of quasar structure (DiPompeo et al. 2017b). However, there are also evolutionary models that show that obscuration could be a phase in the course of a quasar's lifetime, which would allow for a discrepancy in dark matter halo masses (DiPompeo et al. 2017b). Another possibility, raised by recent observations of local AGN, is that the covering factor of AGN tori depends strongly on Eddington ratio (Ricci et al. 2017). Here, we construct a simple model using known halo mass and Eddington ratio distributions as well as empirical relationships between obscuring fraction and Eddington ratio to predict the halo masses of obscured and unobscured quasars. We find that these effects could produce the observed quasar clustering results, but only for a relatively narrow set of relationships between AGN obscuration and Eddington ratio.

4A Peering deep in the radio to uncover the secrets of quasar feedback

Dr. Rachael Alexandroff | Canadian Institute for Theoretical Astrophysics – Dunlap Institute
rachael.alexandroff@dunlap.utoronto.ca

Abstract

Theoretical models of quasar feedback involve radiatively-driven nuclear winds, which propagate into the surrounding interstellar gas (causing shock heating and plowed shells) and resulting in a galaxy-wide wind over the life time of the quasar. There are, however, few observational probes of this particular feedback phenomenon. One relatively unexplored route is to search for the shocked gas in the radio. Though only about 15% of quasars are traditionally "radio-loud", meaning they launch radio jets that can be observed on scales of hundreds of kiloparsecs, we can identify populations of traditionally "radio-quiet" quasars that produce more radio emission than can be easily explained by just star formation. Indeed, the radio luminosity of powerful radio-quiet and radio- intermediate quasars is correlated with the velocity dispersion of ionized gas (measured via the strong [OIII]λ5007Å emission line), suggesting an intimate connection between radio emission and gas outflows. This opens the radio regime as an additional avenue for studying multi-phase quasar winds and the interaction between quasars and their host galaxies. I will present our recent studies on the radio emission from radio-quiet quasars at both $z \sim 0.5$ and $z \sim 2.5$ where we use a combination of radio luminosity, spectral index and morphology in an attempt to disentangle jet- and wind-driven radio emission. In addition, I will present preliminary results from a recent radio survey of $z \sim 0.5$ quasars with multi-component [OIII] 5007 emission which suggests either the presence of bi-conical outflows or dual supermassive black holes and show how radio data allows us to disentangle these scenarios. The most extreme of these objects may represent the "blowout phase" of AGN evolution that proceeds or accompanies the cessation of star formation in the host galaxy due to the effects of radiatively-driven quasar driven winds and new radio studies can help us to probe and study these winds.

4B Extreme Outflow in an AKARI-selected ULIRG at z=0.5

Dr. Xiaoyang Chen | Tohoku University, Astronomical Institute
xy.chen@astr.tohoku.ac.jp

Abstract

Ultra-luminous IR galaxies (ULIRGs) are populations of the most IR luminous galaxies in the local universe. Their large IR luminosity is originated from dusts heated by UV radiation from vigorous starburst and/or AGN. They are thought to represent rapidly growing phase of massive galaxies before quenching of their star formation. In order to construct a unique sample of ULIRGs at intermediate redshifts, we are conducting an optical follow-up program for bright 90μm FIR sources found in the $AKARI$ FIS Bright Source Catalogue (Ver.2) by utilizing the optical imaging data from SDSS. One ULIRG $AKARI$ J0916+0730 identified in our Subaru/FOCAS follow-up observation, indicates signatures of extremely strong outflow in its emission line profiles. The [Oiii] 5007Å shows FWHM of 1700 km s^{-1} and blue shifts of 816 km s^{-1} in relative to the stellar absorption lines. Furthermore low-ionization [Oii] 3726Å 3729Å doublets also show large FWHM of 1088 km s^{-1}, which indicates the outflow can extend beyond the nuclear / bulge region. With the estimation of outflow scale of ~ 8 kpc, the mass outflow and energy ejection rates can be 1000 M$_\odot$ yr^{-1} and 7.3×10^{44} erg s^{-1}, respectively, which are the largest among the outflow associated with luminous AGNs. The SFR of the galaxy is estimated to be as large as ~ 1000 M$_\odot$ yr^{-1} from the SED fitting. The co-existence of the intense star formation and extremely strong galaxy scale outflow is conflicting. One possibility is that the galaxy is in the intermediate stage of evolution in which the feedback just becomes effective and begins to sweep out the ISM in the entire galaxy, i.e., on-set of the quenching.

4C The SUPER survey: exploring the impact of AGN outflows with SINFONI and ALMA

Chiara Circosta | ESO (Garching)
ccircost@eso.org

Abstract

Active galactic nuclei (AGN) feedback is thought to influence the gas reservoir of galaxies through energetic outflows, whose impact is expected to be maximized at $z \sim 2$ when the cosmic star formation history and the black hole accretion rate have their peak. However, a comprehensive study at this redshift is still missing. A key way to quantify the impact of AGN outflows on their host galaxies is to both investigate the properties of such outflows and derive the gas content needed to form stars. Our team is leading an ongoing Large Programme called SUPER (a SINFONI Survey for Unveiling the Physics and the Effect of Radiative Feedback) targeting a representative sample of 40 AGN at $z \sim 2$. It combines VLT/SINFONI observations (supported by adaptive optics capabilities) of the [OIII] emission line, to spatially resolve the ionized phase of outflows on galactic scales, and CO(3–2) observations with ALMA, which probe the amount of molecular gas in the host galaxies. I will present some results exploring whether the properties of the cold molecular gas in our AGN differ from a matched sample of inactive galaxies, by connecting the global picture with the potential presence of AGN-driven outflows.

4D Resolving the Mechanisms of Feeding and Feedback in Nearby AGN

Prof. Mike Crenshaw | Georgia State University
crenshaw@astro.gsu.edu

Abstract

We investigate the processes of AGN feeding and feedback in the narrow line regions (NLRs) of nearby AGN through spatially resolved spectroscopy with the Gemini Near-Infrared Integral Field Spectrometer (NIFS) and the Hubble Space Telescope's Space Telescope Imaging Spectrograph (STIS). We find that the NLR kinematics can often be explained by in situ ionization and radiative acceleration of ambient gas, often in the form of dusty molecular spirals that may be the fueling flow to the AGN. We examine the extent to which radiative acceleration in the gravitational potential of the galaxy can remove gas that could otherwise form stars in the bulges of moderate-luminosity AGN.

4E Spatially Resolved AGN Feedback in a Lensed Main-Sequence Galaxy at $z = 2.39$

Dr. Travis Fischer | NASA's Goddard Space Flight Center
travis.c.fischer@nasa.gov

Abstract

We present rest-frame optical SINFONI integral field spectroscopy and rest-frame UV HST imaging of a lensed galaxy hosting an active galactic nucleus (AGN) at $z = 2.39$. Galactic wind feedback is widely acknowledged to play a critical role in the evolution of galaxies, however, the physical mechanisms involved and the relative importance of AGN and star formation as the main feedback drivers remain poorly understood. AGN-driven feedback has been evident in very luminous but rare quasars and radio galaxies, but observational evidence remains lacking for less extreme, "normal" star-forming galaxies. We report, for the first time at high redshift, spatially resolved velocity profiles and geometries of an AGN-driven outflow and spatial extents and morphologies of Lyα emission and stellar UV continuum in a typical star-forming, AGN-hosting galaxy at cosmic noon.

4F Ram pressure feeding supermassive black holes?

Dr. Jacopo Fritz | IRyA - UNAM
j.fritz@irya.unam.mx

Abstract

Jellyfish galaxies are believed to be the result of ram pressure exerted by the hot intracluster gas on the interstellar medium of galaxies infalling onto clusters. We undertook a systematic investigation of these objects with MUSE@VLT observations of ∼100 of such galaxies in local clusters, with an ESO large program. We found that AGN activity is ubiquitous in those galaxies displaying the largest stripped gas tails, thus strongly hinting to a causal connection between the triggering of nuclear activity and ram pressure stripping phenomena.

4G HARMONI view of high-redshift AGN

Dr. Begoña Garcia-Lorenzo | Instituto de Astrofísica de Canarias
bgarcia@iac.es

Abstract

We present preliminary results on the capabilities of the future HARMONI spectrograph for the European Large Telescope (ELT) for high-redshift AGN studies. We focus on two different scientific approaches: 1) the HARMONI performances on QSOs hosts observations to estimate black holes masses and host galaxies properties at redshift around 1.5; and (2) the HARMONI capabilities to obtain astrometric measurements of kinematically selected regions of broad line regions (BLRs) of lensed QSOs.

4H Spatially Resolved Kinematics and Morphology of Mrk 3

Crystal Gnilka | Georgia State University
pope@astro.gsu.edu

Abstract

We present an analysis of the kinematics and structure of the narrow-line region (NLR) and the host galaxy of the nearby Seyfert 2 Mrk 3. The NLR of Mrk 3 is composed of several overlapping and spatially-defined emission-line knots that together form a characteristic backwards “S” shape. We map the kinematics of these knots, tracing active galactic nuclei (AGN) outflows and fueling flows, with observations from Gemini North’s Near-infrared Integral Field Spectrometer (NIFS). We compare these kinematics and those from the host disk, observed with Apache Point Observatory’s (APO) 3.5m Dual-Imaging Spectrometer (DIS). We find a misaligned gas disk arising from a tidal stream due to an encounter with a nearby gas-rich spiral, UGC 3422. We explore the impact of this encounter on the AGN NLR and circumnuclear inflows and outflows.

4I What makes AGN special? Testing AGN feedback in cosmological hydrodynamic simulations with a complete survey of local AGN

Thomas Jackson | Durham University
thomas.m.jackson@durham.ac.uk

Abstract

Leading models of galaxy formation require AGN feedback to reproduce the properties of galaxies in the local Universe (i.e., colours; metallicities; galaxy stellar mass functions). Using extensive observations of the SWIFT-BAT all-sky sample ($z < 0.05$), we have undertaken a multi-faceted comparison of the properties of local AGN to those predicted by the suite of EAGLE hydrodynamical simulations. We find that EAGLE can reproduce key aspects of the BAT AGN, including the distributions of their host masses, colours, star-formation rates and nuclear luminosities, as well as provide unique insight into the cosmic evolution of this population. Our studies help us identify the physics that make AGN special in both our local Universe and simulated ones.

4J The Teacup: a nearby quasar and superbubble seen in X-rays

Dr. George Lansbury | University of Cambridge
gbl23@ast.cam.ac.uk

Abstract

The "Teacup AGN" (SDSSJ1430+1339) is a $z = 0.085$ type 2 quasar which is interacting dramatically with its host galaxy. The X-ray data reveal a powerful highly obscured central AGN, and a remarkable loop of extended X-ray emission. The latter is co-spatial with a previously identified 10 kpc bubble of radio emission and ionized gas. The X-rays from the bubble are consistent with a thermal gas, the properties of which are in agreement with other systems (e.g., brightest cluster galaxies) undergoing AGN feedback.

4K AGN feedback from radio galaxies: when surveys and cosmological simulations meet

Dr. Leah Morabito | University of Oxford
leah.morabito@physics.ox.ac.uk

Abstract

It is widely accepted that AGN feedback is necessary in cosmological simulations to reproduce observable properties of galaxies in the local Universe, but the details of the physical processes are difficult to isolate. Powerful radio galaxies are clear candidates for providing AGN feedback, and observations from new, deep radio surveys offer a unique method to study how the evolution of some of the most massive galaxies is impacted by the presence or absence of large-scale radio jets. By comparing these observations with the most advanced cosmological simulations, we hope to advance our theoretical understanding of AGN feedback in these powerful radio galaxies. Horizon-AGN is one of the first simulations to include radio emission from AGN, and is an ideal dataset with which to compare a new deep, multi-frequency (1.5 GHz, Very Large Array and 145 MHz, the Low Frequency Array) radio survey of the XMM-LSS field. The breadth and depth multi-wavelength ancillary data (spanning infrared to X-ray) and excellent photometric redshifts available in this field provide critical context for the radio data, and enables us to investigate the redshift dependnce of the observed radio luminosity functions out to $z \sim 3$. Comparing the observed radio luminosity functions with those extracted from the Horizon-AGN light cone, we will test different theories on how and when powerful radio AGN are formed, and how they interact with their environment. I will present the background and preliminary radio luminosity function comparisons, using different AGN selection functions for the cosmological simulations.

4L Do black holes regulate the growth of massive galaxies

Joanna Ramasawmy | University of Hertfordshire
joanna.ramasawmy@googlemail.com

Abstract

Feedback processes from supermassive black holes are thought to play a crucial role in regulating star formation in massive galaxies. Previous studies using Herschel data have resulted in conflicting conclusions as to whether star formation is quenched, enhanced, or not affected by black hole feedback. I use ultradeep submillimetre data from the Scuba-2 Cosmology Legacy survey (S2-CLS) to investigate star formation in a sample of X-ray selected active galaxies. The wide area of S2-CLS, covering well-studied survey fields, allows us to select a sample in a large redshift and luminosity space, probing the most extremely active galaxies. I will present the results of my PhD work so far on an X-ray selected sample of ∼1000 galaxies at high redshift ($1 < z < 3$), using both S2-CLS and far-IR data to estimate star formation rates in these objects. We find no evidence of star formation being quenched by the most active galaxies in our sample.

4M Chandra/HST Analysis of 25 SDSSRM Quasars

Angelica Rivera | Drexel University
abr54@drexel.edu

Abstract

We investigate the diversity of quasars through the analysis of their UV, X-ray, and emission-line properties. We concentrate on a sample of 25 radio-quiet SDSS quasars with HST observations that all have similar optical luminosities ($\log(L_{2500}) < 30.4$) and redshifts ($z \leq 0.5$). Currently the low-z SDSS RM CIV EQW vs. CIV blueshift space is biased against wind-driven quasars that are more often found at high luminosity (and thus high-z). If we fill in this space we can derive mass accretion rates (or L/L_{Edd}) for those objects, and can connect the BH scaling relation between low-z and high-z quasars using FWHM vs. EW FeII (eigenvector 1) space (low-z) and CIV space (high-z). We use Chandra observations to analyze their X-ray properties (Γ, α_{ox}, $\Delta\alpha_{ox}$), in order to determine how accretion disk winds (which are regulated by α_{ox}) contribute to the diversity of UV emission-line properties in quasars. Although we calculated exposure times such that we would obtain 100 counts for each target, many (17 out of the 25) had below 80, indicating that they were X-ray weaker than expected, or intrinsically absorbed. Using spectral fitting, different measures of Γ, and $\Delta\alpha_{ox}$, we determine which are X-ray weak, and which are intrinsically absorbed. With the combined UV and X-ray data, we explore the differences between quasars and attempt to understand how/when quasars can have high L/L_{Edd}, but show little evidence for strong winds.

4N Feedback in low-luminosity active galactic nucleus

Dr. Alberto Rodriguez-Ardila | LNA/MCTIC & IAC
aardila@lna.br

Abstract

Jet-driven outflows are now recognized as an important ingredient in the active galactic nuclei (AGN) feedback scenario. The effects of such mechanism in lower-luminosity radio-quiet AGN (LLAGN, $L_{\rm bol} \leq 10^{43}$ erg cm^{-2} s^{-1}) is not yet clear mainly because results are scarce. Here, we present challenging results of the feedback mechanisms in a sample of LLAGN by means of near-infrared integral field spectroscopy obtained on SINFONI/VLT. The exquisite angular resolution of tens of parsec/spaxel allows us to unveil at unprecedented detail the extension and morphology of the high-ionization gas mapped through the [Si vi] λ19641 Å line. The high-ionization gas (HIG) displays an intricate and complex morphology, following the radio morphology and extending to distances of up to hundreds of parsecs. Bubbles and shells of [Si vi] emission, likely inflated by the thermal expansion produced by the passage of the radio-jet are observed in some objects. We measured outflow mass rates of several M$\odot$ yr^{-1}, similar to those found in powerful radio-galaxies and classical Seyferts. Our results highlight the importance of the mechanical feedback even in LLAGN with low-power radio-jets and shows that its effects to the ISM cannot be underestimated.

4O Star Formation and Gas Kinematics in the Central Kiloparsec of Post-Starburst Quasars

Dr. David Sanmartim | Gemini South Observatory
dsanmartim@gemini.edu

Abstract

Post-Starburst Quasars (PSQs) are an intriguing set of galaxies that simultaneously host AGNs and post-starburst stellar populations, making them one of the most suitable objects to investigate the nature of the connection between these two components. The simultaneous presence of a post-starburst population and nuclear activity may be explained by two possible scenarios. In the secular evolutionary scenario, star formation may cease due to exhaustion of the gas, while in the quenching one it may cease abruptly when the nuclear activity is triggered. In order to test these scenarios we have mapped the star formation history, manifestations of nuclear activity and excitation mechanisms in the central kpc of two nearby PSQs by using GMOS-IFU observations. In these two first exploratory studies, we have found that the young and intermediate age populations are located in a ring at ∼300-500 kpc, with some contribution of the intermediate age component also in the central region. In both of them, the gas outflow does not coincide with the young stellar population ring, which suggests that the ring is not being affected by the AGN feedback, but only the innermost regions. The individual study one of the PSQs of the sample has supported the evolutionary scenario, since the post-starburst population is not located close enough to the nucleus, where the outflow is observed. As a general behaviour, we found that outflows velocity are on the order of ∼600-800 km/s and the mass outflow rates of ∼0.03–0.1 $M_{\odot}$/yr, one order of magnitude greater than the AGN accretion rate, which suggests a scenario where the AGN-driven wind has entrained material from the circumnuclear region. In order to increase the statistical significance of our previous results and to distinguish between the proposed scenarios, we are conducting the same analysis to a wider sample of PSQs, which we hope will indicate more conclusively which is the favored scenario. During the workshop, we will present more detailed results of our two first exploratory studies as well for other 3 PSQs of our sample and compare them to a control sample.

4P ALMA view of a massive spheroid progenitor: a compact rotating core of molecular gas in an AGN host at z=2.226

Dr. Margherita Talia | University of Bologna
margherita.talia2@unibo.it

Abstract

Massive star-forming galaxies with centrally concentrated luminosity profiles at $z > 2$ have been suggested to be the direct progenitors of compact quiescent galaxies (cQGs) at $z = 1.5 - 3$. Some works have been very recently published on the properties of the ionized gas, dust continuum and X-ray emission of samples of compact star-forming galaxies. However, until now there are only a few sources that have been spatially resolved with ALMA. This kind of observations allow not only the study of the general properties of the molecular gas, like density and gas depletion time-scale, but also the measurement of its size and the study of its kinematic, that are fundamental information to understand the evolution of cQGs progenitors. I will present ALMA observations of GMASS 0953, a candidate progenitor of cQGs at $z = 2.226$. We measure for the first time the size of the dust and molecular gas emission of GMASS 0953 that we find to be extremely compact (∼1 kpc). This result, coupled with a very high ISM density ($\log(n) \simeq 5.5$ cm^{-3}), a low gas mass fraction (∼0.2) and a short gas depletion timescale (∼150 Myr) imply that GMASS 0953 is experiencing an episode of intense star-formation in its central region that will rapidly exhaust its gas reservoirs, likely aided by AGN-induced feedback. We are therefore witnessing in this galaxy the rare and short-lived phase immediately before star-formation quenching. Kinematic analysis of the CO(6–5) line shows evidence of rapidly-rotating gas ($V_{\rm rot} = 320$ km/s), as observed also in a handful of similar sources at the same redshift. On-going quenching mechanisms could either destroy the rotation or leave it intact leading the galaxy to evolve into a rotating quiescent galaxy.

4Q Outflow Kinematics of Obscured Quasars at High Redshift

Matthew Temple | Institute of Astronomy, University of Cambridge
mtemple@ast.cam.ac.uk

Abstract

It is known that some intrinsically luminous ($log(L_{bol}[erg/s]) \sim 46 - 48$) quasars at $z \sim 2$ are significantly reddened due to the presence of dust. However, the broad width of the Balmer lines demonstrates that the reddening is not simply due to orientation effects, but is instead consistent with a short-lived evolutionary phase where the most luminous AGN are triggered by a major galaxy merger, during which they are obscured by dust. In this scenario we might expect redder objects to have stronger outflows while the dust is being expelled from the host galaxy. Here we present rest-frame optical spectroscopic observations taken with VLT-SINFONI of a sample of heavily dust-reddened quasars in the redshift range 2.0 < z < 2.6. We use the [OIII] 5008 Angstrom emission line as a tracer of ionised gas, and compare the kinematic properties of the outflows in our sample to a large sample of unobscured quasars matched in redshift and luminosity. This is the first systematic comparison of the outflow properties of obscured and unobscured quasars at these redshifts. By addressing the question of whether heavily dust-obscured quasars have a more efficient feedback mechanism, we can move towards a better understanding of reddened objects at the peak of AGN activity and their importance within the wider quasar population.

4R Catching Sub-kpc Scale AGN Feedback in the Act in the Compact Steep Spectrum source 4C 31.04

Henry Zovaro | Australian National University
henry.zovaro@anu.edu.au

Abstract

The peaked radio spectrum and compact radio emission of Gigahertz Peak Spectrum (GPS) and Compact Steep Spectrum (CSS) sources indicates that they harbour young jets temporarily confined by a dense interstellar medium. Observing these sources therefore enables us to study Active Galactic Nucleus (AGN) feedback processes within the host galaxy in the early stages of radio activity. In my talk I will report on the discovery of sub-kpc scale jet-ISM interaction, in the form of a jet-driven bubble, in the host galaxy of the $z = 0.0602$ CSS source 4C 31.04. 4C 31.04 has a compact (~ 100 pc) double-lobed radio morphology, and is believed to be a very young ($\sim 10^3$ yr old) AGN. Its host galaxy, the giant elliptical MCG 5-4-18, has a dense, multi-phase circumnuclear disc that has been detected in H I, CO and HCO^+ with an estimated gas mass of $M_{\rm gas} \sim 10^{10}\ M_\odot$. Using high spatial resolution AO-assisted H- and K-band integral field Gemini/NIFS observations, we probe two new phases of the circumnuclear medium: (1) the warm (~ 1000 K) molecular gas, traced by ro-vibrational transitions of H_2 in the near-infrared, and (2), Fe II, traced by the [Fe II]1.644μm line, at a much higher angular resolution than previous studies. We detect the warm H_2 in the form of a inflated kpc-scale torus, whilst the [Fe II] emission is localised to the innermost ≈ 300 pc of the galaxy. We conclude that the [Fe II] emission, excited by fast J-shocks, traces a bubble of outflowing gas driven by the jet-driven forward shock. We find the warm H_2 torus is also shock-excited, although its distance from the nucleus is too great to be caused by jet activity. We instead conclude that the shocks are a result of accretion processes.

Participant Directory

James Aird	University of Leicester	james.aird@leicester.ac.uk
David Alexander	Durham University	d.m.alexander@durham.ac.uk
Rachael Alexandroff	University of Toronto	rachael.alexandroff@dunlap.utoronto.ca
Almudena Alonso-Herrero	Centro de Astrobiologia, Madrid	aalonso@cab.inta-csic.es
Roberto Assef	Universidad Diego Portales	roberto.assef@mail.udp.cl
Manda Banerji	University of Cambridge	mbanerji@ast.cam.ac.uk
Amy Barger	University of Wisconsin-Madison	barger@astro.wisc.edu
David Barnes	Massachusetts Institute of Technology	djbarnes@mit.edu
Scott Barrows	University of Colorado Boulder	robert.barrows@colorado.edu
Emmanuel Bernhard	University of Sheffield	e.p.bernhard@sheffield.ac.uk
Patricia Bessiere	Pontifica Universidad Catolica	patricia.bessiere.astro@gmail.com
Keir Birchall	University of Leicester	klb64@leicester.ac.uk
Manuela Bischetti	INAF - Osservatorio di Roma	manuela.bischetti@inaf.it
Abhijeet Borkar	Czech Academy of Sciences	borkar@asu.cas.cz
Martin Bourne	University of Cambridge	mabourne@ast.cam.ac.uk
Richard Bower	Durham University	r.g.bower@durham.ac.uk
McKinley Brumback	Dartmouth College	mckinley.c.brumback.gr@dartmouth.edu
Marcella Brusa	University of Bologna	marcella.brusa3@unibo.it
Leonard Burtscher	Universiteit Leiden	burtscher@strw.leidenuniv.nl
Gabriela Calistro Rivera	Leiden Observatory	gcalistrorivera@gmail.com
Rebecca Canning	Stanford University	rcanning@stanford.edu
Rosamaria Carraro	Universidad de Valparaiso	carrarorosamaria@gmail.com
Christopher Carroll	Dartmouth College	christopher.m.carroll.gr@dartmouth.edu
Renyue Cen	Princeton University	cen@astro.princeton.edu
Yu-Yen Chang	ASIAA, Taiwan	yuyenchang.astro@gmail.com
Xiaoyang Chen	Tohoku University	xy.chen@astr.tohoku.ac.jp
Chiara Circosta	European Southern Observatory	ccircost@eso.org
Alison Coil	UC San Diego	acoil@ucsd.edu
Anca Constantin	James Madison University	constaax@jmu.edu
Lennox Cowie	University of Hawaii	cowie@ifa.hawaii.edu
D. Michael Crenshaw	Georgia State University	crenshaw@astro.gsu.edu
Giovanni Cresci	INAF - Osservatorio di Arcetri	gcresci@arcetri.astro.it
Ric Davies	MPE Garching	davies@mpe.mpg.de
Colin DeGraf	University of Cambridge	cdegraf@ast.cam.ac.uk
Ignacio del Moral-Castro	Instituto de Astrofisica de Canarias	imoralc@iac.es
Yohan Dubois	Sorbonne Université CNRS	dubois@iap.fr
Jacobo Ebrero	European Space Agency	jebrero@sciops.esa.int
Anastasia Efthymiadou	University of Bath	a.efthymiadou@bath.ac.uk
Kimberly Emig	Leiden University	emig@strw.leidenuniv.nl
Vicky Fawcett	Durham University	vixf123@hotmail.co.uk
Travis Fischer	NASA Goddard Space Flight Center	travis.c.fischer@nasa.gov
Adi Foord	University of Michigan	foord@umich.edu
Sotiria Fotopoulou	Durham University	sotiria.fotopoulou@durham.ac.uk
Jacopo Fritz	UNAM, Mexico	j.fritz@irya.unam.mx
Begoña Garcia-Lorenzo	Instituto de Astrofisica de Canarias	bgarcia@iac.es
Michele Ginolfi	Sapienza University of Rome	micheleginolfi@gmail.com
Crystal Gnilka	Georgia State University	pope@astro.gsu.edu
Melanie Habouzit	Flatiron Institute	mhabouzit@flatironinstitute.org
Martin Hardcastle	University of Hertfordshire	m.j.hardcastle@herts.ac.uk
Christopher Harrison	European Southern Observatory	charriso@eso.org
Wanqiu He	Tohoku University	he_wanqiu@astr.tohoku.ac.jp

Participant Directory

Ryan Hickox	Dartmouth College	ryan.c.hickox@dartmouth.edu
Erin Hicks	University of Alaska Anchorage	ekhicks@alaska.edu
Li-Ting Hsu	Academia Sinica Institute	lthsu@asiaa.sinica.edu.tw
Thomas Jackson	Durham University	thomas.m.jackson@durham.ac.uk
Yashashree Jadhav	Rochester Institute of Technology	ysj1195@rit.edu
Kristen Jones	Arecibo Observatory	kmj.jones@gmail.com
Mackenzie Jones	Dartmouth College	Mackenzie.L.Jones.GR@Dartmouth.edu
Minbae Kim	Kyung Hee University	mbkim@khu.ac.kr
Lizelke Klindt	Durham University	lizelke.klindt@durham.ac.uk
Dale Kocevski	Colby College	dale.kocevski@colby.edu
Charutha Krishnan	University of Nottingham	charutha.krishnan@nottingham.ac.uk
Joanna Kuraszkiewicz	CfA - Harvard Smithsonian	jkuraszkiewicz@cfa.harvard.edu
Stephanie LaMassa	Space Telescope Science Institute	slamassa@stsci.edu
George Lansbury	University of Cambridge	gbl23@ast.cam.ac.uk
Lauranne Lanz	Dartmouth College	lauranne.lanz@dartmouth.edu
Nora Loiseau	European Space Agency	nloiseau@sciops.esa.int
Elisabeta Lusso	Durham University	elisabeta.lusso@durham.ac.uk
Madeline Marshall	University of Melbourne	madelinem1@student.unimelb.edu.au
Alberto Masini	Dartmouth College	alberto.masini@dartmouth.edu
Chiara Mazzucchelli	MPIA Heidelberg	mazzucchelli@mpia.de
Stuart McAlpine	Durham University	s.r.mcalpine@durham.ac.uk
Leah Morabito	University of Oxford	leah.morabito@physics.ox.ac.uk
Emily Moravec	University of Florida	emoravec@ufl.edu
James Mullaney	University of Sheffield	j.mullaney@sheffield.ac.uk
Kentaro Nagamine	Osaka University	kn@astro-osaka.jp
Emil Noordeh	Stanford University	emiln@stanford.edu
Roderik Overzier	Observatorio Nacional, Brazil	roderikoverzier@gmail.com
Meredith Powell	Yale University	meredith.powell@yale.edu
Sandra Raimundo	Dark Cosmology Centre	s.raimundo@dark-cosmology.dk
Joanna Ramasawmy	University of Hertfordshire	j.ramasawmy@herts.ac.uk
Angelo Ricarte	Yale University	angelo.ricarte@yale.edu
Federica Ricci	Pontificia Universidad Catolica de Chile	fricci@astro.puc.cl
Rogerio Riffel	Federal University of Rio Grande do Sul	riffel@ufrgs.br
Rogemar A. Riffel	Universidade Federal de Santa Maria	rogemar@ufsm.br
Angelica Rivera	Drexel University	abr54@drexel.edu
Alberto Rodriguez-Ardila	Laboratorio Nacional de Astrofisica	aardila@lna.br
David Rosario	Durham University	david.rosario@durham.ac.uk
Nicholas Ross	University of Edinburgh	npross@roe.ac.uk
David Sanmartim	Gemini Observatory	dsanmartim@gemini.edu
Jan Scholtz	Durham University	honzascholtz@gmail.com
Taro Shimizu	MPE Garching	shimizu@mpe.mpg.de
Debora Sijacki	University of Cambridge	deboras@ast.cam.ac.uk
Brooke Simmons	UC San Diego	bdsimmons@ucsd.edu
Vernesa Smolcic	University of Zagreb	vs@phy.hr
Lisa Steinborn	LMU Munich	steinborn@usm.lmu.de
Thaisa Storchi Bergmann	Intituto de Fisica - UFRGS	thaisa@ufrgs.br
Margherita Talia	University of Bologna	margherita.talia2@unibo.it
Matthew Temple	University of Cambridge	mtemple@ast.cam.ac.uk
Bryan Terrazas	University of Michigan	bterraza@umich.edu
Benny Trakhtenbrot	ETH Zurich	benny.trakhtenbrot@phys.ethz.ch

Participant Directory

Bram Venemann	MPIA Heidelberg	venemans@mpia.de
Marianne Vestergaard	University of Copenhagen	mvester@nbi.ku.dk
Giustina Vietri	Excellence Cluster Universe - ESO	giustina.vietri@eso.org
Carolin Villforth	University of Bath	c.villforth@bath.ac.uk
Madalyn Weston	University of Missouri	mew9bc@mail.umkc.edu
Kelly Whalen	Dartmouth College	kelly.e.whalen.gr@dartmouth.edu
Imogen Whittam	University of the Western Cape	iwhittam@uwc.ac.za
Dawei Xu	National Astronomical Observatories of China	dwxu@nao.cas.cn
Wei Yan	Dartmouth College	wei.yan.gr@dartmouth.edu
Nadia Zakamska	Johns Hopkins University	zakamska@jhu.edu
Dongyao Zhao	KIAA, Peking University	zdymoon@pku.edu.cn
Henry Zovaro	The Australian National University	henry.zovaro@anu.edu.au