Contents

AGN versus star formation: the fate of the gas in galaxies

Dartmouth-Durham Extragalactic Workshop,

Durham, England 28 July–1 August 2014

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

How is AGN activity connected to star formation? This remains one of the key unsolved questions in astronomy and cosmology. Both processes are driven by a cold gas supply and we should therefore expect a loose connection. However, a slew of empirical and theoretical evidence suggest an unexpectedly tight symbiotic link between AGN activity and star formation, whereby the fuelling and regulation of one process is dictated by the other. The effectiveness of this fuelling and regulation and (most crucially) whether it is predominantly dictated by AGN activity or star formation is a matter of intense debate, and has important implications for the growth of galaxies and black holes over cosmic time.

The objective of this workshop is to bring together observers and theorists to discuss the connection between AGN activity and star formation on small (< 100 pc), large (≈ 0.1–10 kpc), and cosmological scales to address the following key questions:

- What evidence is there for a symbiotic connection between AGN activity and star formation?
- What physical processes drive gas into the centre/how do star formation and AGN activity compete for cold gas?
- How does star formation control AGN activity?
- What impact does AGN activity have on star formation?
- How different would the Universe look without AGNs?
- What key tests and observations do we need to make progress?

Workshop Format

The talks and posters have been organised into three main session, called “Evidence” (session A), “Feeding” (session B) and “Impact” (session C) to address the questions listed above. After the talks for each of the three main sessions there will be a 1.25 hour discussion session. Each discussion session will begin with 1 min poster talks, followed by a chaired discussion reflecting upon the talks and posters that have been presented.

Scientific Organising Committee

David Alexander ● Ryan Hickox ● Tom Theuns ● Almudena Alonso-Herrero ● Frederic Bournaud ● Ric Davies ● Raffaella Morganti ● James Mullaney ● Rachel Somerville

Local Organising Committee

James Aird ● David Alexander ● Adlyka Annuar ● Richard Bower ● Agnese Del Moro ● Poshak Gandhi ● Chris Harrison ● George Lansbury ● Manolis Rovilos ● Flora Stanley ● Mark Swinbank

Venue and Locations

Oral presentations	Kingsley Barrett Lecture Theatre, top floor of the Calman Learning Centre at Durham University
Posters, coffee &	Derman Christopherson Room, adjacent to the Kingsley
Sunday evening buffet reception	Barrett Lecture Theatre (Calman, top floor)
Breakfasts	Collingwood College and Durham Business School
Lunches	Derman Christopherson Room, adjacent to the Kingsley Barrett Lecture Theatre (Calman, top floor)
Public lecture by Jenny Greene	Centre for Life - Newcastle
Workshop photograph & dinner	Durham Castle
Prince Bishop boat cruise	The Boathouse, Elvet Bridge
Hadrians Wall excursion	Pick up outside Physics building (Rochester)
End of workshop BBQ	Physics building (Rochester) quadrangle

Presentation Information

Talks – Review talks are 35+5 minutes and the invited and contributed talks are 17+3 minutes. We request that all speakers provide us with their talk on a thumb drive in advance of their presentation to avoid any technical issues.

Posters – Posters are displayed for the duration of the workshop in the Derman Christopherson Room. 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. All presenters have the option to give a 1 min oral presentation of their poster.

Invited Speakers and Discussion Leaders

James Aird ● Almudena Alonso-Herrero ● Frederic Bournaud ● Richard Bower ● Francoise Combes ● Ric Davies ● Chris Done ● Jared Gabor ● Jenny Greene ● Chris Harrison ● Ryan Hickox ● Dale Kocevski ● Matt Lehnert ● James Mullaney ● Amelie Saintonge ● Clive Tadhunter ● Robert Thacker ● Tom Theuns ● Sylvain Veilleux ● Vivienne Wild

Twitter

We encourage you two Tweet throughout the conference using #agnsf2014.
Our account is: @AGNvsSF_2014.

Workshop Programme

Sunday 27th July 2014

6.00–8.00 **Evening Reception: top floor of the Calman Learning Centre**

Monday 28th July 2014

8.00 **Registration**

9.00 **Scientific Motivation of the Workshop (Alexander)**

9.20 **Session A "Evidence", block 1** – *Chair: Alexander*

Hickox [R]	The SF-AGN connection: does AGN activity follow or prevent star formation?
Ciesla	AGNs and host galaxies: the constraints on their physical properties from panchromatic SED fitting
Hatziminaoglou	AGN and starburst signatures in the mid- and far-IR

10.45 **Coffee Break and Poster Session**

11.30 **Session A "Evidence", block 2** – *Chair: Ward*

Shimizu	Measuring the starburst-AGN connection with an unbiased low redshift sample
Rosario	Star-formation in powerful and obscured AGN
Chen	Obscuration and star formation in luminous quasars
Magliocchetti	Far-infrared properties of radio-selected AGN

1.00 **Lunch**

2.00 **Session A "Evidence", block 3** – *Chair: Wilkes*

Azadi	The connection between star formation rate and AGN activity
Vito	Black hole accretion preferentially occurs in gas rich galaxies
Juneau	AGN triggering in star-forming galaxies and its break-down at late times
Reines	AGN and star formation in dwarf galaxies

3.30 **Coffee Break and Poster Session**

4.15 **Session A "Evidence", block 4**

Poster talks for session A (Chair: Hainline)
Discussion session A (Chairs: Aird & Mullaney)

5.30 **End**

7.00 **Prince Bishop Boat Cruise and Dinner**

Workshop Programme

Tuesday 29th July 2014

9.00 **Session B "Feeding", block 1** – *Chair: Gandhi*

Combes [R]	Gas flows
Davies	Where do Seyferts get their gas?
Zanella	AGC: Active Galactic Clumps?

10.30 **Coffee Break and Poster Session**

11.15 **Session B "Feeding", block 2** – *Chair: Villforth*

Saintonge	The role of molecular gas in feeding star formation and AGN activity
LaMassa	Investigating the AGN/star-formation connection in local obscured AGN
Kocevski	Insights on the AGN-galaxy connection at z≈2 from CANDELS
Lackner	Double yolk galaxies: late-stage galaxy mergers in COSMOS

12.45 **Lunch**

2.00 **Session B "Feeding", block 3** – *Chair: Del Moro*

Alonso-Herrero [R]	Connecting the AGN and SF phenomena on nuclear scales
Blank	Viscous time lags between starburst and AGN activity
Bauer	Probing the torus structure of nearby AGN

3.30 **Coffee Break and Poster Session**

4.15 **Session B "Feeding", block 4** – *Chair: Rovilos*

Wild	Tracking AGN activity following a starburst
Hampton	The nature of composite galaxies
Thacker	AGN feedback models: correlations with star formation and observational implications of time evolution
Dubois	BH growth and the impact of AGN feedback on galaxy evolution

5.45 **End**

6.30-9.00
Public Talk by Jenny Greene: "Tiny But Powerful: The Smallest Supermassive Black Holes"
A public event at the Centre for Life in Newcastle that will also include a planaterium show and a talk by Gary Fildes (director of Kielder Observatory). Anyone wishing to attend will need to make their own way to Newcastle (≈15 minutes on the train).

Workshop Programme

Wednesday 30th July 2014

9.00	**Session B "Feeding", block 5**
	Poster talks for session B (Chair: Hainline) Discussion session B (Chairs: Davies & Gandhi)
10.15	**Coffee Break and Poster Session**
10.45	**Session C "Impact", block 1** – *Chair: Croom*
Lehnert [R]	What impact does AGN activity have on star formation?
Veilleux	Powerful neutral atomic and molecular outflows in nearby active galaxies
Colina	The multi-phase view of gas outflows in low-z U/LIRGs
12.15	**Free afternoon or Hadrians wall excursion**
7.30	**Conference drinks and group photo**
8.00	**Conference dinner**
10.00	**Entertainment from The George Lansbury Project**
	Durham Castle Bar

Workshop Programme

Thursday 31st July 2014

9.00 **Session C "Impact", block 2** – *Chair: Barthel*

Harrison	Observational constraints on the influence of luminous AGN on star formation using multiple approaches
Barger	Suppressed star-formation in X-ray luminous AGN
Lutz	AGN driven nuclear outflows in massive star-forming galaxies
Marconi	Fast outflows quenching star formation in quasar host galaxies

10.30 **Coffee Break and Poster Session**

11.15 **Session C "Impact", block 3** – *Chair: Vignali*

Mainieri	Testing AGN impact on star formation from the SFR-$M_\star$ plane
Tadhunter	Star formation in powerful radio galaxies
Bower [R]	Black holes and the star formation history of the Universe

12.45 **Lunch**

2.00 **Session C "Impact", block 4** – *Chair: Lacey*

Gabor	Simulating AGN fueling and feedback in high-redshift disk galaxies
Zubovas	Positive AGN feedback on turbulent ISM
Hirschmann	Cosmological simulations of BH growth: AGN luminosities and the connection to their host galaxies
DeGraf	Impact of bursty black hole accretion and feedback on host galaxy formation

3.30 **Coffee Break and Poster Session**

4.15 **Session C "Impact", block 5** – *Chair: Blain*

Fanidakis	AGN - star formation correlation in a universe with AGN feedback
Furlong	Evolution of AGNs in hydrodynamical simulations
Theuns [R]	AGN implementations in cosmological simulations

5.45 **End**

Workshop Programme

Friday 1st August 2014

9.00		**Session C "Impact", block 6**
		Poster talks for session C (Chair: Hainline) Discussion session C (Chairs: Done & Thacker)
10.15		**Coffee Break and Poster Session**
11.00		**Concluding Session** – *Chair: Hickox*
	Greene [R]	Future experiments Workshop wrap up
12.30		**End of workshop BBQ**

Poster Programme

Posters are displayed throughout the workshop in the coffee area (Derman Christopherson Room). The numbers given below refer to the board on which each poster is displayed. Session A is "Evidence", session B is "Feeding", and session C is "Impact".

Blain	A1	The overdense environment of SMGs around WISE-selected AGNs
Carroll	A2	Modeling Obscured Quasar SEDs with Linear Least Squares Fitting
Gurkan Uygun	A3	The connection between star-formation and AGN activity in radio-loud and radio-quiet active galaxies
Jones	A4	Testing the star formation-AGN connection with SDSS
Matsuoka	A5	Comparing AGN and SF Luminosities of Local Active Galaxies using Multi-Wavelength Data
Mingo	A6	Radio-loud AGN through the eyes of 3XMM, WISE and FIRST/NVSS
Oti-Floranes	A7	X-rays in Seyfert 2 Galaxies: Disentangling Nuclear Activity and Star Formation
Podigachoski	A8	Fireworks in the early universe
Rocca-Volmerange	A9	Star Formation Laws and AGN evolution in high-z radio galaxies
Stanley	A10	Constraining the SFRs of galaxies hosting an AGN: Is Star Formation dependent of AGN power?
White	A11	Radio-Quiet Quasars in the VIDEO Survey: Evidence for AGN-powered radio emission below 1 mJy
Woo	A12	AGN and star formation in X-ray selected galaxy groups at $0.5 < z < 1.1$

Annuar	B1	Towards A Complete Census of Compton-thick AGN and $N_{\rm H}$ Distribution in the Local Universe
Bessiere	B2	The stellar populations of type II quasar host galaxies
Chies Santos	B3	AGN in A901/902 from the OMEGA survey
Fan	B4	Structure and morphology of massive galaxies at high redshift revealed by HST/WFC3
Frank	B5	HI and AGN Morphology in NGC 3998
Lansbury	B6	Studying the Cosmic X-ray Background Population with NuSTAR
Lin	B7	Dense Molecular Gas in Nearby Seyfert Galaxies
Richardson	B8	The physical reason for the variation in AGN and star forming galaxy emission line spectra
Rovilos	B9	SED decomposition of SDSS galaxies
Schulze	B10	The cosmic growth of the active black hole population
Vignali	B11	Obscured accretion and star formation at $z \approx 1$
Villforth	B12	Triggering Active Galactic Nuclei from Seyferts to Quasars: Do mergers matter?
Weigel	B13	The systematic search for $z > 5$ AGN in the Chandra Deep Field South

Cashmore	C1	High Resolution Simulations of SN feedback in Dwarf Spheroidals
Croom	C2	Spatially resolving the AGN/star-formation connection
Feldmann	C3	Massive Galaxies in their Prime - Mass Accretion and Star Formation at and above $z \approx 2$
Hainline	C4	The Immense Sizes and Disturbed Kinematics of Obscured Quasar Narrow-Line Regions
Husemann	C5	Quenching of star formation in Seyfert galaxies and luminous QSO hosts
Morselli	C6	Mass versus environment quenching in the SFR-stellar mass plane
Newton	C7	Simulations of AGN and SN in disc galaxy mergers
Rashed	C8	High resolution observations of SDSS J080800.99+483807.7 in the optical and radio domain: A possible example of jet-triggered star formation
Roos	C9	The limited impact of AGN radiation on Star Formation
Saturni	C10	Absorption variability in the outflowing gas of the broad-absorption line quasar APM 08279+5255
Wurster	C11	How does an AGN subgrid model affect a galaxy merger?

Oral Programme Abstracts

Monday, 28th July 2014

The SF-AGN connection: Does AGN activity follow or prevent star formation?

Prof Ryan Hickox | Dartmouth College
Ryan.C.Hickox@dartmouth.edu

Abstract

This workshop is largely motivated by a basic question that has remained largely unanswered: Does the fueling of AGN activity *follow* along with star formation in galaxies, or does feedback from AGN *prevent* star formation? I will review a range of recent observations and argue that both scenarios take place depending on the properties of the galaxy and its dark matter halo: In star-forming galaxies in moderate-mass halos, star formation and black hole growth are strongly correlated (although some AGN drive powerful outflows that can have a significant influence on star formation). In passive galaxies in massive halos, mechanical feedback from AGN serves to heat gaseous atmospheres and prevent further star formation. In the context of this picture, I will point toward new results presented by various talks and posters at the workshop.

Notes

AGNs and host galaxies: the constraints on their physical properties from panchromatic SED fitting

Dr Laure Ciesla | University of Crete
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Abstract

The interplay between the AGNs and their host galaxies is at the core of the study of the evolution of galaxies. Identifying correlations between the physical characteristics of the host galaxy, such as the stellar mass and the star formation rate, and the AGN properties, such as bolometric luminosity and accretion rate, is one of the keys to understand this interplay. However, the emission of the AGN in optical-NIR affects our ability to derive some of the host galaxy properties. Recently a number of ground based and space born facilities have provided a wealth of high quality data enabling us to sample the full SED, from the UV to IR, for statistically significant samples of nearby and distant galaxies. Furthermore a number of SED fitting techniques have been proposed to interpret the energy production in these systems. To quantify the accuracy of our ability to estimate the physical parameters of AGNs and their host galaxies based on SED fitting, we use the Star Formation Histories provided by the SAM GALFORM code to build galaxies from which we know their true SFR and stellar masses. We have added optical-NIR components of different types of AGN, and examine the ability of the SED fitting - bayesian like - CIGALE code to retrieve these parameters and estimate the power of an enshrouded AGN. We place our finding into context by applying the our CIGALE SED fits to derive from the IR the AGN properties of a subsample of X-ray AGN from the GOODS fields.

Notes

AGN and Starburst Signatures in the Mid- and Far-IR

Dr. Evanthia Hatziminaoglou | ESO
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Abstract

I will present results of a study of a large sample of Herschel sources from the Herschel Multi-tiered Extragalactic Survey (HerMES) with available Spitzer/IRS spectra, with focus on the observational signatures of nuclear and star-formation activities in the mid- and far-infrared regimes. A multitude of data was used to perform broad-band SED fitting as well as spectral decomposition and the outcome of the two methods on the AGN and starburst content of the objects will be discussed. Star formation rates derived from different indicators in AGN- and starburst-dominated objects will also be presented, followed by a discussion on possible effects of the AGN on the star formation process of their hosts.

Notes

Measuring the Starburst-AGN Connection with an Unbiased Low Redshift Sample

Mr Taro Shimizu | University of Maryland
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Abstract

We present results from our Herschel PACS and SPIRE (70 - 500 microns) imaging campaign of 313 AGN selected from the 58 month Swift/BAT catalog (14–195 keV). This represents the largest and most unbiased view of AGN in the far-infrared (FIR), and fills in the gap in their spectral energy distributions (SEDs) at wavelengths >100 micron allowing a detailed look into the connection between host galaxy star formation and AGN activity. We find a correlation between each Herschel waveband luminosity and AGN luminosity in Seyfert 1's but not for Seyfert 2's. While the majority of the FIR colors are similar to inactive galaxies, there seems to be a sub-sample of AGN with abnormal colors, possibly showing evidence for a non-thermal contribution. We will present the SED's of our sample along with dust temperatures and emissivities from several different models and derived star formation rates (SFR), FIR luminosities, and dust masses. While the absolute SFR's span a wide range (.01–100 $M_{\odot}$/yr), we find that a large fraction of our sample are spatially compact in the FIR leading to star formation rate densities ($M_{\odot}$/yr/kpc^2) above the threshold for starburst driven-winds. Building upon previous work, the AGN contribution to the FIR is found to decrease with increasing wavelength, however especially for the 70 micron waveband, the AGN contribution can still be >50%. We compare the main sequence of star-forming galaxies, a tight correlation between SFR and stellar mass for star-forming galaxies, to our sample and find that anywhere from 40–80% of AGN host galaxies live at least 1-sigma below the correlation signifying strong quenching of star formation possibly related to the AGN. Finally we will discuss implications of our results on galaxy evolution and feedback models and relate them to high redshift sources.

Notes

Star-formation in powerful and obscured AGN

Dr David Rosario | MPE
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Abstract

The Herschel legacy of deep and wide area FIR surveys give workers the best current capability for studying obscured star-formation in galaxies and AGN across a wide range of redshifts. I will report on the most comprehensive study to-date of star-formation in luminous unobscured AGN to $z \sim 2$ and show that they are very likely in relatively normal galaxies. I will then discuss and compare this to a parallel study of obscured AGN, selected through mid-IR methods. Evidence will be presented for an evolution in the star-forming properties of AGN hosts, which may point to changes in the dominant mode of AGN fueling over cosmic time.

Notes

Obscuration and Star Formation in Luminous Quasars

Mr Chien-Ting Chen | Dartmouth College
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Abstract

The connection between star formation in galaxies and the growth of their super-massive black holes is an important and still uncertain aspect of galaxy evolution that has seen dramatic progress with the launch of Herschel. I will present our recent studies using Herschel and a range of multiwavelength data for powerful quasars in the Bootes field. We find evidence for a link between nuclear obscuration and host galaxy star formation in powerful quasars, which supports a scenario in which obscuration in quasars might be associated with the star-forming dust in the host galaxies.

Notes

Far infrared properties of radio-selected AGN

Dr. Manuela Magliocchetti | IAPS-INAF
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Abstract

In order to investigate the FIR properties of radio-selected AGN we have considered 1537 radio sources from the VLA-COSMOS survey which also had a reliable redshift estimate and sub-divided them into star-forming galaxies and AGN solely on the basis of their radio luminosity. Our criteria ensure that the AGN sample is complete with respect to radio selection at all $z \lesssim 3.5$. 832 radio sources were found to have a counterpart in the Herschel-PEP catalogue, either at 100μm or at 160μm. Of these, 175 are AGN. Their redshift distribution closely resembles that of the radio-selected AGN population as a whole, and exhibits two marked peaks at z$\sim$0.9 and z$\sim$2.5. We find that the probability for a radio-selected AGN to be detected at FIR wavelengths is both a function of radio power and redshift, whereby powerful sources are more likely to be FIR emitters at higher redshifts. For a typical AGN with $P_{1.4GHz} \gtrsim 10^{23}$ [W Hz sr^{-1}], such a probability increases from $\sim$10–20 to $\sim$50–60% at the highest redshifts probed by our analysis. This is due to two distinct effects: 1) at all radio luminosities, FIR activity is found to monotonically increase with look-back time and 2) radio activity of AGN origin is increasingly less effective at inhibiting FIR emission at the earlier epochs. Radio-selected AGN which present FIR emission are also observed to be hosted by smaller galaxies with respect to the total radio-AGN population. Furthermore, there seems to be a preferential (stellar) mass scale $M_* \sim [10^{10} - 10^{11}]M_\odot$ which maximizes the chances for a radio AGN to also be an active FIR emitter. This finding is however true only for $z \lesssim 2$. Beyond this value, the probability for enhanced FIR emission is found not to depend on mass. Finally, we investigate the origin of such FIR (and MIR) emission and conclude that it is due to processes related to ongoing star-formation, indistinguishable from those which power star-forming galaxies. It follows that radio emission observed in at least 35% of the entire radio-active AGN population is the sum of two contributions: one due to AGN accretion and another generated by star-forming processes within the host galaxy.

Notes

The connection between star formation rate and AGN activity

Ms Mojegan Azadi | UC San Diego, Center for Astrophysics & Space Sciences
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Abstract

I will study the evidence for a symbiotic connection between AGN activity and star formation by investigating the correlation between the X-ray luminosity of AGNs and the star formation rate of their host galaxies at $0.2 < z < 1.2$. We identify a sample of moderate-luminosity X-ray AGNs within PRIMUS, a low-resolution spectroscopic survey of ∼120,000 galaxies and divide the host galaxies into star-forming and quiescent populations. We find no evidence of a direct correlation between the star-formation rate and X-ray luminosity within either the star-forming or quiescent host sub-samples. However, a higher fraction of the X-ray AGN hosts are classified as star-forming, compared to non-active galaxies with the same stellar masses, indicating an underlying connection between star formation and the presence and of an AGN. Nevertheless, AGNs are found in quiescent galaxies, and we show that they have a wide, power-law distribution of accretion rates in both the star-forming and quiescent galaxy populations, with a factor ∼2–3 enhancement in the probability of finding an AGN in a star-forming galaxy.

Notes

Black hole accretion preferentially occurs in gas rich galaxies

Mr. Fabio Vito | Dipartimento di Fisica e Astronomia, INAF-OAB
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Abstract

We have investigated the gas content of a sample of several hundred AGN host galaxies at $z < 1$ and compared it with a sample of inactive galaxies, matched in bins of stellar mass and redshift. Gas masses have been inferred from the dust masses, obtained by stacked Herschel far-IR and sub-mm data in the GOODS and COSMOS fields, under reasonable assumptions and metallicity scaling relations for the dust-to-gas ratio. We find that AGNs are hosted in galaxies much more gas rich than inactive galaxies. In the vast majority of cases the gas content of AGN hosts is higher than in inactive galaxies with the same stellar mass. The difference is up to a factor of ten higher in low stellar mass galaxies, with a significance of 6.5σ. In almost half of the AGN sample the gas content is three times higher than in the control sample of inactive galaxies. Our result strongly suggests that the probability of having an AGN activated is simply driven by the amount of gas in the host galaxy; this can be explained in simple terms of statistical probability of having a gas cloud falling into the gravitational potential of the black hole. The connection between AGN activity and star formation, identified by previous works, is probably an indirect consequence of the more direct relation between gas content and AGN activity, found in this paper, combined with the Schmidt-Kennicut law for star formation.

Notes

AGN triggering in star-forming galaxies and its break-down at late times

Dr Stephanie Juneau | CEA-Saclay
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Abstract

There is recent, growing evidence that growth rates of stars in galaxies, and of their central black holes are on average highly correlated, even down to moderate Seyfert luminosities, and despite large galaxy-to-galaxy variations. This feature can be accomplished through either a scaling between galaxy Star Formation Rates (SFRs) and average AGN luminosities, or a connection between SFRs and AGN duty cycles. The latter can be approximately traced by the incidence of AGN at a given bolometric luminosity. We explore more closely this question using a new sample of star-forming galaxies at $z = 0.5$–1 from the deepest GOODS-Herschel and CANDELS-Herschel surveys, for which we have an excellent handle on SFRs, and apply multiwavelength AGN selection methods allowing us to characterize both the incidence and X-ray absorption of AGN. Our results indicate that the dominant AGN-Galaxy connection is triggering of AGN activity in galaxies that are star-forming, and that the duty cycle may be more strongly affected than the amplitude of the AGN luminosity variation. On the other hand, we also find evidence that while AGN hosts are typically star-forming at $z > 0.5$–1, it is no longer the case at low redshifts ($z < 0.1$), indicating a faster decline in the SFRs of AGN hosts relative to the decline of "main-sequence" star-forming galaxies, and that the tight SFR-AGN link may break at $z < 0.5$ as we enter the "Quenching era". Lastly, I will present updated AGN emission-line diagnostics, adapted to deal with an increasing importance of the interplay with host SFRs at higher redshifts and with survey detection limits.

Notes

AGN and Star Formation in Dwarf Galaxies

Dr. Amy Reines | NRAO
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Abstract

The role of black hole feedback in dwarf galaxies has hitherto been neglected in models of galaxy formation and evolution, as very few dwarfs were even known to harbor massive black holes. However, we now know that massive black holes exist in a significant fraction of dwarf galaxies (Reines et al. 2013), which has implications for the interplay between black hole growth and star formation in these systems. In this talk I will discuss our multi-wavelength efforts to find active massive black holes in dwarf galaxies and to study the impact of these AGN on their surrounding environment. In particular, I will present exciting new results from our search for AGN in dwarf galaxies undergoing recent bursts of star formation similar to Henize 2-10.

Notes

Oral Programme Abstracts

Tuesday, 29th July 2014

Gas flows

Prof Francoise Combes | Observatoire de Paris
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Abstract

Fueling of AGN is a complex process which includes simultaneously positive and negative feedback on star formation. Both from new high-resolution observations and numerical simulations, the topic has seen a lot of progress that will be reviewed: radial flows due to non-axisymmetric features, and gravity torques during violent events such as interactions and mergers, or less violent ones including bars and secular evolution, viscous torques and dynamical friction, gas accretion, or outflows dragged by AGN jets.

Notes

Where do Seyferts get their gas?

Dr Richard Davies | MPE
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Abstract

We have analysed the spatially resolved molecular gas properties in the central regions of a sample of matched active and inactive galaxies, where the dynamical timescales are comparable to the timescale for significant variation in AGN luminosity. We find systematic differences in the distribution and kinematics of the molecular gas, presenting direct evidence for external accretion (i.e. stochastic events), as well as circumnuclear spirals driven by large scale bars (i.e. steady-state processes), and molecular outflows. We discuss the circumstances under which Seyferts may be able to drive molecular outflows, as well as the implications of the modest outflow velocities and rates observed. And we argue that the circumnuclear dust structures and molecular gas kinematics are influenced by the environment of the galaxies, relating our small sample to other samples which provide greater statistical significance. We suggest that galaxies in which the circumnuclear region is disturbed exist in moderately dense groups with 10–15 members where accretion of gas streamers can easily occur.

Notes

AGC: Active Galactic Clumps?

Miss Anita Zanella | CEA Saclay
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Abstract

The way super massive black holes (SMBHs) form and grow coupled with the stellar mass assembly is still a major challenging question in extragalactic astrophysics. High resolution hydrodynamical simulations suggest that violent disk instabilities can fragment high redshift disks into giant clumps where intense star formation can take place and seeds of SMBHs can form. If giant clumps survive stellar feedback they are expected to migrate toward the center of the galaxy where they can merge to form the bulge and a central SMBH. In order to test this scenario we analyze a sample of 68 [O III] emitters at redshift $z \sim 2$ that have been observed with Wide Field Camera 3 (WFC3) on board HST providing imaging and slitless spectroscopy. We find a galaxy with a clear off-center [O III] emission. From spatially resolved [O III], [O II] and Hβ emission line maps we are able to distinguish an off-center unresolved emission and a diffused component that traces the stellar continuum of the galaxy. In order to understand if the [O III] emission is powered by an AGN or a low metallicity star forming region we use emission line diagnostics and line ratios from the HST/WFC3 slitless spectroscopic data in combination with the long slit spectroscopy of the entire galaxy from the Subaru telescope. The analysis of this peculiar object together with a statistical study of the [O III] emission of our whole sample of galaxies can shade light on the relation between star formation and SMBHs growth.

Notes

The role of molecular gas in feeding star formation and AGN activity

Dr Amelie Saintonge | UCL
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Abstract

Observations of molecular gas in galaxies are experiencing a coming-of-age, transitioning from a "discovery" to a "survey" mode. New and upgraded facilities are now making it possible to survey molecular gas efficiently in large galaxy samples at both low and high redshifts, and these observations are proving to be critical in refining our general picture of galaxy evolution. In this talk, I will review recent results from the largest surveys for molecular gas, in particular the IRAM COLDGASS ($z \sim 0$) and PHIBSS ($z = 1 - 2$) surveys. Combined with an extensive multi-wavelength dataset, I will show how the molecular gas data provide strong support in favour of the "equilibrium" model for galaxy evolution, under which most of galaxy evolution is regulated by gas supply, the efficiency of the star formation process, and the return of material to the outside environment via SF- and AGN-driven outflows. The size of the samples now allow us to disentangle the impact and relation of the two different processes (star formation vs AGN) on the cold gas contents of galaxies.

Notes

Investigating the AGN/Star-formation Connection in Local Obscured AGN

Dr. Stephanie LaMassa | Yale University
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Abstract

Exploring the link between AGN activity and host galaxy star formation requires identifying probes that cleanly trace each process. Using a sample of ∼260 star-forming galaxies, ∼50 composite galaxies, and ∼70 Seyfert 2 (Sy2) galaxies, we compared optical and infrared indicators of starburst activity to determine which of these are least biased by the effects of supermassive black hole (SMBH) accretion. We found that the optical star formation rates (SFRs) derived from the Sloan Digital Sky Survey (SDSS) and the mid-infrared [Ne II] 12.8 micron line show no evidence of bias from AGN activity while the mid-infrared [Ne III] 15.6 micron emission line and polycyclic aromatic hydrocarbon features at 7.7, 11.3 and 17 microns show some evidence of AGN contamination. We then used the SDSS derived SFRs to study the connection between SMBH fueling (parameterized by the AGN-only contribution to the optical [O III] 5007 Angstrom line) and star formation in ∼28,000 composite and Sy2 galaxies. As both quantities are measured through the 3″ SDSS spectroscopic fiber, the projected aperture size encompasses greater amounts of the host galaxy with increasing redshift, allowing us to probe the AGN/star-formation link over scales ranging from ∼1.7 to 3.5 kpc. We demonstrate that the star formation associated with SMBH accretion dominates over the omnipresent host galaxy star formation when the AGN becomes more luminous, and is on circumnuclear rather than galaxy-wide scales. This AGN-related SFR has a sub-linear dependence on SMBH fueling.

Notes

Insights on the AGN-Galaxy Connection at $z \approx 2$ from CANDELS

Prof Dale Kocevski | University of Kentucky
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Abstract

I will summarize the insights gained from the CANDELS survey regarding the mechanisms that fuel AGN activity at $z \sim 2$, the epoch when nuclear activity and star formation activity in the Universe are at their peak. I will also discuss the recent discovery of a large population of compact, star forming galaxies that host rapidly growing SMBHs at $z = 2.5$. Based on their size, stellar mass, and star formation rates, these galaxies appear to be the direct progenitors of the red nugget population. Our findings suggest the first generation of quenched galaxies emerged in the early Universe directly following a phase of rapid SMBH growth. I will discuss what these observations are revealing about the connection between AGN activity and the rise of the red sequence at $z \sim 2$.

Notes

Double yolk galaxies: Late-stage galaxy mergers in COSMOS

Dr. Claire Lackner | Kavli IPMU
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Abstract

The role of major mergers in galaxy and black hole formation is not well constrained. To help address this, we have developed an automated method to identify late stage galaxy mergers before coalescence of the galactic cores. Our method relies on median-filtering of high-resolution images in order to distinguish two concentrated galaxy nuclei at small separations. We apply this method to a magnitude-limited sample of 44177 galaxies from the COSMOS HST/ACS catalog. We find that the fractional merger rate increases with redshift at least as $(1+z)^{2.0\pm1.4}$, consistent with earlier studies and with dark matter halo merger rates. The large sample of mergers allows us to rule out the hypothesis of no evolution in the galaxy merger rate with redshift. Separating the sample into blue and red galaxies demonstrates that the merger rate for red galaxies is essentially constant, while the fractional merger rate for blue galaxies increases as $(1+z)^{2.1\pm1.2}$. The star formation rates and X-ray selected AGN activity in late-stage mergers are enhanced by factors of $\sim$1.3–2 relative to a control sample. Combining our results with results from more widely separated pairs, we find that 17$\pm$4% of star formation and 21% of AGN activity is triggered by mergers, suggesting that major mergers are not the only channel for black

Notes

Connecting the AGN and SF phenomena on nuclear scales

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Abstract

The fueling of AGN requires that material be driven from the host galaxy to physical scales of less than 1 pc. Therefore, nuclear (<100 pc) star formation (SF) would appear as an inevitable consequence of this process. I will review the relation between AGN and SF activity in the nuclear regions of local AGN. Indeed, there is plenty of observational evidence of the presence of SF in the host galaxies of AGN. However, detecting and quantifying nuclear SF activity in AGN, especially in type 1s, is not an easy task. I will review the different SF indicators routinely used in AGN and summarize recent results on the nuclear SF activity in local AGN. I will also discuss possible relations with the properties of nuclear gas disks and dusty tori as well as with the properties of the AGN itself.

Notes

Viscous time lags between starburst and AGN activity

Mr. Marvin Blank | University of Kiel
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Abstract

Recent observations indicate a time lag of order of some 100 Myr between starburst and AGN activity in galaxies. Dynamical time lags have been invoked to explain this. We extend this approach by introducing a viscous time lag the gas additionally needs to flow through the AGN's accretion disc before it reaches the central black hole. Our calculations reproduce the observed time lags and are in agreement with the observed correlation between black hole mass and stellar velocity dispersion.

Notes

Probing the Torus Structure of Nearby AGN

Dr Franz Bauer | PUC/SSI
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Abstract

The detailed structure of the material orbiting around and spiralling into supermassive black holes should play a substantial role in how the AGN and nuclear star formation relate to each other. In particular, the so-called AGN torus provides a large reservoir of gas from which stars could form, and its morphology and composition should relate to how easily molecular clouds can remain intact to form stars and how easily AGN feedback processes impart energy into the neighboring gas. I will present new constraints on the torus structure based on deep Chandra data of nearby AGN. These observations may help to explain the variety of features via mid-IR interferometry for the same targets, and ultimately refine our understanding of AGN tori in general.

Notes

Tracking AGN activity following a starburst

Dr Vivienne Wild | University of St Andrews
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Abstract

The majority of black hole accretion in local AGN occurs in unspectacular circumstances. However, a small fraction of galaxies which have undergone a major star formation episode in the last ≈0.5 Gyr have the highest average black hole growth rates in the local Universe. While "standard" automated morphology analyses fail to show any difference between these galaxies and ordinary blue-sequence galaxies, human classifiers clearly identify a high fraction as post-mergers. The average rate of accretion of matter on to the black hole rises steeply roughly 250 Myr after the onset of the starburst. CO and FIR observations reveal substantial reservoirs of gas remain in the galaxies following the starburst, but the ISM temperature decreases rapidly with time. Is mechanical heating by the supernovae winds sufficient to prevent the accretion of both slower stellar winds and residual gas?

Notes

The Nature of Composite Galaxies

Ms Elise Hampton | Australian National University
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Abstract

The nature of composite galaxies is a topic of hot debate. Composite galaxies lie between the starburst sequence and the AGN region on the standard optical diagnostic diagrams. Composite galaxies have been proposed to contain starburst and AGN activity, a combination of starburst and shock activity, or may simply be evolved starbursts. We present the first results of our investigation into the nature of composite galaxies and our investigation into the shocks and galactic winds that may be the connections between starbusts and AGNs in composite galaxies, using a statistically significant sample with multi-wavelength observations. We combine IFS, X-ray, and infrared spectra to investigate the power sources in composite galaxies at different wavelengths. We resolve the nature of composite galaxies, and discuss the possible relationships between starbursts, AGNs, shocks, and galactic winds.

Notes

AGN feedback models: Correlations with star formation and observational implications of time evolution

Prof Robert Thacker | Saint Mary's University
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Abstract

While observational ensemble statistics, focusing especially on the star formation rates (SFR) and black hole accretion rates (BHAR), sometimes use sample averaging to capture variations in the BHAR with time, we instead pose the question: how would correlations appear if the intrinsic time variation of a single halo was sampled? We hence examine the correlations of star formation and AGN activity, and the associated time evolution, across seven different AGN models, three different stages of evolution and two distinct sub-populations of star formation, for a total of 63 different cases. Despite many of the models fitting the $M - \sigma$ relationship well, we find markedly different behaviour across models when examined in these new SFR-BHAR contexts. At a general level, models that employ Bondi-Hoyle-type accretion and variants of it, show similar qualitative behaviour, although in situations where there is a distinct correlation, such as post-merger, the power-law correlations vary by almost a factor of two. Importantly, some of the models show evolution in the SFR-BHAR parameter space that is diametrically across the averaged SFR-BHAR trend, suggesting that such relationships are less about a direct physical relationship and more an approximate statistical trend, as suggested by Hickox et al. Breaking SFRs into nuclear and extended components again shows notable differences between models and only modest agreement with studies examining this in Seyfert galaxies although we emphasize this comparison must be taken with caution, as the overall luminosity of the simulated merger system is higher than typical Seyfert luminosities. We do, however, find qualitative agreement in the sense that nuclear SFRs correlate more strongly with the BHAR than outer SFRs. The contributions of mergers to the final black hole mass varies by as much as a factor of three between models, and is highly dependent on the mass accretion behaviour post-merger. This also translates into almost a factor of three difference between post-starburst mass growth in the models. These results again highlight the challenges in accurately predicting black hole mass growth and feedback in simulations of galaxy formation.

Notes

BH growth and the impact of AGN feedback on galaxy evolution

Dr Yohan Dubois | IAP
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Abstract

I will show recent results on how black hole (BH) growth is driven by rapid gas accretion (through direct cold streams or clumpy accretion) at high redshift and by BH-BH coalescence at low redshift. In return, it changes the properties of BH spins and how much energy is released in AGN feedback. Finally, I will discuss the implications for galaxy morphological properties.

Notes

Oral Programme Abstracts

Wednesday, 30th July 2014

What impact does AGN activity have on star formation?

Dr Matthew Lehnert | Institut d'Astrophysique de Paris
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Abstract

AGN can influence the star formation rate and distribution in their host galaxies through a variety of mechanism. I will begin by reviewing the possible physical mechanisms through which AGN might regulate star-formation: depleting the gas, generating high turbulence, over-pressure, changing the chemistry of the dense gas through cosmic rays and radiation, etc. Then I will review the observations of the relation between star formation and AGN and what mechanisms and conditions might be conducive to negative and positive feedback as suggested by these observations.

Notes

Powerful Neutral Atomic and Molecular Outflows in Nearby Active Galaxies

Prof Sylvain Veilleux | University of Maryland
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Abstract

I will highlight the recent discovery of powerful neutral-atomic and molecular kpc-scale winds in nearby galaxies and quantity the role of AGN/quasars in driving these winds.

Notes

The multi-phase view of gas outflows in low-z U/LIRGs

Dr. Luis Colina | CSIC
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Abstract

Near-infrared integral field spectroscopy of a sample of about 20 low-z LIRGs and ULIRGs will be presented. The various phases of the interstellar medium (coronal, ionized, partially ionized, and hot molecular) traced by different emission lines (Pα, Brγ, [Si VI], [Fe II], H_2) will be discussed. The complex 2D structure and properties of the multi-phase outflows associated with central AGN, young (i.e. ionization domminated) and aged (i.e. supernovae-dominated) will be discussed in specific cases.

Notes

Oral Programme Abstracts

Thursday, 31st July 2014

Observational constraints on the influence of luminous AGN on star formation using multiple approaches

Dr Chris Harrison | Durham University
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Abstract

It is a popular idea that high-accretion rate AGN are capable of having an impact upon the star formation in their host galaxies by driving large-scale outflows. However, the observational picture is very mixed. On the one hand, detailed observations of luminous AGN have identified multi-phase high-velocity outflows. On the other hand, we lack direct observational evidence that luminous AGN have an impact upon star formation across the global population. In this talk I will outline the current status of our observational programme that is studying large populations of low and high redshift luminous AGN to address this issue. Our programme consists of three main elements. (1) We are constraining the prevalence of ionised outflows by measuring the properties of large samples of spectra. (2) We are performing follow-up multi-wavelength observations (e.g., IFU observations) to measure outflow properties and determine what is driving any outflows that are observed. (3) We are using IR SED fitting to search for any signatures of the influence of luminous AGN on the star formation in their host galaxies across the global population.

Notes

Suppressed star-formation in X-ray luminous AGN

Prof Amy Barger | University of Wisconsin
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Abstract

Deep submillimeter (SCUBA-2) and radio observations (enhanced VLA) of the CDF-N and CDF-S Chandra deep fields allow us to re-examine whether star formation is suppressed in galaxies which host X-ray luminous AGN as would be expected if feedback from the AGN expels the surrounding gas. Star-formation is indeed quenched in many of the most X-ray luminous sources. In combination with Herschel data on the fields I will also examine how the AGN spectral energy distribution varies with X-ray luminosity and AGN spectral class and how the host star-formation rate depends on the AGN luminosity and redshift.

Notes

AGN driven nuclear outflows in massive star-forming galaxies.

Dr. Dieter Lutz | MPE
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Abstract

A large fraction of the gas in galaxies avoids deciding between the fate of ending in a star or in an SMBH, by flowing back out. I will present SINFONI near-infrared imaging spectroscopic evidence on outflows from $z \sim 2$ star forming galaxies, including the recent discovery of almost ubiquitous nuclear and plausibly AGN-driven outflows in massive $\log(M_*) \gtrsim 11$ main sequence type star forming galaxies. They may mark a decisive quenching point in the life of massive galaxies, in the framework of the 'equilibrium' picture of galaxy evolution and the mounting evidence for AGN-driven outflows in star forming galaxies in other contexts.

Notes

Fast outflows quenching star formation in quasar host galaxies

Prof Alessandro Marconi | University of Florence
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Abstract

AGN feedback is believed to be the physical mechanism linking black hole to galaxy growth as it provides a quick and efficient way to quickly quench star formation and BH growth by sweeping away the gas from the host galaxy. In recent years there has been increasing observational evidence for fast outflows in AGN host galaxies at all wavelengths from X-rays to submm. However we are still missing a convincing, smoking-gun evidence of fast outflows quenching star formation. I will present the results of the studies of two samples of quasars at low ($z < 1$) and intermediate ($z \sim 2.5$) redshift where we found evidence for star formation quenching associated to fast ionised outflows in the [O III]]5007 emission line. For the lower redshift sample, this evidence stems from a comparison between the [O III] kinematics and the far-infrared emission of the host galaxies. For the higher redshift sample, I will present the results of integral field observations showing blueshifted conical emission which is anti-correlated with emission in the host galaxy, which is very likely tracing star formation regions. I will finally show how the physical properties of the outflows compare with predictions from models of wind acceleration.

Notes

Testing AGN impact on star formation from the SFR-$M_\star$ plane

Dr. Vincenzo Mainieri | ESO
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Abstract

What impact does AGN activity have on star formation? This is one of the key question of this workshop. We propose to test models ascribing to AGN feedback the quenching of star formation in $z > 1$ galaxies starting from the SFR-$M_\star$ plane. We have used a large sample of X-ray selected AGN from the ECDFS and COSMOS fields. Stellar masses for their host have been derived from an SED multi-component (AGN+galaxy) fit and star-formation rate estimated using the FIR emission measured by Herschel. A control sample of inactive galaxies has been selected from the same fields. If AGN feedback is playing a role in shutting off star-formation in its host galaxy, one may expect that signs of this feedback should be more evident in galaxies below the main-sequence rather than in galaxies in or above it. We divided the SFR-Mstar plane in bins of stellar mass and distance from the main sequence and created composite spectra for each bin by averaging all the single optical spectra of the AGN host galaxies in that specific bin. We will present the comparison of these stacked spectra with those obtained for inactive galaxies in the same regions of the SFR-$M_\star$ plane and discuss the velocity offsets of high-excitation emission lines relative to the composite systemic velocity, which is obtained from photospheric stellar absorption lines and nebular emission lines.

Notes

Star formation in powerful radio galaxies

Prof Clive Tadhunter | University of Sheffield
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Abstract

Powerful radio galaxies provide a unique insight into the link between star formation and AGN activity because they are invariably hosted by massive early-type galaxies. Therefore the cold gas reservoirs that fuel both their star formation and luminous AGN activity must have an external origin – most likely gas-rich mergers. I will present new results on the relationship between star formation and AGN activity in radio galaxies, based on Herschel and Spitzer observations.These results provide strong support for the idea that the activity in most nearby radio galaxies is triggered in relatively minor mergers between mature elliptical galaxies and gas-rich companions. I will also present near-IR spectroscopic results for one radio galaxy which show that the feedback effect of the radio jets is not always destructive, but in some cases may actively promote star formation activity.

Notes

Black holes and the star formation history of the Universe

Prof Richard Bower | Durham University
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Abstract

It is now widely accepted that black holes have a profound effect on the star formation rates of their host galaxies. But this agreement is not what it seems. I will tease out the big picture from the details by reviewing the impact of black holes in semi-analytic galaxy formation galaxy formation. I will look at what “quasar mode” and “radio mode” mean in these models, and I will distinguish their impact. The critical question is to understand if these results are consistent the emerging observational data. At the end of my talk in will preview some results on AGN feedback in the EAGLE hydrodynamic simulations. These simulations do not distinguish different mode of AGN accretion, yet the phenomena built-in to the semi-analytic models emerge from the hydrodynamics.

Notes

Simulating AGN fueling and feedback in high-redshift disk galaxies

Dr Jared Gabor | CEA-Saclay
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Abstract

AGNs at the cosmic peak of black hole growth are commonly hosted by star-forming disk galaxies, suggesting that mergers play little role in their triggering. I will present high-resolution simulations that illustrate substantial black hole growth in gas-rich, isolated disk galaxies like those observed at $z = 2$. In these simulations, clouds of dense gas lose angular momentum via mutual scattering interactions, allowing them to collide with the black hole. During such collisions, the black hole can reach Eddington-limited accretion rates for periods of $\sim$10 Myrs. This accretion leads to sufficient mass growth to keep galaxies on the M_{BH}–M_{bulge} relation and explains most observed AGNs. The associated feedback drives hot, fast winds out of the galaxy with mass outflow rates near the SFR. Despite these powerful outflows, star formation in the galactic disk is not quenched since the dense gas is not expelled. This "unstable disk" fueling mode could be responsible for most AGNs and may contribute substantially to galactic outflows.

Notes

Positive AGN feedback on turbulent ISM

Dr Kastytis Zubovas | Centre for Physical Sciences and Technology, Vilnius
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Abstract

In recent years, high resolution galaxy-scale simulations revealed that the effect of AGN activity upon star formation in the host galaxy is more complicated than simple quenching. AGN jets and outflows can also compress the ISM, leading to a burst of star formation. In other words, AGN feedback upon star formation can be positive as well as negative. We run numerical simulations of AGN wind feedback upon a turbulent ISM. The feedback model we use is very successful in recovering the properties of observed AGN outflows, and was recently shown to promote gravitational instabilities and formation of giant clumps in the bulges of gas-rich galaxies. We also test the importance of numerical resolution by running the models at resolutions comparable to those of cosmological simulations. We find that: a) A large-scale AGN outflow removes the least dense ISM gas, but compresses the denser gas and enhances star formation. In this way, AGN activity ultimately halts star formation, but does so through two concurrent channels: gas expulsion and gas consumption via induced star formation. b) Cosmological simulations, which only resolve galaxies with 10^3–10^4 particles, are unable to reproduce this dichotomy. Instead, all the gas is removed in an outflow, with no enhancement of star formation. This finding is potentially very important when evaluating predictions of cosmological simulations.

Notes

Cosmological simulations of BH growth: AGN luminosities and the connection to their host galaxies

Dr Michaela Hirschmann | IAP
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Abstract

In this study, we present a detailed, statistical analysis of BH growth, the evolution of AGN luminosity functions and the connection between AGN and their host galaxies using fully, cosmological hydrodynamic simulations run down to $z = 0$. The simulations self-consistently follow star formation, BH growth and associated feedback processes from both supernovae typeII/Ia and AGN. They provide a large volume of $(500\,\mathrm{Mpc})^3$ allowing for a direct, statistical comparison with recent observational surveys. We find that the simulations are in remarkably good agreement with present-day black hole properties and with the observed evolution of the AGN luminosity function since $z = 3$. These results nicely demonstrate that the observed "antihierarchical" trend in the AGN number density evolution is self-consistently predicted by the simulations as a consequence of the evolution of the gas density in the resolved vicinity of a (massive) black hole. In addition, the simulations are in qualitative agreement with several observed properties of AGN host galaxies: they do not reveal any significant excess of star-bursting activity, they roughly follow the main-sequence of 'normal' galaxies, but at a given stellar mass the hosts of very luminous AGN tend to be slightly more quiescent than the normal galaxies. As in the simulations AGN activity is preferentially merger-driven, these results do not necessarily contradict a scenario where AGN activity is mainly triggered by merger events.

Notes

Impact of bursty black hole accretion and feedback on host galaxy formation

Dr Colin DeGraf | Hebrew University of Jerusalem
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Abstract

Recent work on isolated galaxies has suggested the importance of short (∼10 Myr) episodes of rapid accretion for supermassive black holes caused by collisions between the black hole and massive dense clouds within the host. Accretion of such clouds could potentially provide the dominant source for black hole growth in isolated, high-z galaxies, and are capable of driving significant nuclear outflows. I will discuss an incorporation of this stochastic cloud accretion in high-resolution cosmological zoom-in simulations used to investigate the importance of such bursts of accretion and the corresponding feedback in the presence of both galaxy mergers and cosmological gas inflow. In particular, I will show the effect of such accretion bursts on the growth of the black hole, and the efficiency of the feedback for quenching star formation and black hole growth, both through galactic heating/outflows, and by coupling with inflowing gas to prevent gas replenishment of the host galaxy.

Notes

AGN - Star Formation correlation in a universe with AGN feedback

Dr Nikolaos Fanidakis | MPIA
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Abstract

In a Universe where black holes and massive galaxies co-evolve a strong correlation between AGN activity and star formation is expected. If the gas giving birth to stars is also responsible for feeding the central black hole, then a positive correlation is expected. If powerful AGN are responsible for the star formation quenching in massive galaxies, then a negative correlation is expected. I will explore these arguments by means of a semi-analytic model in which black hole growth and galaxy evolution is strongly coupled. With this model I will demonstrate that the correlation between star formation and AGN luminosity is complex in its nature and that is shaped by several factors such as the AGN feedback, the mechanisms that trigger accretion, but also the limitations of current surveys.

Notes

Evolution of AGNs in hydrodynamical simulations

Miss Michelle Furlong | Durham University
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Abstract

I will present a study of the evolution of AGN in the EAGLE simulations. These state-of-the-art hydrodynamic simulations are designed to produce a virtual Universe that closely matches the observed properties of galaxies, in particular the galaxy stellar mass function. The simulation encompasses a 100 Mpc region, at the same time resolving the formation of individual galaxies with a resolution of 700 pc. Black hole feedback is a key part of the model, and I will describe how this is implemented and the importance of accounting for gas angular momentum. Remarkably, the model matches the observed properties of X-ray AGN extremely well. I will summarise our main findings, focusing on predictions for the evolution of the soft/hard X-ray luminosity. I will explore Soltan argument, showing how black holes of different mass contribute to the present-day black hole mass function.

Notes

AGN implementations in cosmological simulations

Prof Tom Theuns | Durham University
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Abstract

Cosmological simulations that use feedback from supernovae to regulate star formation produce galaxies that are too massive and too blue compared to observations. Simulations include feedback from black holes to resolve this discrepancy, however they lack the resolution and the physics to model the accretion flow as well as the coupling of the energetic outflow to the surrounding gas accurately, and cannot resolve the formation of the black hole seeds. I will review and contrast various popular "subgrid physics" models in use, and discuss how these encode the missing physics and account for finite resolution. I will also discuss the issue of numerical convergence and predictive power of such models.

Notes

Oral Programme Abstracts

Friday, 1st August 2014

Notes for Discussion Session C

Future Experiments

Prof Jenny Greene | Princeton University
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Abstract

I start with a brief update on black hole demographics using a new sample of megamaser disk galaxies. I then discuss how upcoming instrumentation, both ground-based and space-based, can be most effectively used to address the central themes of the conference. I will specifically spend some time on the Prime Focus Spectrograph for Subaru that we at Princeton are heavily involved in, but I will also touch on ALMA, JWST, 30-m class telescopes, etc.

Notes

Poster Programme Abstracts

Monday, 28th July to Friday, 1st August 2014

A1 The overdense environment of SMGs around WISE-selected AGNs

Prof Andrew Blain | University of Leicester
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Abstract

WISE provided an all-sky survey that can efficiently select AGN from their red-mid-infrared spectral energy distributions. We have conducted follow-up JCMT-SCUBA2 850-micron imaging of two distinct samples, one drawn from the most luminous objects over the sky with known redshifts (Eisenhardt et al), and the other radio-co-selected (Lonsdale et al.), intending to study the submm-wave properties of the host galaxies of the targets, and any companions. We find modest submm emission from the WISE-selected targets, but very considerable overdensities of dusty luminous SMGs in both samples, exceeded the surface density of field SMG surveys by about factors of 2 and 4 respectively in the two samples, but with no sign of an angular clustering signal. Thus rare ultraluminous WISE AGN appear to be associated with unvirialized 10–100Mpc-scale overdensities of SMGs.

A2 Modeling Obscured Quasar SEDs with Linear Least Squares Fitting

Mr Christopher Carroll | Dartmouth College
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Abstract

Obscured quasars represent a large fraction of the total number of powerful AGNs and their observations are necessary to describe the full quasar population. Dust extinction in obscured quasars allow us to observe their host galaxies, and modeling the spectral energy distributions (SEDs) for these systems is necessary to make connections between AGN emission and physical properties of their hosts, as well as obtaining estimates of photometric redshift. In this work, we study a sample of obscured quasars identified by their mid-infrared photometry detected by the Wide-Field Infrared Survey Explorer (WISE) and cross-matched with optical photometry from the Sloan Digital Sky Survey (SDSS). We model the SEDs of our obscured quasars with empirical AGN and galaxy templates using a linear least squares fitting approach to minimize Chi-squared statistics and find that the majority of galaxies in our sample include a strong AGN component. Finally, we use the AGN luminosity function to weight the Chi-squared fitting for more accurate photometric redshift determination.

A3 The connection between star-formation and AGN activity in radio-loud and radio-quiet active galaxies

Mrs Gulay Gurkan Uygun | University of Hertfordshire
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Abstract

We constructed a matched sample of AGN to examine the relation between the star formation and AGN activity as a function of different type of AGN and emission-line galaxies. Our sample has ∼4500 sources including both radio-loud and radio-quiet AGN with $0 < z < 0.56$. Radio-loud sources are classified as high-excitation and low-excitation radio galaxies (HERGs, LERGs) using their emission lines and WISE 22μm luminosity. We trace the AGN activity and jet power in these active galaxies by using [O III] emission-line and radio luminosity. Star formation rate (SFR) and specific star formation rate (SSFR) were derived using Herschel 250μm luminosity and the stellar mass measurements from the MPA-JHU catalogue. In the past star formation studies of AGN have mostly focused on high-redshift sources to observe the thermal dust emission peaks in the far-infrared, which limited the samples to powerful objects. However, with Herschel we can expand this to low redshifts. We focus on radio-loud and radio-quiet active galaxies because they are the ideal sites to test possible models to explain the link between black holes and their host galaxies, and place constraints on their validity. Our stacking analyses show that SFRs and SSFRs of both radio-loud and radio-quiet AGN increase with increasing AGN power. Additionally, radio-quiet AGN are found to have about an order of magnitude higher SSFRs than radio-loud AGN for a given AGN power. The same trend is valid for both HERGs and LERGs. The difference between the star-formation properties of radio-loud and -quiet AGN is also seen in samples matched in their stellar-mass.

A4 Testing the star formation-AGN connection with SDSS

Ms Mackenzie Jones | Dartmouth College
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Abstract

There is increasing evidence that the average black hole accretion rate is related to host galaxy star formation rate in active galactic nuclei (AGN), whereas for individual galaxies this relationship is observed to be much weaker. Recently, Hickox et al. (2014) presented a model to explain this observation based on a tight relationship between star formation and AGN activity, along with short-term variability of the AGN over a wide dynamic range. In this work, we test this model directly using a sample of galaxies from the Sloan Digital Sky Survey Data Release 7. We simulate a population of galaxies using a linear correlation between black hole accretion rate and star formation rate, as well as a broad instantaneous luminosity distribution described by our fiducial model, a Schechter function with an exponential cutoff near the Eddington limit. This simulated AGN population is then compared to observed galaxies via emission line excitation, color-mass space, and Eddington ratio.

A5 Comparing AGN and SF Luminosities of Local Active Galaxies using Multi-Wavelength Data

Dr Kenta Matsuoka | Seoul National University
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Abstract

To understand the connection between active galactic nuclei (AGNs) and star formation (SF), we investigated the relation between AGN bolometric and far-infrared (FIR) luminosities, using type-2 AGNs. By matching type-2 AGNs at $z < 0.2$ selected from the SDSS based on the emission-line diagnostics, against the AKARI/FIS All-Sky Survey and the COSMOS PEP (PACS Evolutionary Probe) Survey Catalogues, we obtained a sample of 729 type-2 AGNs detected in the AKARI survey (90μm) and 17 ones detected in the PEP survey (100μm). We also collected ultraviolet and mid-infrared data from current GALEX and WISE surveys in addition to above catalogues to probe their SEDs in detail. For AGN bolometric luminosities, we adopted an estimate based on the [O III] and [O I] line luminosities. We confirmed that there is a correlation between AGN bolometric and FIR luminosities with a large scatter, which is consistent with previous studies. However, we claim that this correlation suffers from various artificial effects, e.g., FIR detection limits, survey volumes, and so on. In this workshop we will discuss the connection between AGN and SF based on above results, and mention observational limitations of studying it using currently available facilities.

A6 Radio-loud AGN through the eyes of 3XMM, WISE and FIRST/NVSS

Dr. Beatriz Mingo | University of Leicester
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Abstract

We present the results from a new radio-loud AGN sample, obtained through the cross-correlation between the 3XMM, WISE and FIRST/NVSS catalogues. The radio selection allows us to eliminate the restrictions traditionally associated with mid-IR and X-ray sample selections, and to explore the population of lower luminosity AGN, in which the host galaxy contribution is substantial. We investigate the correlations between radio, mid-IR and X-ray emission associated to both stellar and AGN activity, and whether they can be disentangled. This work has been carried out as part of the ARCHES project. ARCHES (Astronomical Resource Cross-matching for High Energy Studies), funded within the EU/FP7-Cooperation Space framework, is a project which aims to produce well-characterised multi-wavelength data for large samples of sources drawn from the 3XMM serendipitous source catalogue.

A7 X-rays in Seyfert 2 Galaxies: Disentangling Nuclear Activity and Star Formation

Dr. Hector Oti-Floranes | IA-UNAM
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Abstract

Under the AGN paradigm, X-ray emission from Seyfert 2 galaxies is highly absorbed by the dusty gaseous torus which surrounds the supermassive black hole and its accretion disk. On the other hand, X-rays are also produced in galaxies by star formation (starbursts), both thermally (gas heated by SNe and stellar winds) and non-thermally (High-Mass X-rays Binaries). Thus, unlike in other types of AGN, in Seyfert 2 sources contribution by host galaxy star formation to X-ray emission is expected to be comparable to -rather than overwhelmed by- the AGN emission, especially in the soft X-ray range. In the present work, we reduced, fitted and analysed the X-ray XMM-Newton spectra of a sample of Seyfert 2 galaxies. Different spectral contributions were identified with 1) star formation (SF), and 2) AGN emissions. We checked with evolutionary population synthesis models in the sources analysed that, for instance, the thermal soft X-ray contribution by the identified SF component is compatible with the value expected for a starburst which would account for the Far Infrared Luminosity observed. Thus, we argue that disentanglement of the X-ray contributions by AGN and star formation is feasible in Seyfert 2 galaxies using X-ray spectra.

A8 Fireworks in the early universe

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Abstract

Massive galaxies formed rapidly in the early universe. Scaling relations imply that their massive black holes also formed rapidly. Active massive galaxies are thus ideal objects to probe for coeval black hole and host galaxy growth. Using our Herschel, supplemented with other multiwavelength data, we study the spectral energy distributions of a large sample of massive high z galaxies - the hosts of distant 3C radio sources. We separate the respective black hole accretion (AGN) and star formation (SF) contributions to the total IR luminosities, and obtain various physical properties for the hosts of these powerful active nuclei. Our study reveals prodigious SF activity in many objects, coeval with the BH activity, with typical SFRs of hundreds of solar masses per year. The radio source properties permit to address feedback effects - these will also be discussed.

A9 Star Formation Laws and AGN evolution in high-z radio galaxies

Prof Brigitte Rocca-Volmerange | Institut d'Astrophysique de Paris
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Abstract

The interpretation of the UV to submm continuous SEDs of high-z radio galaxies with the help of the evolutionary model Pegase.3 concludes to three components: young, old stellar and AGN. On the basis of Pegase Star Formation Laws, a new interpretation of the relation AGN-starburst is proposed. (Rocca-Volmerange et al, 2013).

A10 Constraining the SFRs of galaxies hosting an AGN: Is Star Formation dependent on AGN power?

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Abstract

We have compiled the largest sample of X-ray detected AGN with FIR coverage in the fields of GOODSH-N, -S, and COSMOS. Our sample spans over a broad range of X-ray luminosities, from moderate-luminosity AGN to quasars, and is in the redshift range of 0.5–2.5, and consists of ≈2200 AGN. With the use of deblended catalogues of the Herschel FIR observations we do SED fitting to each individual source of our sample. The SED fitting analysis that we use allows us to decompose the AGN and host contributions to the IR SED, resulting to the best possible calculation of the SFRs of these galaxies. Our results show no evidence of a strong dependency of the SFRs on the luminosity of the AGN up to high luminosities. The large number of data also allows us to compare to models that try to connect the luminosity of the AGN to the SFR of its host.

A11 Radio-Quiet Quasars in the VIDEO Survey: Evidence for AGN-powered radio emission below 1 mJy

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Abstract

Understanding the interplay between black-hole accretion and star formation, and how to disentangle the two, is crucial to our understanding of galaxy formation and evolution. To investigate, we use a combination of optical and near-infrared photometry to select a robust sample of quasars from the VISTA Deep Extragalactic Observations (VIDEO) Survey. The depth of VIDEO, with $K < 23.8$ allows us to study very low accretion rates and/or lower-mass black holes. 24% of the candidate quasar sample has been spectroscopically confirmed using SALT and the VIMOS VLT Deep Survey. We use a radio-stacking technique to sample below the nominal flux-density threshold using existing VLA data at 1.4 GHz and find, in agreement with other work, that a power-law fit to the number counts is inadequate at these faint luminosities. However, we suggest that this radio emission is predominantly caused by accretion activity rather than star-formation activity, and that star formation is found for only the most luminous quasars.

A12 AGN and star formation in X-ray selected galaxy groups at $0.5 < z < 1.1$

Prof Jong-Hak Woo | Seoul National University
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Abstract

We present the properties of AGNs and star formation of 16 galaxy groups at $0.5 < z < 1.1$ in the Chandra Deep Field-South, which are4 identified based on the diffuse X-ray gas. The X-ray AGN fraction ($L > 10^{42}$ erg/s) of group galaxies ($M < -20$) is about 8 ± 3% at $\langle z \rangle \sim 0.74$, which is a factor of two higher than the AGN fraction found for rich clusters at comparable redshift. This extends the trend found at low redshift for groups to have higher AGN fractions than clusters. Our estimate of the AGN fraction is also more than a factor of 3 higher than that of low redshift X-ray-selected groups. Compared to low-redshift AGN, the FIR luminosity is higher at a given AGN luminosity, indicating that AGN in galaxy groups at $\langle z \rangle = 0.7$ are hosted by galaxies with higher star formation rates than local galaxies. This may indicate that X-ray AGN host galaxies in the group environment follow a similar trend of a relative growth of stars and supermassive black holes to the general galaxy population in other environments at the same redshift while the higher X-ray AGN fraction in group galaxies implies that the triggering of AGN and star formation is more frequent in the group environment than in the cluster environment.

B1 Towards A Complete Census of Compton-thick AGN and $N_{\rm H}$ Distribution in the Local Universe

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Abstract

Several observations and surveys done have shown that the number of heavily obscured AGN ($N_{\rm H} > 10^{23}\,{\rm cm}^{-2}$) dominates the overall AGN population in the local universe. While most are detected in energy band <10 keV, a large population of Compton-thick AGN (CTAGN) remain hidden in this band. CTAGN are defined by AGN that are obscured in the X-ray band by the circumnuclear torus of column density greater than the inverse Thomson scattering constant, i.e $N_{\rm H} > 10^{24}\,{\rm cm}^{-2}$. We present an updated census of CTAGN population in the local universe using a volume-limited sample of mid-IR selected AGN complete to D = 15 Mpc. 20% of the sample has been identified as bona fide CTAGN from current X-ray studies. Further CT candidates are then identified using mid-IR:X-ray and optical [O III]λ5007:X-ray diagnostics. Based on these analyses, we find that 25–45% of the AGN in our sample are CT. However due to lack of data, we believe that this fraction could also be as high as 70%. Of the three diagnostics used, we find that the mid-IR approach provides the most unbiased method to identify CTAGN as it yields the highest CTAGN fraction within the sample. Finally, we estimate the intrinsic $N_{\rm H}$ distribution of the AGN population in the local universe. This work provides a well-defined local benchmark for AGN obscuration studies.

B2 The stellar populations of type II quasar host galaxies

Miss Patricia Bessiere | University of Sheffield
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Abstract

Although AGN activity is now thought to be a fundamental phase in the evolution of galaxies, the mechanism and timing of their triggering is still poorly understood. One suggested triggering mechanism for high luminosity AGN (quasars) is gas-rich major mergers, because they have the potential to provide the cold gas necessary to fuel the nuclear activity, and the torques required to funnel it into the central region. If this is indeed the case, the burst of star-formation that we would expect to accompany such a merger can be used as a clock to determine how soon after the merger event takes place the quasar activity is triggered. In order to exploit this possibility, we have obtained high quality Gemini GMOS-S data which have used to determine the ages of up to two stellar populations (old and young) that we assume to be present in the quasar host galaxy. We find that, in our sample of 19 type II quasar host galaxies, a substantial proportion ($\sim$70%) require a stellar component with an age $<$100 Myr, as well as an underlying 8 Gyr old component. This implies that both the quasar and star-formation activity are triggered quasi-simultaneously, a finding which challenges merger-driven AGN models that predict offsets of a few hundred million years between the peak of star-formation and the optical detection of quasar activity.

B3 AGN in A901/902 from the OMEGA survey

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Abstract

The OSIRIS Mapping of Emission-line Galaxies in A901/902 (OMEGA) is a tunable filter emission-line imaging survey carried out on the 10m GTC telescope. The survey targets Hα and [N ii] in the region of the Abell 901/902 system at $z \sim 0.165$. This structure samples a very broad range of galaxy environments and masses at a single redshift. We make use of the recently proposed WHAN diagram (the line ratio [N II]/Hα vs. EW of Hα) and separate AGN from star-forming objects. I will present a census of the AGN population in the region.

B4 Structure and morphology of massive galaxies at high redshift revealed by HST/WFC3

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Abstract

Recent observations show the dramatic evolution of the sizes of massive quiescent galaxies : Massive quiescent galaxies at redshifts $z \sim 2$ exhibit on average physical sizes smaller, by factors 3–5, than local ETGs endowed with the same stellar mass. I will show the recent results up to redshift 4 based on HST WFC3 observations. The second part of this talk will introduce the morphology of X-ray selected AGN hosts at $z \sim 2$. Compared with a control sample of normal galaxies with similar stellar mass and redshift, we find there is no morphological difference and no enhanced signal of major merger. We conclude that major merger may be not the main triggering mechanism for X-ray selected AGN at $z \sim 2$.

B5 HI and AGN Morphology in NGC 3998

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Abstract

NGC3998 is an red and dead early-type galaxy, and is part of the ATLAS3D sample. Deep L-band observations with WSRT reveal a bubble-like continuum emission along with a flat-spectrum AGN core. The galaxy has a relatively large amount of HI, which is organized in a regularly rotating disk structure which is highly offset from the optical counterpart. There is evidence that NGC3998 has acquired some of its HI from it's companions. The ATLAS3D multi-wavelength picture of NGC3998 challenges our understanding of how gas accretion, AGN activity and star formation are related. There are a few intriguing questions which we aim to explore - why is there no evidence of no recent star formation, despite there being a large enough reservoir of HI? Has the merger/interaction affected the possible episodic activity of the AGN? In this work I outline the observational picture relating to NGC3998, and I explore the prospects of future work to study the interesting nature of this galaxy.

B6 Studying the Cosmic X-ray Background Population with NuSTAR

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Abstract

One of the key goals of high-energy astrophysics is to determine the detailed composition of the cosmic X-ray background (CXB) at $\sim$20–30 keV in order to understand the evolution of AGNs. A great breakthrough in studying the CXB is the Nuclear Spectroscopic Telescope Array (NuSTAR), the first focusing X-ray observatory with high sensitivity at $>$10 keV. Here we present results from: (i) the NuSTAR serendipitous survey, a key component of the NuSTAR extragalactic survey programme; and (ii) pointed NuSTAR observations of heavily obscured (Type 2) quasars, selected from the SDSS. In both studies: (1) we study X-ray emission at $>$10 keV, where X-rays from the central black hole are relatively unabsorbed, in order to better constrain absorbing column densities; (2) we characterize the physical properties of the sources through broad-band UV to mid-IR spectral energy distribution (SED) analyses. We find that the dominant source population sampled by NuSTAR is quasars with $L_{10-40keV} > 10^{44}$erg/s. This population is broadly similar to the population of nearby high-energy selected AGNs sampled by Swift/BAT, but scaled up in luminosity and mass. We find that for obscured quasars at $z \sim 0.5$, NuSTAR provides a significant improvement compared to lower energy ($<$10 keV) Chandra and XMM-Newton observations alone, as higher column densities can now be reliably constrained.

B7 Dense Molecular Gas in Nearby Seyfert Galaxies

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Abstract

The dusty molecular disk on scales of 100-0300 pc plays a key role in the connection between AGN and circumnuclear star formation activity. It is both an ideal gas reservoir for accretion onto the supermassive black hole and a cradle of massive star formation. Here we investigate the dense molecular gas in central regions of nearby Seyfert galaxies, focusing on the emission from HCN and HCO+, which has been detected by Plateau de Bure Interferometer (PdBI) observations. In one remarkable case, NGC 3079, there are deep blue-shifted absorption lines of HCN and HCO+. These are not associated with an outflow, but instead also trace disk rotation, and allow us to independently estimate the column density through the disk. We try to study the physical properties in the vicinity of AGN to assess whether star formation might be suppressed in the central regions of nearby Seyfert galaxies. Approaching this issue from a different perspective, we report on an analysis of molecular line ratios in 2 Seyferts, indicating that the clouds are not self-gravitating and hence cannot form stars.

B8 The physical reason for the variation in AGN and star forming galaxy emission line spectra

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Abstract

Emission line galaxies across the BPT diagram form two distinct sequences, an AGN sequence and a star forming galaxy sequence. While many interpretations exist, the most successful models, physical or empirical, describe the AGN sequence as a mixing sequence combined with differences in ionization parameter and power law index. Varying metallicity and ionization parameter typically reproduces the star forming sequence. Using a novel technique known as Mean Field Independent Component Analysis (MFICA), we extracted "pure" subsamples of AGN and star forming galaxies from SDSS, extending well into the composite region of the BPT diagram. This result, coupled with many weaker emission lines acting as additional diagnostic constraints, gave us a superior data set compared to previous work. We applied a locally optimally emitting cloud (LOC) model to determine the physical parameters responsible for the observed variation of emission line galaxies. Our results show that tuning the radial distribution and density distribution of clouds can fit the vast majority of emission line ratios that constrain the excitation mechanism, spectral energy distribution, abundances and physical conditions within these galaxies. This is an improvement over interpretations that reproduce only a handful of diagnostic diagrams and require different parameters to explain both sequences.

B9 SED decomposition of SDSS galaxies

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Abstract

I will present the first results of a large SED decomposition survey based on SDSS galaxies detected in the mid-infrared by WISE. A three-component fit is applied, including a reddened synthetic stellar template, a starburst template and an AGN template. I will present the cases where an AGN template is statistically important and compare it to the spectroscopic sample of AGN in the SDSS.

B10 The cosmic growth of the active black hole population

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Abstract

Understanding the influence of black hole growth on star formation and galaxy evolution over cosmic time scales requires a census of the AGN population, in particular in respect to their black hole masses and accretion rates. We present results on the joint determination of the active black hole mass function and the Eddington ratio distribution function of broad line AGN, from $1 < z < 2$, based on the combination of type 1 AGN samples from SDSS, VVDS and COSMOS. We augment these new results with previous work at $z = 0$ from the Hamburg/ESO Survey and at $z < 1$ from the SDSS. We find a strong evolution of the active black hole mass function and hence of the active fraction as a function of mass, while the Eddington ratio distribution shows a more modest evolution. We disentagle the AGN downsizing phenomenon into its physical parameters and identify the black hole mass as the main driver of the downsizing trend. Towards higher redshift, we are witnessing a phase of intense black hole growth, which is largely driven by the onset of AGN activity in massive SMBHs towards $z = 2$.

B11 Obscured accretion and star formation at z∼1

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Abstract

Recent models of joint evolution of super-massive black holes (SMBHs) and their host galaxies predict the presence of a key phase where accretion, traced by heavily obscured Active Galactic Nuclei (AGN) emission, is likely coupled with powerful star formation. At the end of this phase, feedback processes likely play a major role in self-regulating the SMBH growth and in quenching the star-formation activity. Current X-ray background models predict a significant population of such highly obscured (likely Compton-thick) AGN at z∼1. Despite the extensive multi-wavelength efforts of the last decade, the quest for this AGN population is still ongoing, and their number density is currently poorly constrained. We present the properties of a sample of Type 2 AGN at z∼1 selected by means of their [Ne v]3426 emission line. We use the 2-10 keV/[Ne v] emission-line flux ratio as a diagnostic tool to discover heavily obscured AGN, and stacking analysis to derive average properties for the X-ray undetected population. Using Spitzer and Herschel observations, we present indications of enhanced star formation in this obscured quasar sample. This is consistent with some recent scenarios of BH-galaxy co-evolution.

B12 Triggering Active Galactic Nuclei from Seyferts to Quasars: Do mergers matter?

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Abstract

The discovery that supermassive black holes reside in the centers of most if not all massive galaxies has emphasized the importance of Active Galactic Nuclei (AGN) in galaxy evolution. Despite this, the processes that trigger Active Galactic Nuclei remain poorly understood. While low luminosity AGN require fuel supplies low enough to allow fueling through so-called secular processes, the gas masses required to power luminous AGN are so large that major mergers of gas-rich galaxies are likely the only triggering mechanisms. Theoretical models therefore often assume that major mergers trigger both massive starbursts and AGN activity. However, the observational evidence for a connection between mergers and AGN remains mixed. I will present a HST study analyzing AGN host galaxy morphologies compared to control carefully matched control samples in a sample of moderate redshift ($z = 0.5$–0.8) AGN spanning a wide range of luminosities to answer the question at what luminosity (if any) merger triggering becomes dominant. We find no higher incidence of merger features in AGN hosts compared to control as well as no increase in the prevalence of merger signatures with AGN luminosity. Major mergers therefore either play only a very minor role in the triggering of AGN in the luminosity and redshift range studied or time delays are too long for merger features to remain visible. I will also presents results from an ongoing HST imaging campaign of luminous quasars.

B13 The systematic search for $z > 5$ AGN in the Chandra Deep Field South

Miss Anna Katharina Weigel | ETH Zurich
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Abstract

I will present our systematic search for $z > 5$ AGN based upon the Chandra 4 Msec catalog which contains the deepest X-ray observations to date. To find these high redshift active Black Holes we apply the Lyman Break Technique, Color Criteria, Stacking and a photometric redshift code. Furthermore, I will highlight how we use X-rays as a photometric redshift indicator. Our results indicate an absence of Black Hole growth in the early universe. This poses new constraints on our current understanding of Black Hole seed formation and evolution.

C1 High Resolution Simulations of SN feedback in Dwarf Spheroidals

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Abstract

The population of dwarf spheroidal galaxies (dSphs) around the Milky Way are devoid of gas. Supernova-driven winds are expected to have played a crucial role in the evolution of dSphs, regulating the star formation rate, metal enrichment of the ISM and their present day mass. The low escape velocities of dSphs imply that a supernova event should be able to eject a significant amount of gas from these low mass galaxies, however many host more than one distinct stellar population. Two key questions arise: how do dSphs manage to retain enough gas after the first burst of star formation to supply a subsequent burst, and why is there such a variety in the SFHs? We use Gadget to simulate the effect of supernova feedback on a dwarf galaxy in either a spherical or disky morphology. We investigate the properties of the resulting dwarf, with the future aim to compare the efficiency of gas expulsion by supernovae to gas removal from an external AGN outflow and to explore how both of these processes influence the star formation rate of dSphs.

C2 Spatially resolving the AGN/star-formation connection

Dr. Scott Croom | University of Sydney
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Abstract

New integral field surveys of the local Universe will have a dramatic effect on our understanding on the AGN/star-formation connection. Using integral field spectroscopy of 17 luminous type II AGN we demonstrate that winds are ubiquitous and are able to localize where star formation and/or AGN ionization is dominant. The SAMI Galaxy Survey, an integral field survey of over 3000 galaxies, will vastly extend this work, and I will show early results from this survey which has already observed over 600 galaxies.

C3 Massive Galaxies in their Prime - Mass Accretion and Star Formation at and above $z \sim 2$

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Abstract

Observations show a prevalence of high redshift galaxies with large stellar masses and predominantly passive stellar populations. A variety of processes have been suggested that could reduce the star formation in such galaxies to observed levels, including quasar mode feedback, virial shock heating, or galactic winds driven by stellar feedback. However, the main quenching mechanisms have yet to be identified. I will present a study of star formation quenching based on the Argo simulation, a cosmological zoom-in simulation that follows the evolution of a massive galaxy at $z > 2$. The resulting galaxy has properties consistent with those of observed, massive quiescent galaxies at $z = 2$ and with abundance matching predictions. However, our models do not include AGN feedback indicating that supermassive black holes likely play a subordinate role in determining masses and sizes of massive quiescent galaxies at high z. The specific star formation rate (sSFR) of the simulated galaxy matches the observed $M_\star$–sSFR relation at early times. This period of smooth stellar mass growth comes to a sudden halt at $z = 3.5$ when the sSFR drops by almost an order of magnitude within a few hundred Myr and the galaxy changes from a star forming into a more quiescent galaxy. I will discuss the origin of this transformation and its relation to stellar feedback processes.

C4 The Immense Sizes and Disturbed Kinematics of Obscured Quasar Narrow-Line Regions

Dr Kevin Hainline | Dartmouth College
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Abstract

We discuss current research into the size and kinematics of the narrow-line regions (NLRs) in obscured quasars out to $z < 0.7$. There exists strong evidence that quasars are responsible for kinematically disturbing gas throughout their host galaxies, with resolved velocity dispersions at large galactic distances in contrast with what would be expected in star forming galaxies. Using data from the literature as well as spatially resolved Southern African Large Telescope RSS And Gemini-N GMOS long-slit spectroscopy, we also estimate the size of the NLR and compare it to AGN IR luminosity. These data, which span multiple orders of magnitude in IR luminosity, provide strong evidence that there is a flattening of the relationship between NLR size and AGN luminosity. These results support the existence of a maximal size of the narrow-line region around luminous quasars; beyond this size either there is not enough gas, or the gas is over-ionized and does not produce enough [O III]λ5007 emission.

C5 Quenching of star formation in Seyfert galaxies and luminous QSO hosts

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Abstract

I present the results of our investigation of the star formation in Seyfert galaxies and luminous QSO hosts by means of 3D spectroscopy. The spatially resolved extinction-corrected Hα luminosity is our star formation (SF) tracer. It is more robust than estimates mid-IR, UV, and radio luminosity because of a the significant AGN contribution in those bands. We find that the SFR in 18 luminous QSO hosts is quite diverse with several QSO host exactly on, above or below the main sequence of star formation. In addition, we obtained single-dish CO(1-0) line spectroscopy in January 2014 to probe the condition of star formation in these QSO hosts with the star formation efficiency. I am going to present the first results of this study. However, without a control sample of normal SF galaxies it is unclear whether QSOs really influence star formation. By observing 20 Seyfert galaxies and 20 matched SF galaxies, we are able to directly compare the star formation for a decent sample. I present our preliminary results indicating that the AGN distribution peaks a factor 2 lower in specific SFR than the control sample.

C6 Mass versus environment quenching in the SFR-stellar mass plane

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Abstract

Since the discovery of the scaling relations between the black hole (BH) mass and host galaxy properties, AGN feedback has became a key ingredient in the modern models of galaxy formation and evolution. The main prediction of such models is a substantial coevolution of the central BH accretion and the host galaxy star formation (SF) activity. However, what is hitherto left open in these calculations is the physical origin of the adopted energy feedback. Alternatively, the importance of the environment in galaxy evolution is increasing steadily. Using scaling relations to covert the bulge properties into BH mass and the galaxy parent halo mass to characterize the environment, I analyze the relative importance of ”mass” and “environment” quenching in the SF rate–stellar mass plane. I show preliminary results and I discuss future progress.

C7 Simulations of AGN and SN in disc galaxy mergers

Dr Rick Newton | International Centre for Radio Astronomy Research
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Abstract

Active Galactic Nuclei (AGN) are increasingly being considered as a key component in simulations of galaxy formation. Together with supernovae (SNe), they act to suppress star formation over a range of mass scales, bringing the high-mass end of the luminosity function into line with observational constraints. However, the methods used to model these processes, and the interaction between them, are less well understood. We present findings from a suite of idealised isolated and merging disc galaxy simulations performed with a range of AGN accretion and feedback models, discussing how AGN in different models affect their host system, the growth of the central super massive black hole (SMBH), and how they interact with SN-driven feedback.

C8 High resolution observations of SDSS J080800.99+483807.7 in the optical and radio domain: A possible example of jet-triggered star formation

Mr. Yasir Rashed | University of Cologne
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Abstract

Stars could be forming in an unusual way in a distant galaxy - in the backwash of a massive jet of gases spraying from the galaxy's core. This process could trigger a high tar-formation activity in a relatively small galaxy with small black hole at its galaxy. In my talk I would like to present my recent results that had been published in "A&A" and mentioned as well in the "Nature" journal. The source that we investigated is a double-lobed radio galaxy named SDSS J080800.99+483807.7. We used radio data obtained with MERLIN at 18 cm and optical data taken with the Multi-Object Double Spectrograph (MODS) at the Large Binocular Telescope (LBT). The result of my research was a precise redshift of the galaxy of $z = 0.2805 \pm 0.0003$, resulting in a linear size of the observed radio structure of about 26.3 kpc. In addition, we estimated the mass of the central black hole to be $\log(M_{BH}/M_{\odot})$ of about 6.9. The optical line emission as well as the infrared and radio continuum emission suggest a high star-formation activity. We speculate that this activity is triggered by the back flow of material along the jet interacting with the gas in the galaxy host.

C9 The limited impact of AGN radiation on Star Formation

Miss Orianne Roos | CEA-Saclay
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Abstract

AGNs are common in high-redshift disk galaxies and are good candidates to expel gas from their hosts, and suppress star formation: in the radiative mode, a fraction of the huge energy acquired by the AGN during accretion phases is re-injected in the surrounding material, creating hot, sometimes ionized, expanding bubbles of diluted gas. However, most simulations mainly focus on thermal feedback, and ionization is omitted since a complete treatment of the radiative transfer has not been affordable in terms of computation time and memory so far. We study a high-redshift disk galaxy simulation allowing us to resolve the realistic ISM of an entire galaxy up to very high resolution (6 pc). It includes standard thermal feedback, and is post-processed to add a complete radiative transfer treatment, as ionization is expected to play a role on star formation. We determine the distribution of the gas heated and/or ionized by the AGN and find that the reduction of the total instantaneous SFR of the galaxy is surprisingly very small. Even in the strongest quasar regime, it reaches only a few percents. Plus, despite the large volume of gas ionized, the corresponding mass fraction remains low. This shows that the dense star forming clumps typical of a $z = 2$ disk shield themselves against AGN radiation. This low impact seems to confirm studies arguing that AGNs can produce outflows without necessarily quenching their hosts, and may show that other physical mechanisms have to be investigated to explain the quenching of star formation in galaxies.

C10 Absorption variability in outflowing gas of the broad absorption line quasar APM 08279+5255

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Abstract

Broad Absorption Lines (BALs) observed in quasar spectra testify the existence of conspicuous gas outflows, which can affect the quasar environment. Unfortunately, structure and dynamics of the absorbing gas are still poorly known. BAL variability can provide important constraints on the motion and location of the absorbers. Previous variability studies were mostly based on samples of several BAL QSOs, each observed at few epochs. Since 2003, we repeatedly observed the optical spectrum of the luminous BAL QSO APM 08279+5255 at $z = 3.911$, and collected all the spectra available in the literature, to obtain a real monitoring of a broad absorption trough of C IV (λ1549). During a major absorption change, we obtain for the first time the evidence of a strong correlation between continuum flux (λ1350) and absorption line variability. In addition, the structure function of the absorption variability is comparable with the typical optical variability of quasar continua, supporting the notion that changes in the 200 AA ionising continuum flux are the cause of the observed absorption variability.

C11 How does an AGN subgrid model affect a galaxy merger?

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Abstract

Preventing spurious motions of black hole particles in numerical simulations can be a challenging task, with several advection algorithms already available in the literature. One such method uses a tracer mass (a particle with mass much greater than any other particle) to represent the black hole, and a second method is to displace the black hole particle (whose mass represents the real mass of the black hole) towards the bottom of the gravitational potential. To test the affect of the tracer mass on the global SFR and disc morphology, we perform simulations of a major merger of two Milky Way-sized galaxies. We vary the algorithms governing the black hole accretion rate (BHAR), the form and rate of AGN feedback, the black hole advection method, and the mass of the stellar bulge. Models that use the tracer mass but different BHARs and feedback algorithms yield very similar SFRs and disc morphologies. Comparing these models to their non-tracer-mass counterparts (i.e. where the black hole particle represents the real mass of the black hole) yields distinctly different SFRs and morphologies from both the tracer mass models and from each other. Models with a more massive bulge but no tracer mass have morphologies similar to their lower bulge mass counterparts. Thus, tracer masses must be used with caution since they will effect the results in a way that is distinct from a more massive bulge.

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