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Accepted Abstracts - Submitted Abstracts - Thesis Abstracts
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From the Editor

Happy new year! Welcome to all the new subscribers, and thanks to everyone who contributed to this issue of the Active Galaxies Newsletter.

This newsletter is intended to disseminate paper abstracts, meeting announcements, job adverts and other information which may be of interest to the active galaxies community. It is produced monthly and, whilst the deadline for contributions is the last day of the month, contributions may be submitted at any time. The Latex macros for submitting abstracts and dissertation abstracts are appended to each issue of the newsletter and are also available on the web page. As always, any suggestions or feedback regarding the newsletter are welcome.

Many thanks for your continued subscription.

Megan Argo

Abstracts of recently accepted papers

The Link Between Ejected Stars, Hardening and Eccentricity Growth of Super Massive Black Holes in Galactic Nuclei

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The hierarchical galaxy formation picture suggests that super massive black holes (MBHs) observed in galactic nuclei today have grown from coalescence of massive black hole binaries (MBHB) after galaxy merging. Once the components of a MBHB become gravitationally bound, strong three-body encounters between the MBHB and stars dominate its evolution in a "dry" gas free environment, and change the MBHB's energy and angular momentum (semi-major axis, eccentricity and orientation). Here we present high accuracy direct N-body simulations of spherical and axisymmetric (rotating) galactic nuclei with order 10^6 stars and two massive black holes that are initially unbound. We analyze the properties of the ejected stars due to *slingshot* effects from three-body encounters with the MBHB in detail. Previous studies have investigated the eccentricity and energy changes of MBHs using approximate models or Monte-Carlo three body scatterings. We find general agreement with the average results of previous semi-analytic models for spherical galactic nuclei, but our results show a large statistical variation. Our new

results show many more phase space details of how the process works, and also show the influence of stellar system rotation on the process. We detect that the angle between the orbital plane of the MBHBs and that of the stellar system (when it rotates) influences the phase-space properties of the ejected stars. We also find that massive MBHB tend to switch stars with counter-rotating orbits into co-rotating orbits during their interactions.

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Nuclear star formation activity and black hole accretion in nearby Seyfert galaxies

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Recent theoretical and observational works indicate the presence of a correlation between the star formation rate (SFR) and active galactic nucleus (AGN) luminosity (and, therefore, the black hole accretion rate, $\dot{M}_{\rm BH}$) of Seyfert galaxies. This suggests a physical connection between the gas forming stars on kpc scales and the gas on sub-pc scales that is feeding the black hole. We compiled the largest sample of Seyfert galaxies to date with high angular resolution ($\sim 0.4 - 0.8$") mid-infrared (8–13 μ) spectroscopy. The sample includes 29 Seyfert galaxies drawn from the AGN Revised Shapley-Ames catalogue. At a median distance of 33 Mpc, our data allow us to probe nuclear regions on scales of ~ 65 pc (median value). We found no general evidence of suppression of the 11.3 μ polycyclic aromatic hydrocarbon (PAH) emission in the vicinity of these AGN, and we used this feature as a proxy for the SFR. We detected the 11.3 μ PAH feature in the nuclear spectra of 45% of our sample. The derived nuclear SFRs are, on average, five times lower than those measured in circumnuclear regions of 600 pc in size (median value). However, the projected nuclear SFR densities (median value of $22\,{\rm M}_\odot\ {\rm yr}^{-1}\,{\rm kpc}^{-2}$) are a factor of 20 higher than those measured on circumnuclear scales. This indicates that the SF activity per unit area in the central ~ 65 pc of Seyfert galaxies is much higher than at larger distances from their nuclei. We studied the connection between the nuclear SFR and $\dot{M}_{\rm BH}$ and showed that numerical simulations reproduce our observed relation fairly well.

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A structure for quasars under the scope of polarization - I. The UV/optical polarization dichotomy of type-1 and type-2 AGN

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We present UV/optical spectropolarimetric modelling of the phenomenologically-based structure for quasars proposed by Elvis (2000). In this first paper of a series, we explore the continuum polarisation emerging from radiatively accelerated and bent winds that were vertically launched from the accretion disc in an active galactic nucleus (AGN). We simulate the radiative transfer occurring in Thomson scattering and dust extinction media over a range of morphological parameters and optical depths of the wind. We demonstrate that the wind geometry proposed by Elvis with a phenomenologically-derived bending angle of $\theta = 60^\circ$ still underestimates the observed optical polarisation percentage of type-1 and type-2 AGN and does

not yet reproduce the expected dichotomy of the polarisation position angle. To recover the observed polarisation properties, a smaller bending angle and some amount of dust shielding in the equatorial region should be considered. A two-phase outflow is found to generate both the observed polarisation dichotomy and acceptable levels of polarisation degree if the wind has a bending angle $\theta = 45^\circ$, and the conical shells have a half-opening angle of $3^\circ < \delta\theta < 10^\circ$. The absorbing dust column at the wind base should be in the range of $1 < \tau_{dust} \leq 4$ (τ being integrated over 2000 – 8000 Å). Straightforward observational tests from spectropolarimetry and from determining the number density of different AGN types can be performed to further constrain the wind geometry.

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An outflow perpendicular to the radio jet in the Seyfert nucleus of NGC 5929

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We report the observation of an outflow perpendicular to the radio jet in near-infrared integral field spectra of the inner 250 pc of the Seyfert 2 galaxy NGC 5929. The observations were obtained with the Gemini Near infrared Integral Field Spectrograph at a spatial resolution of ∼20 pc and spectral resolution R≈5300 and reveal a region ∼ 50 pc wide crossing the nucleus and extending by ∼ 300 pc perpendicularly to the known radio jet in this galaxy. Along this structure – which we call SE-NW strip – the emission-line profiles show two velocity components, one blueshifted and the other redshifted by -150km s^{-1} and 150km s^{-1}, respectively, relative to the systemic velocity. We interpret these two components as due to an outflow perpendicular to the radio jet, what is supported by low frequency radio emission observed along the same region. We attribute this feature to the interaction of ambient gas with an "equatorial outflow" predicted in recent accretion disk and torus wind models. Perpendicularly to the SE-NW strip, thus approximately along the radio jet, single component profiles show blueshifts of ≈ -150km s^{-1} to the north-east and similar redshifts to the south-west, which can be attributed to gas counter-rotating relative to the stellar kinematics. More double-peaked profiles are observed in association with the two radio hot-spots, attributed to interaction of the radio jet with surrounding gas.

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A correlation between the stellar and [Fe II] velocity dispersions in Active Galaxies

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We use near-infrared spectroscopic data from the inner few hundred parsecs of a sample of 47 active galaxies to investigate possible correlations between the stellar velocity dispersion ($\sigma_\star$), obtained from the fit of the K-band CO stellar absorption bands, and the gas velocity dispersion (σ) obtained from the fit of the emission-line profiles of [S III]λ0.953μm, [Fe II]λ1.257μm, [Fe II]λ1.644μm and $H_2\lambda 2.122\mu$m. While no correlations with $\sigma_\star$ were found for H_2 and [S III], a good correlation was found for the two [Fe II] emission lines, expressed by the linear fit $\sigma_\star = 95.4 \pm 16.1 + (0.25 \pm 0.08) \times \sigma_{[\mathrm{Fe\,II}]}$. Excluding barred objects from the sample a better correlation is found between $\sigma_\star$ and $\sigma_{[\mathrm{Fe\,II}]}$, with a correlation coefficient of $R = 0.80$ and fitted by the following relation: $\sigma_\star = 57.9 \pm 23.5 + (0.42 \pm 0.10) \times \sigma_{[\mathrm{Fe\,II}]}$. This correlation can be used to estimate $\sigma_\star$ in cases it cannot be directly measured and the [Fe II] emission lines are present in the spectra, allowing to obtain the mass of the supermassive black hole (SMBH) from the $M_\bullet - \sigma_\star$ relation. The scatter from a one-to-one relationship between $\sigma_\star$ and its value derived from $\sigma_{[\mathrm{Fe\,II}]}$ using the equation above for our sample is 0.07 dex, which is smaller than that obtained in previous studies which use $\sigma_{[\mathrm{O\,III}]}$ in the optical as a proxy for $\sigma_\star$. The use of $\sigma_{[\mathrm{Fe\,II}]}$ in the near-IR instead of $\sigma_{[\mathrm{O\,III}]}$ in the optical is a valuable option for cases in which optical spectra are not available or are obscured, as is the case of many AGN. The comparison between the SMBH masses obtained using the $M_\bullet - \sigma_\star$ relation in which $\sigma_\star$ was directly measured with those derived from $\sigma_{[\mathrm{Fe\,II}]}$ reveals

only a small average difference of $\Delta\log M_\bullet = 0.02$ with a scatter of 0.32 dex for the complete sample and $\Delta\log M_\bullet = 0.00$ with a scatter of 0.28 dex for a sub-sample excluding barred galaxies.

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AGN X-ray variability in the XMM-COSMOS survey

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We took advantage of the observations carried out by XMM in the COSMOS field during 3.5 years, to study the long term variability of a large sample of AGN (638 sources), in a wide range of redshift ($0.1 < z < 3.5$) and X-ray luminosity ($10^{41} < L_{0.5-10} < 10^{45.5}$). Both a simple statistical method to asses the significance of variability, and the Normalized Excess Variance (σ^2_{rms}) parameter, where used to obtain a quantitative measurement of the variability. Variability is found to be prevalent in most AGN, whenever we have good statistic to measure it, and no significant differences between type-1 and type-2 AGN were found. A flat (slope -0.23 ± 0.03) anti-correlation between σ^2_{rms} and X-ray luminosity is found, when significantly variable sources are considered all together. When divided in three redshift bins, the anti-correlation becomes stronger and evolving with z, with higher redshift AGN being more variable. We prove however that this effect is due to the pre-selection of variable sources: considering all the sources with available σ^2_{rms} measurement, the evolution in redshift disappears. For the first time we were also able to study the long term X-ray variability as a function of $M_{\rm BH}$ and Eddington ratio, for a large sample of AGN spanning a wide range of redshift. An anti-correlation between σ^2_{rms} and $M_{\rm BH}$ is found, with the same slope of the anti-correlation between σ^2_{rms} and X-ray luminosity, suggesting that the latter can be a byproduct of the former one. No clear correlation is found between σ^2_{rms} and the Eddington ratio in our sample. Finally, no correlation is found between the X-ray σ^2_{rms} and the optical variability.

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Massive Star-Forming Host Galaxies of Quasars on Sloan Digital Sky Survey Stripe 82

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The stellar properties of about 800 galaxies hosting optically luminous, unobscured quasars at $z < 0.6$ are analyzed. Deep co-added Sloan Digital Sky Survey (SDSS) images of the quasars on Stripe 82 are decomposed into nucleus and host galaxy using point spread function and Sérsic models. The systematic errors in the measured galaxy absolute magnitudes and colors are estimated to be less than 0.5 mag and 0.1 mag, respectively, with simulated quasar images. The effect of quasar light scattered by the interstellar medium is also carefully addressed. The measured quasar-to-galaxy ratio in total flux decreases toward longer wavelengths, from $\sim$8 in the u band to $\sim$1 in the i and z bands. We find that the SDSS quasars are hosted exclusively by massive galaxies (stellar mass $M_{\rm star} > 10^{10} M_\odot$), which is consistent with previous results for less luminous narrow-line (obscured) active galactic nuclei (AGNs). The quasar hosts are very blue and almost absent on the red sequence, showing stark contrast to the color–magnitude distribution of normal galaxies. The fact that more powerful AGNs reside in

galaxies with higher star-formation efficiency may indicate that negative AGN feedback, if it exists, is not concurrent with the most luminous phase of AGNs. We also find positive correlation between the mass of supermassive black holes (SMBHs; $M_{\rm BH}$) and host stellar mass, but the $M_{\rm BH} - M_{\rm star}$ relation is offset toward large $M_{\rm BH}$ or small $M_{\rm star}$ compared to the local relation. While this could indicate that SMBHs grow earlier than do their host galaxies, such an argument is not conclusive, as the effect may be dominated by observational biases.

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X-Ray Selected AGN Host Galaxies are Similar to Inactive Galaxies out to $z = 3$: Results from CANDELS/CDF-S

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We use multi-band spatially resolved photometry from the Cosmic Assembly Near-IR Deep Legacy Survey in the 4 Ms Chandra Deep Field-South to explore the nuclear and extended colors, color gradients, and stellar populations of the host galaxies of X-ray selected active galactic nuclei (AGNs) out to $z = 3$. Based on a study of their central light, we develop X-ray based criteria to exclude objects with strong AGN contamination. We use stellar masses from the FIREWORKS database to understand and account for stellar mass selection effects and carefully study, for the first time, the resolved host galaxy properties of AGNs at $z \sim 2$ in their rest-frame optical light without substantial nuclear contamination. AGN hosts span a sizable range of stellar masses, colors, and color gradients at these redshifts. Their colors, color gradients, and stellar population properties are very similar to inactive galaxies of the same stellar mass. At $z \sim 1$, we find a slightly narrower range in host colors compared to inactive galaxies, as well as hints of more recent star formation. These differences are weaker or non-existent among AGN hosts at $z \sim 2$. We discuss the importance of AGN-driven feedback in the quenching of galaxies at $z > 1$ and speculate on possible evolution in the relationship between black hole accretion and the host galaxy toward high redshifts.

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Nuclear Activity is More Prevalent in Star-forming Galaxies

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We explore the question of whether low and moderate luminosity active galactic nuclei (AGNs) are preferentially found in galaxies that are undergoing a transition from active star formation (SF) to quiescence. This notion has been suggested by studies of the UV-optical colors of AGN hosts, which find them to be common among galaxies in the so-called Green Valley, a region of galaxy color space believed to be composed mostly of galaxies undergoing SF quenching. Combining the deepest current X-ray and Herschel/PACS far-infrared (FIR) observations of the two Chandra Deep Fields with redshifts, stellar masses, and rest-frame photometry derived from the extensive and uniform multi-wavelength data in these fields, we compare the rest-frame $U - V$ color distributions and star formation rate distributions of AGNs and carefully constructed samples of inactive control galaxies. The UV-to-optical colors of AGNs are consistent with equally massive inactive galaxies at redshifts out to $z \sim 2$, but we show that such colors are poor tracers of SF. While the FIR distributions of both star-forming AGNs and star-forming inactive galaxies are statistically similar, we show that AGNs are preferentially found in star-forming host galaxies, or, in other words, AGNs are less likely to be found in weakly star-forming or quenched galaxies. We postulate that, among X-ray-selected AGNs of low and moderate accretion luminosities, the supply of cold gas primarily determines the accretion rate distribution of the nuclear black holes.

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The Mid-infrared Emission of Narrow-line Active Galactic Nuclei: Star Formation, Nuclear Activity, and Two Populations Revealed by WISE

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We explore the nature of the long-wavelength mid-infrared (MIR) emission of a sample of 13,000 local Type II (narrow-line) active galactic nuclei (AGNs) from the Sloan Digital Sky Survey (SDSS) using 12 μm and 22 μm photometry from the WISE all-sky survey. In combination with FIRST 1.4 GHz photometry, we show that AGNs divide into two relatively distinct populations or "branches" in the plane of MIR and radio luminosity. Seyfert galaxies lie almost exclusively on an MIR-bright branch (Branch A), while low-ionization nuclear emission line galaxies (LINERs) are split evenly into Branch A and the MIR-faint Branch B. We devise various tests to constrain the processes that define the branches, including a comparison to the properties of pure star-forming inactive galaxies on the MIR-radio plane. We demonstrate that the total MIR emission of objects on Branch A, including most Seyfert galaxies, is governed primarily by host star formation, with $\approx 15\%$ of the 22 μm luminosity coming from AGN-heated dust. This implies that ongoing dusty star formation is a general property of Seyfert host galaxies. We show that the 12 μm broadband luminosity of AGNs on Branch A is suppressed with respect to star-forming galaxies, possibly due to the destruction of PAHs or deeper 10 μm Si absorption in AGNs. We uncover a correlation between the MIR luminosity and [O III] λ5007 luminosity in AGNs. This suggests a relationship between the star formation rate and nuclear luminosity in the AGN population, but we caution on the importance of selection effects inherent to such AGN-dominated emission-line galaxies in driving such a correlation. We highlight the MIR-radio plane as a useful tool in comparative studies of star formation and nuclear activity in AGNs.

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The mean star-forming properties of QSO host galaxies

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Quasi-stellar objects (QSOs) occur in galaxies in which supermassive black holes (SMBHs) are growing substantially through rapid accretion of gas. Many popular models of the co-evolutionary growth of galaxies and black holes predict that QSOs are also sites of substantial recent star formation (SF), mediated by important processes, such as major mergers, which rapidly transform the nature of galaxies. A detailed study of the star-forming properties of QSOs is a critical test of these models. We present a far-infrared Herschel/PACS study of the mean star formation rate (SFR) of a sample of spectroscopically observed QSOs to $z \sim 2$ from the COSMOS extragalactic survey. This is the largest sample to-date of moderately luminous QSOs (with nuclear luminosities that lie around the knee of the luminosity function) studied using uniform, deep far-infrared photometry. We study trends of the mean SFR with redshift, black hole mass, nuclear bolometric luminosity, and specific accretion rate (Eddington ratio). To minimize systematics, we have undertaken a uniform determination of SMBH properties, as well as an analysis of important selection effects of spectroscopic QSO samples that influence the interpretation of SFR trends. We find that the mean SFRs of these QSOs are consistent with those of normal massive star-forming galaxies with a fixed scaling between SMBH and galaxy mass at all redshifts. No strong enhancement in SFR is found even among the most rapidly accreting systems, at odds with several co-evolutionary models. Finally, we consider the qualitative effects on mean SFR trends from different assumptions about the SF properties of QSO hosts and from redshift evolution of the SMBH-galaxy relationship. While currently limited by uncertainties, valuable constraints on AGN-galaxy co-evolution can emerge from our approach.

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