Active Galaxies Newsletter	*An electronic publication dedicated to the observation and theory of active galaxies*
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Accepted Abstracts - Submitted Abstracts - Thesis Abstracts
Jobs Adverts - Meetings Adverts - Special Announcements

From the Editor

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

Feeding Versus Feedback in NGC 1068 probed with Gemini NIFS. I. Excitation

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We present emission-line flux distributions and ratios for the inner $\approx$200 pc of the narrow-line region of the Seyfert 2 galaxy NGC 1068, using observations obtained with the Gemini Near-infrared Integral Field Spectrograph (NIFS) in the J, H and K bands at a spatial resolution of $\approx$ 10 pc and spectral resolution of $\approx$ 5300. The molecular gas emission – traced by the K-band H_2 emission lines – outlines an off-centered circumnuclear ring with a radius of $\approx$100 pc showing thermal excitation. The ionized gas emission lines show flux distributions mostly outlining the previously known [O III]λ5007 ionization bicone. But while the flux distributions in the H I and He II emission lines are very similar to that observed in [O III], the flux distribution in the [Fe II] emission lines is more extended and broader than a cone close to the nucleus, showing a "double bowl" or "hourglass" structure. This difference is attributed to the fact that the [Fe II] emission, besides coming from the fully ionized region, comes also from the more extended partially ionized regions, in gas excited mainly by X-rays from the active galactic nucleus. A contribution to the [Fe II] emission from shocks along the bicone axis to NE and SW of the nucleus is also supported by the enhancement of the [Fe II](1.2570 μm)/[P II](1.1885 μm) and [Fe II](1.2570 μm)/Paβ emission-line ratios at these locations and is attributed to the interaction of the radio jet with the NLR. The mass of ionized gas in the inner 200 pc of NGC 1068 is $M_{\rm HII} \approx 2.2\times10^4$ M$_\odot$, while the mass of the H_2 emitting gas is only $M_{H_2} \approx 29$ M$_\odot$. Taking into account the dominant contribution of the cold molecular gas, we obtain an estimate of the total molecular gas mass of $M_{\rm cold} \approx 2 \times 10^7$ M$_\odot$.

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Preprint available at http://arxiv.org/abs/1404.7125

Broad-line region structure and kinematics in the radio galaxy 3C 120

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Broad emission lines originate in the surroundings of supermassive black holes in the centers of active galactic nuclei (AGN). These broad-line emitting regions are spatially unresolved even for the nearest AGN. The origin and geometry of broad-line region (BLR) gas and their connection with geometrically thin or thick accretion disks is of fundamental importance for the understanding of AGN activity. One method to investigate the extent, structure, and kinematics of the BLR is to study the continuum and line profile variability in AGN. We selected the radio-loud Seyfert 1 galaxy 3C120 as a target for this study. We took spectra with a high signal-to-noise ratio of 3C 120 with the 9.2m Hobby-Eberly Telescope between Sept. 2008 and March 2009. In parallel, we photometrically monitored the continuum flux at the Wise observatory. We analyzed the continuum and line profile variations in detail (1D and 2D reverberation mapping) and modeled the geometry of the line-emitting regions based on the line profiles. We show that the BLR in 3C 120 is stratified with respect to the distance of the line-emitting regions from the center with respect to the line widths (FWHM) of the rms profiles and with respect to the variability amplitude of the emission lines. The emission line wings of Hα and Hβ respond much faster than their central region. This is explained by accretion disk models. In addition, these lines show a stronger response in the red wings. However, the velocity-delay maps of the helium lines show a stronger response in the blue wing. Furthermore, the He II λ4686 line responds faster in the blue wing in contradiction to observations made one and a half years later when the galaxy was in a lower state. The faster response in the blue wing is an indication for central outflow motions when this galaxy was in a bright state during our observations. The vertical BLR structure in 3C 120 coincides with that of other AGN. We confirm the general trend: the emission lines of narrow line AGN originate at larger distances from the midplane than AGN with broader emission lines.

A&A in press

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Preprint available at http://arxiv.org/abs/1405.1588

AGN Feedback in the Hot Halo of NGC 4649

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Using the deepest available *Chandra* observations of NGC 4649 we find strong evidences of cavities, ripples and ring like structures in the hot interstellar medium (ISM) that appear to be morphologically related with the central radio emission. These structures show no significant temperature variations in correspondence with higher pressure regions (0.5 kpc $< r <$ 3 kpc). On the same spatial scale, a discrepancy between the mass profiles obtained from stellar dynamic and *Chandra* data represents the telltale evidence of a significant non-thermal pressure component in this hot gas, which is related to the radio jet and lobes. On larger scale we find agreement between the mass profile obtained form *Chandra* data and planetary nebulae and globular cluster dynamics. The nucleus of NGC 4649 appears to be extremely radiatively inefficient, with highly sub-Bondi accretion flow. Consistently with this finding, the jet power evaluated from the observed X-ray cavities implies that a small fraction of the accretion power calculated for the Bondi mass accretion rate emerges as kinetic energy. Comparing the jet power to radio and nuclear X-ray luminosity the observed cavities show similar behavior to those of other giant elliptical galaxies.

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AGN Emission Line Diagnostics and the Mass-Metallicity Relation up to Redshift $z \sim 2$: The Impact of Selection Effects and Evolution

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Emission line diagnostic diagrams probing the ionization sources in galaxies, such as the Baldwin-Phillips-Terlevich (BPT) diagram, have been used extensively to distinguish AGN from purely star-forming galaxies. Yet, they remain poorly understood at higher redshifts. We shed light on this issue with an empirical approach based on a $z \sim 0$ reference sample built from ~300,000 SDSS galaxies, from which we mimic selection effects due to typical emission line detection limits at higher redshift. We combine this low-redshift reference sample with a simple prescription for luminosity evolution of the global galaxy population to predict the loci of high-redshift galaxies on the BPT and Mass-Excitation (MEx) diagnostic diagrams. The predicted bivariate distributions agree remarkably well with direct observations of galaxies out to $z \sim 1.5$, including the observed stellar mass-metallicity (MZ) relation evolution. As a result, we infer that high-redshift star-forming galaxies are consistent with having *normal* ISM properties out to $z \sim 1.5$, after accounting for selection effects and line luminosity evolution. Namely, their optical line ratios and gas-phase metallicities are comparable to that of low-redshift galaxies with equivalent emission-line luminosities. In contrast, AGN narrow-line regions may show a shift toward lower metallicities at higher redshift. While a physical evolution of the ISM conditions is not ruled out for purely star-forming galaxies, and may be more important starting at $z > 2$, we find that reliably quantifying this evolution is hindered by selections effects but the recipes provided here may serve as a basis for future studies toward this goal. Code to predict the loci of galaxies on the BPT and MEx diagnostic diagrams, and the MZ relation as a function of emission line luminosity limits, is made publicly available.

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Preprint available at http://adsabs.harvard.edu/abs/2014arXiv1403.6832J
Public IDL routines available at https://sites.google.com/site/agndiagnostics/home/mex

High Redshift Standard Candles: Predicted Cosmological Constraints

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We investigate whether future measurements of high-redshift standard candles will be a powerful probe of dark energy, when compared to other types of planned dark energy measurements. Active galactic nuclei, gamma ray bursts, and certain types of core collapse supernova have been proposed as potential candidates of such a standard candle. Due to their high luminosity, they can be used to probe unexplored regions in the expansion history of the universe. Information from these regions can help constrain the properties of dark energy, and in particular, whether it varies over time.

We consider both linear and piecewise parameterizations of the dark energy equation-of-state, $w(z)$, and assess the optimal redshift distribution a high-redshift standard-candle survey could take to constrain these models. The more general the form of the dark energy equation-of-state $w(z)$ being tested, the more useful high-redshift standard candles become. For a linear parameterization of $w(z)$, they give only small improvements over planned supernova and baryon acoustic oscillation measurements; a wide redshift range with many low redshift points is optimal to constrain this linear model. However to constrain a general, and thus potentially more informative, form of $w(z)$, having many high-redshift standard candles can significantly improve limits on the nature of dark energy, even compared to dark energy experiments currently only in the planning stages.

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The narrow Fe Kα line and the molecular torus in active galactic nuclei - an IR/X-ray view

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The narrow component of the iron Kα is an almost ubiquitous feature in the X-ray spectra of active galactic nuclei (AGN) and is believed to originate in neutral material, possibly located in the molecular torus. This would imply a tight connection between the Fe Kα equivalent width (EW) and the physical properties of the torus. In a recent work we have shown that the decrease of the covering factor of the torus with the luminosity, as expected by luminosity-dependent unification models, would be able to explain the decrease of Fe Kα EW with the luminosity (i.e., the X-ray Baldwin effect). Recent developments in the study of the mid-IR (MIR) spectrum of AGN allow important parameters of the torus to be deduced, such as its covering factor ($f_{\rm obs}$) and equatorial column density ($N_{\rm H}^{\rm T}$), by applying clumpy torus models. Using *XMM-Newton*/EPIC observations of a sample of 24 type-I AGN, we investigate the relation between the physical parameters of the torus obtained by recent MIR works and the properties of the Fe Kα line. We correct the values of the Fe Kα EW by taking the inclination angle, the photon index, the equatorial column density, and half-opening angle of the torus into account using a physical torus model of X-ray reprocessed radiation. We find that the relation between Fe Kα EW and $f_{\rm obs}$ shows a slope that is consistent with the expected value, albeit with a low statistical significance. A trend that is consistent with the theoretical prediction is also found when comparing the Fe Kα EW to $N_{\rm H}^{\rm T}$. Our work seems to confirm that the bulk of the narrow Fe Kα line is produced by the same material responsible for the MIR emission.

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The Most Massive Active Black-Holes at $z \sim 1.5 - 3.5$ Have High Spins and Radiative Efficiencies

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The radiative efficiencies (η) of 72 luminous unobscured Active Galactic Nuclei (AGNs) at $z \sim 1.5 - 3.5$, powered by some of the most massive black holes (BHs), are constrained. The analysis is based on accretion disk (AD) models, which link the continuum luminosity at rest-frame optical wavelengths and the black hole mass ($M_{\rm BH}$) to the accretion rate through the AD, $\dot{M}_{\rm AD}$. The data are gathered from several literature samples with detailed measurements of the Hβ emission line complex, observed at near-IR bands. When coupled with standard estimates of bolometric luminosities ($L_{\rm bol}$), the analysis suggests high radiative efficiencies, with most of the sources showing $\eta > 0.2$ - that is, higher than the commonly assumed value of 0.1, and the expected value for non-spinning BHs ($\eta = 0.057$). Even under more conservative assumptions regarding $L_{\rm bol}$ (i.e., $L_{\rm bol} = 3 \times \lambda L_{\lambda}\left[5100\text{Å}\right]$), most of the extremely massive BHs in the sample (i.e., $M_{\rm BH} > 3 \times 10^{9}\, M_{\odot}$) show radiative efficiencies which correspond to very high BH spins (a_*), with typical values well above $a_* \simeq 0.7$. These results stand in contrast to the predictions of a "spin-down" scenario, in which a series of randomly-oriented accretion episodes lead to $a_* \simeq 0$. Instead, the analysis presented here strongly supports a "spin-up" scenario, which is driven by either prolonged accretion or a series of anisotropically-oriented accretion episodes. Considering the fact that these extreme BHs require long-duration continuous accretion to account for their high masses, it is argued that the most probable scenario for the SMBHs under study is that of an almost continuous sequence of randomly- yet not isotropically-oriented accretion episodes.

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Star formation and black hole growth at $z \simeq 4.8$

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We report *Herschel, Spitzer* and *WISE* observations of 44 $z \simeq 4.8$ active galactic nuclei (AGNs). Ten objects were detected by *Herschel* and five show emission that is not associated with the AGNs. The star formation (SF) luminosity (LSF) obtained by fitting the spectral energy distribution (SED) with standard SF templates, taking into account AGN contribution, is $10^{46.62} - 10^{47.21}$ erg/sec corresponding to SF rates of $1090 - 4240$ Msun/yr. Very luminous submillimeter galaxy SEDs give LSF smaller by 0.05–0.1 dex. T=40K gray-body fits to the $500\mu m$ fluxes reduce LSF by about 0.3 dex. Stacking 29 undetected sources give significant signals in all three bands with LSF=$10^{46.19-46.23}$ erg/sec and T=40K fit to the stacked $500\mu m$ flux gives LSF=$10^{45.95}$ erg/sec. The mean BH mass (M_{BH}) and AGN luminosity (LAGN) of the detected sources are significantly higher than those of the undetected ones. The spectral differences are seen all the way from UV to far infrared wavelengths. The optical-UV spectra are similar to the ones predicted for thin accretion disks around BHs with the measured properties. We examine two alternative explanations to the correlation of LSF, LAGN and M_{BH}, one involving no AGN feedback and one a moderate feedback but no quenching in 3/4 of the sources. We compare LSF and LAGN to lower redshift samples and show a new correlation between LSF and M_{BH}. We also examine several speculative ideas including the possibility that the detected sources are above the mass sequence (MS), perhaps in mergers, and most of the undetected sources are on the MS.

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Relics of Galaxy Merging: Observational Predictions for a Wandering Massive Black Hole and Accompanying Star Cluster in the Halo of M31

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Galaxies and massive black holes (BHs) presumably grow via galactic merging events and subsequent BH coalescence. As a case study, we investigate the merging event between the Andromeda galaxy (M31) and a satellite galaxy. We compute the expected observational appearance of the massive BH that was at the center of the satellite galaxy prior to the merger, and is currently wandering in the M31 halo. We demonstrate that a radiatively inefficient accretion flow with a bolometric luminosity of a few tens of solar luminosities develops when Hoyle-Lyttleton accretion onto the BH is assumed. We compute the associated broadband spectrum and show that the radio band (observable with EVLA, ALMA and SKA) is the best frequency range to detect the emission. We also evaluate the mass and the luminosity of the stars bound by the wandering BH and find that such a star cluster is sufficiently luminous that it could correspond to one of the star clusters found by the PAndAS survey. The discovery of a relic massive BH wandering in a galactic halo will provide a direct means to investigate in detail the coevolution of galaxies and BHs. It also means a new population of BHs (off-center massive BHs), and offers targets for clean BH imaging that avoids strong interstellar scattering in the center of galaxies.

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High Energy Emission Processes in OJ 287 during 2009 Flare

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The broadband spectrum of a BL Lac object, OJ 287, from radio to γ-rays obtained during a major γ-ray flare detected by *Fermi* in 2009 are studied to understand the high energy emission mechanism during this episode. Using a simple one-zone leptonic model, incorporating synchrotron and inverse Compton emission processes, we show that the explanation of high energy emission from X-rays to γ-rays, by considering a single emission mechanism, namely, synchrotron self-Compton (SSC) or external Compton (EC) requires unlikely physical conditions. However, a combination of both SSC and EC mechanisms can reproduce the observed high energy spectrum satisfactorily. Using these emission mechanisms we extract the physical parameters governing the source and its environment. Our study suggests that the emission region of OJ 287 is surrounded by a warm infrared (IR) emitting region of $\sim 250\,K$. Assuming this region as a spherical cloud illuminated by an accretion disk, we obtain the location of the emission region to be $\sim 9\ pc$. This supports the claim that the γ-ray emission from OJ 287 during the 2009 flare arises from a location far away from the central engine as deduced from millimeter-gamma ray correlation study and very long baseline array images.

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Meetings

PhD course: Introduction to sub-mm interferometry and science with ALMA

Place: Dark Cosmology Centre (DARK), Niels Bohr Institute, University of Copenhagen Dates: 13-21 August, 2014

Webpage: http://dark.nbi.ku.dk/calendar/calendar2014/interferometry_science_course/
Email: mcl@dark-cosmology.dk

DARK Associate Professors, Marianne Vestergaard and Lise Christensen, along with Wouter Vlemmings from the Nordic ALMA regional centre (ARC), Chalmers University of Technology and Sé bastien Mü ller (ARC) will provide a 10-day course on research and observations with the Atacama Large Millimeter Array (ALMA) with fellow instructors Ivan Marti-Vidal (ARC) and Matthias Maercker (ARC). Several talks on possible science with ALMA covering many subfields of astronomy will be held by Kirsten Kraiberg Knudsen (Chalmers Technical University, Onsala), and DARK Fellow Julie Wardlow, among others. The interferometry experts will provide background reading and lectures on interferometry. Exercises will include hands-on tutorials and exercises, including introduction to and use of the data manipulation and analysis software CASA, feasibility calculations and technical computations relevant for proposal preparations, hints on proposal writing, and possibly small science projects.

The course will provide 2.5 ETCS points for student not participating in the exercises and the exam and 5 ETCS points for students participating in the exercises//project work. There is no fee for attending the course, but students coming from outside of Copenhagen will have to cover their own transport and housing costs. There is a limited space available; the list of participants will be confirmed later this spring and early summer.