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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. Please note that the editor may reject submissions which do not use the template. As always, any suggestions or feedback regarding the newsletter are welcome.

Thanks for your continued subscription.

Megan Argo

Abstracts of recently accepted papers

The peculiar optical-UV X-ray spectra of the X-ray weak quasar PG 0043+039

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The object PG 0043+039 has been identified as a broad absorption line (BAL) quasar based on its UV spectra. However, this optical luminous quasar has not been detected before in deep X-ray observations, making it the most extreme X-ray weak quasar known today. This study aims to detect PG 0043+039 in a deep X-ray exposure. The question is what causes the extreme X-ray weakness of PG 0043+039? Does PG 0043+039 show other spectral or continuum peculiarities? We took simultaneous deep X-ray spectra with XMM-Newton, far-ultraviolet (FUV) spectra with the Hubble Space Telescope (HST), and optical spectra of PG 0043+039 with the Hobby-Eberly Telescope (HET) and Southern African Large Telescope (SALT) in July, 2013. We have detected PG 0043+039 in our X-ray exposure taken in 2013. We presented our first results in a separate paper (Kollatschny et al. 2015). PG 0043+039 shows an extreme α_{ox} gradient (α_{ox}=−2.37). Furthermore, we were able to verify an X-ray flux of this source in a reanalysis of the X-ray data taken in 2005. At that time, it was fainter by a factor of 3.8 ±0.9 with α_{ox}=−2.55. The X-ray spectrum is compatible with a normal quasar power-law spectrum ($\Gamma = 1.70^{+0.57}_{-0.45}$) with moderate intrinsic absorption ($N_H = 5.5^{+6.9}_{-3.9} \times 10^{21}$ cm^{-2}) and reflection. The UV/optical flux of PG 0043+039 has increased by a factor of 1.8 compared to spectra taken in the years 1990-1991. The FUV spectrum is highly peculiar and dominated by broad bumps besides Lyα. There is no detectable Lyman edge associated with the BAL absorbing gas seen in the CIV line. PG 0043+039 shows a maximum in the overall continuum flux at around $\lambda \approx 2500$ Å in contrast to most other AGN where the maximum is found at shorter wavelengths. All the above is compatible with an intrinsically X-ray weak quasar, rather than an absorbed X-ray emission. Besides strong FeII multiplets and broad Balmer and HeI lines in the optical band we only detect a narrow [O II]λ3727 emission line and a BAL system in the CaH λ3968, CaK λ3934 lines (blueshifted by 4900 kms^{-1}) and in the He I λ3889 line (blueshifted by 5600 kms^{-1}).

A&A in press

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The hard X-ray emission of the luminous infrared galaxy NGC 6240 as observed by NuSTAR

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We present a broad–band (∼0.3–70 keV) spectral and temporal analysis of *NuSTAR* observations of the luminous infrared galaxy NGC 6240, combined with archival *Chandra*, *XMM–Newton* and *BeppoSAX* data. NGC 6240 is a galaxy in a relatively early merger state with two distinct nuclei separated by ∼1.″5. Previous *Chandra* observations have resolved the two nuclei, showing that they are both active and obscured by Compton–thick material. Although they cannot be resolved by *NuSTAR*, thanks to the unprecedented quality of the *NuSTAR* data at energies >10 keV, we clearly detect, for the first time, both the primary and the reflection continuum components. The *NuSTAR* hard X–ray spectrum is dominated by the primary continuum piercing through an absorbing column density which is mildly optically thick to Compton scattering ($\tau \simeq 1.2$, $N_{\rm H} \sim 1.5\times 10^{24}$ cm^{-2}). We detect moderate hard X–ray (> 10 keV) flux variability up to 20% on short ($15-20$ ksec) timescales. The amplitude of the variability is maximum at ∼30 keV and is likely to originate from the primary continuum of the southern nucleus. Nevertheless, the mean hard X–ray flux on longer timescales (years) is relatively constant. Moreover, the two nuclei remain Compton–thick, although we find evidence of variability of the material along the line of sight with column densities $N_{\rm H}{\leq}2{\times}10^{23}$ cm^{-2} over long (∼3–15 years) timescales. The observed X–ray emission in the *NuSTAR* energy range is fully consistent with the sum of the best–fit models of the spatially resolved *Chandra* spectra of the two nuclei.

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A NuSTAR Survey of Nearby Ultraluminous Infrared Galaxies

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We present a *NuSTAR*, *Chandra*, and *XMM–Newton* survey of nine of the nearest ultraluminous infrared galaxies (ULIRGs). The unprecedented sensitivity of *NuSTAR* at energies above 10 keV enables spectral modeling with far better precision than was previously possible. Six of the nine sources observed were detected sufficiently well by *NuSTAR* to model in detail their broadband X-ray spectra, and recover the levels of obscuration and intrinsic X-ray luminosities. Only one source (IRAS 13120–5453) has a spectrum consistent with a Compton–thick AGN, but we cannot rule out that a second source (Arp 220) harbors an extremely highly obscured AGN as well. Variability in column density (reduction by a factor of a few compared to older observations) is seen in IRAS 05189–2524 and Mrk 273, altering the classification of these border-line sources from Compton-thick to Compton-thin. The ULIRGs in our sample have surprisingly low observed fluxes in high energy (>10 keV) X-rays, especially compared to their bolometric luminosities. They have lower ratios of unabsorbed 2–10 keV to bolometric luminosity, and unabsorbed 2–10 keV to mid-IR [O IV] line luminosity than do Seyfert 1 galaxies. We identify IRAS 08572+3915 as another candidate intrinsically X-ray weak source, similar to Mrk 231. We speculate that the X-ray weakness of IRAS 08572+3915 is related to its powerful outflow observed at other wavelengths.

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The sign of active galactic nucleus quenching in a merger remnant with radio jets

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We investigate optical, infrared, and radio active galactic nucleus (AGN) signs in the merger remnant Arp 187, which hosts luminous jets launched in the order of 10^5 yr ago but whose present-day AGN activity is still unknown. We find AGN signs from the optical BPT diagram and infrared [O IV]25.89 μm line, originating from the narrow line regions of AGN. On the other hand, *Spitzer*/IRS show the host galaxy dominated spectra, suggesting that the thermal emission from the AGN torus is considerably small or already diminished. Combining the black hole mass, the upper limit of radio luminosity of the core, and the fundamental plane of the black hole enable us to estimate X-ray luminosity, which gives $< 10^{40}$ erg s^{-1}. Those results suggest that the AGN activity of Arp 187 has already been quenched, but the narrow line region is still alive owing to the time delay of emission from the past AGN activity.

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Unveiling the X-ray/UV properties of disk winds in active galactic nuclei using broad and mini-broad absorption line quasars

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We present the results of the uniform analysis of 46 XMM-Newton observations of six BAL and seven mini-BAL QSOs belonging to the Palomar-Green Quasar catalogue. Moderate-quality X-ray spectroscopy was performed with the EPIC-pn, and allowed to characterise the general source spectral shape to be complex, significantly deviating from a power law emission. A simple power law analysis in different energy bands strongly suggests absorption to be more significant than reflection in shaping the spectra. If allowing for the absorbing gas to be either partially covering the continuum emission source or to be ionised, large column densities of the order of 10^{22-24} cm^{-2} are inferred. When the statistics was high enough, virtually every source was found to vary in spectral shape on various time scales, from years to hours. All in all these observational results are compatible with radiation driven accretion disk winds shaping the spectra of these intriguing cosmic sources.

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Dichroic polarization at mid-infrared wavelengths: a Bayesian approach

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A fast and general Bayesian inference framework to infer the physical properties of dichroic polarization using mid-infrared imaging- and spectro-polarimetric observations is presented. The Bayesian approach is based on a hierarchical regression and No-U-Turn Sampler method. This approach simultaneously infers the normalized Stokes parameters to find the full family of solutions that best describe the observations. In comparison with previous methods, the developed Bayesian approach allows the user to introduce a customized absorptive polarization component based on the dust composition, and the appropriate extinction curve of the object. This approach allows the user to obtain more precise estimations of the magnetic field strength and geometry for tomographic studies, and information about the dominant polarization components of the object. Based on this model, imaging-polarimetric observations using two or three filters located in the central 9.5−10.5 μu, and the edges 8−9 μu and/or 11−13 μu, of the wavelength range are recommended to optimally disentangle the polarization mechanisms.

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The Search for Active Black Holes in Nearby Low-Mass Galaxies using Optical and mid-IR data

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We investigated AGN activity in low-mass galaxies, an important regime that can shed light on to black hole (BH) formation and evolution, and their interaction with their host galaxies. We identified 336 AGN candidates from a parent sample of $\sim 48,000$ nearby low-mass galaxies ($M_\star \leq 10^{9.5} M\odot$, $z < 0.1$) in the Sloan Digital Sky Survey. We selected the AGN using the classical BPT diagram, a similar optical emission line diagnostic based on the HeIIλ4686 line, and mid-IR colour cuts. Different criteria select host galaxies with different physical properties such as stellar mass and optical colour and only 3 out of 336 sources fulfil all three criteria. This could be in part due to selection biases. The resulting AGN fraction of $\sim 0.7\%$ is at least one order of magnitude below the one estimated for more massive galaxies. At optical wavelengths, the HeII-based AGN selection appears to be more sensitive to AGN hosted in star-forming galaxies than the classical BPT diagram, at least in the low-mass regime. The archival X-ray and radio data available for some of the optically selected AGN candidates seem to confirm their AGN nature, but follow-up observations are needed to confirm the AGN nature of the rest of the sample, especially in the case of mid-IR selection. Our sample will be important for future follow-up studies aiming to understand the relation between BHs and host galaxies in the low-mass regime.

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Rest-frame UV single-epoch black hole mass estimates of low-luminosity AGN at intermediate redshifts

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The ability to accurately derive black hole (BH) masses at progressively higher redshifts and over a wide range of continuum luminosities has become indispensable in the era of large-area extragalactic spectroscopic surveys. In this paper we present an extension of existing comparisons between rest-frame UV and optical virial BH mass estimators to intermediate redshifts and luminosities comparable to the local Hβ reverberation mapped active galactic nuclei (AGN). We focus on the MgII, CIV, and CIII] broad emission lines and compare them to both Hα and Hβ. We use newly acquired near-infrared spectra from the FMOS instrument on the Subaru telescope for 89 broad-lined AGN at redshifts between 0.3 and 3.5, complemented by data from the AGES survey. We employ two different prescriptions for measuring the emission line widths and compare the results. We confirm that MgII shows a tight correlation with Hα and Hβ, with a scatter of ~ 0.25 dex. The CIV and CIII] estimators, while showing larger scatter, are viable virial mass estimators after accounting for a trend with the UV-to-optical luminosity ratio. We find an intrinsic scatter of ~ 0.37 dex between Balmer and carbon virial estimators by combining our dataset with previous high redshift measurements. This updated comparison spans a total of 3 decades in BH mass. We calculate a virial factor for CIV/CIII] $\log f_{\rm CIV/CIII]} = 0.87$ with an estimated systematic uncertainty of ~ 0.4 dex and find excellent agreement between the local reverberation mapped AGN sample and our high-z sample.

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PAGaN I: Multi-Frequency Polarimetry of AGN Jets with KVN

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Active Galactic Nuclei (AGN) with bright radio jets offer the opportunity to study the structure of and physical conditions in relativistic outflows. For such studies, multi-frequency polarimetric very long baseline interferometric (VLBI) observations are important as they directly probe particle densities, magnetic field geometries, and several other parameters. We present results from first-epoch data obtained by the Korean VLBI Network (KVN) within the frame of the *P*lasma Physics of *A*ctive *Ga*lactic *N*uclei (PAGaN) project. We observed seven radio-bright nearby AGN at frequencies of 22, 43, 86, and 129 GHz in dual polarization mode. Our observations constrain apparent brightness temperatures of jet components and radio cores in our sample to $> 10^{8.01}$ K and $> 10^{9.86}$ K, respectively. Degrees of linear polarization m_L are relatively low overall: less than 10%. This indicates suppression of polarization by strong turbulence in the jets. We found an exceptionally high degree of polarization in a jet component of BL Lac at 43 GHz, with $m_L \sim 40\%$. Assuming a transverse shock front propagating downstream along the jet, the shock front being almost parallel to the line of sight can explain the high degree of polarization.

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PAGaN II: The Evolution of AGN jets on Sub-Parsec Scales

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We report first results from KVN and VERA Array (KaVA) VLBI observations obtained in the frame of our *P*lasma-physics of *A*ctive *Ga*lactic *N*uclei (PAGaN) project. We observed eight selected AGN at 22 and 43 GHz in single polarization (LCP) between March 2014 and April 2015. Each source was observed for 6 to 8 hours per observing run to maximize the uv coverage. We obtained a total of 15 deep high-resolution images permitting the identification of individual circular Gaussian jet components and three spectral index maps of BL Lac, 3C 111 and 3C 345 from simultaneous dual-frequency observations. The spectral index maps show trends in agreement with general expectations – flat core and steep jets – while the actual value of the spectral index for jets shows indications for a dependence on AGN type. We analyzed the kinematics of jet components of BL Lac and 3C 111, detecting superluminal proper motions with maximum apparent speeds of about $5c$. This constrains the lower limits of the intrinsic component velocities to $\sim 0.98c$ and the upper limits of the angle between jet and line of sight to $\sim$20deg. In agreement with global jet expansion, jet components show systematically larger diameters d at larger core distances r, following the global relation $d \approx 0.2r$, albeit within substantial scatter.

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A Search for AGN Intra-day Variability with KVN

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Active galactic nuclei (AGN) are known for irregular variability on all time scales, down to intra-day variability with relative variations of a few percent within minutes to hours. On such short timescales, unexplored territory, such as the possible existence of a shortest characteristic time scale of activity and the shape of the high frequency end of AGN power spectra, still exists. We present the results of AGN single-dish fast photometry performed with the Korean VLBI Network (KVN). Observations were done in a "anti-correlated" mode using two antennas, with always at least one antenna pointing at the target. This results in an effective time resolution of less than three minutes. We used all four KVN frequencies, 22, 43, 86, and 129 GHz, in order to trace spectral variability, if any. We were able to derive high-quality light curves for 3C 111, 3C 454.3, and BL Lacertae at 22 and 43 GHz, and for 3C 279 at 86 GHz, between May 2012 and April 2013. We performed a detailed statistical analysis in order to assess the levels of variability and the corresponding upper limits. We found upper limits on flux variability ranging from $\sim$1.6% to $\sim$7.6%. The upper limits on the derived brightness temperatures exceed the inverse Compton limit by three to six orders of magnitude. From our results, plus comparison with data obtained by the University of Michigan Radio Astronomy Observatory, we conclude that we have not detected source-intrinsic variability which would have to occur at sub-per cent levels.

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Abstracts of recently submitted papers

Constraining the dynamical importance of hot gas and radiation pressure in quasar outflows using emission line ratios

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Quasar feedback models often predict an expanding hot gas bubble which drives a galaxy-scale outflow. In many circumstances the hot gas is predicted to radiate inefficiently, making the hot bubble hard to observe directly. We present an indirect method to detect the presence of a hot bubble using hydrostatic photoionization models of the cold ($\sim 10^4$ K) line-emitting gas. These models assume that the cold gas is in pressure equilibrium with either the hot gas pressure or with the radiation pressure, whichever is larger. We compare our models with observations of the broad line region (BLR), the inner face of the dusty torus, the narrow line region (NLR), and the extended NLR, and thus constrain the hot gas pressure over a dynamical range of 10^5 in radius, from ~ 0.1 pc to ~ 10 kpc. We find that the emission line ratios observed in the average quasar spectrum are consistent with radiation-pressure-dominated models on all scales. On scales < 40 pc a dynamically significant hot gas pressure is ruled out for an average quasar spectrum, while on larger scales the hot gas pressure cannot exceed six times the local radiation pressure. In individual quasars, $\approx 25\%$ of the objects exhibit narrow line ratios that are inconsistent with radiation-pressure-dominated models by a factor of ~ 2, though in these objects the hot gas pressure is also unlikely to exceed the radiation pressure by an order of magnitude or more. The upper limits we derive on the hot gas pressure imply that the instantaneous gas pressure force acting on galaxy-scale outflows falls short of the time-averaged force needed to explain the large momentum fluxes $\dot{p} \gg L_{\rm AGN}/c$ inferred for galaxy-scale outflows in luminous quasars. This apparent discrepancy can be reconciled if the optical quasars observed today previously experienced a buried, fully-obscured phase during which the hot gas bubble was more effectively confined and during which most of the galactic wind acceleration occurred.

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Thesis Abstracts

Aspects of Supermassive Black Hole Growth in Nearby Active Galactic Nuclei

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Super-massive black holes (SBHs) have long been identified as the engines of active galactic nuclei (AGNs) and are now considered to play a key role in galaxy evolution. In this dissertation I present results from two observational studies conducted on nearby AGNs with the aim of furthering our understanding of SBH growth and their interplay with the host galaxies.

The first study is an observational search for SBHs spatially offset from the center of their host galaxies. Such offsets can be considered signatures of gravitational recoil following the coalescence of an SBH binary system (formed in the aftermath of a galaxy merger) due to emission of gravitational waves. The study is based on a photometric analysis of fourteen nearby elliptical galaxies observed with the Hubble Space Telescope. I find that parsec-scale offsets are common. However, while these are individually consistent with residual gravitational recoil oscillations, there is a high probability that larger offsets than those actually observed should have been found in the sample as a whole. There are a number of possible explanations for this result: the galaxy merger rate may be lower than current estimates; SBH-binaries may reach the merger stage with a configuration which minimizes recoil velocities; or the SBH oscillations are more quickly damped than predicted.

In the second study I use integral field spectroscopy obtained with the Gemini South telescope to investigate the kinematics of the circum-nuclear ionized gas in two active galaxies: NGC 1386, a Seyfert 2, and NGC 1365, a Seyfert 1. The goal of the study is to investigate outflows in low-luminosity AGNs, and the mechanisms channeling gas (the SBH fuel) from the inner kiloparsec down to a few tens of parsecs from the SBH. I find that the dominant kinematic components can be explained as a combination of rotation in the large-scale galactic disk and compact outflows along the axis of the AGN radiation cone. However, in the case of NGC 1386, there is also compelling evidence for an equatorial outflow, which provides a new clue to the physical processes operating in AGNs.