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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

Identification of a New γ-Ray Emitting Narrow-Line Seyfert 1 Galaxy, at Redshift ~ 1

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We report on the identification of a new γ-ray emitting Narrow-Line Seyfert 1 (NLS1) galaxy, SDSS J122222.55+041315.7, which increases the number of known objects of this remarkable but rare type of Active Galactic Nuclei (AGN) to seven. Its optical spectrum, obtained in the SDSS-BOSS, reveals a broad Hβ emission line with a width (FWHM) of $1734\pm104\,\mathrm{km\,s^{-1}}$. This, along with strong optical Fe II multiplets [$R_{4570} = 0.9$] and a weak [O III] $\lambda5007$ emission line, makes the object a typical NLS1. On the other hand, the source exhibits a high radio brightness temperature, rapid infrared variability, and a flat X-ray spectrum extending up to $\sim$200 keV. It is associated with a luminous γ-ray source detected significantly with *Fermi*/LAT. Correlated variability with other wavebands has not yet been tested. The spectral energy distribution can be well modeled by a one-zone leptonic jet model. This new member is by far the most distant γ-ray emitting NLS1, at a redshift of $z = 0.966$.

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The radio properties of radio-loud narrow-line Seyfert 1 galaxies on parsec scales

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We present the detection of compact radio structures of fourteen radio-loud narrow line Seyfert 1 (NLS1) galaxies from Very Long Baseline Array observations at 5 GHz, which were performed in 2013. While 50% of the sources of our sample show a compact core only, the remaining 50% exhibit a core-jet structure. The measured brightness temperatures of the cores range from $10^{8.4}$ to $10^{11.4}$ K with a median value of $10^{10.1}$ K, indicating that the radio emission is from non-thermal jets, and that, likely, most sources are not strongly beamed, then implying a low jet speed in these radio-loud NLS1 galaxies. In combination with archival data taken at multiple frequencies, we find that seven sources show flat or even inverted radio spectra, while steep spectra are revealed in the remaining seven objects. Although all these sources are very radio-loud with $R > 100$, their jet properties are diverse, in terms of their milli-arcsecond (mas) scale (pc scale) morphology and their overall radio spectral shape. The evidence for slow jet speeds (i.e., less relativistic jets), in combination with the low kinetic/radio power, may offer an explanation for the compact VLBA radio structure in most sources. The mildly relativistic jets in these high accretion rate systems are consistent with a scenario, where jets are accelerated from the hot corona above the disk by the magnetic field and the radiation force of the accretion disk. Alternatively, a low jet bulk velocity can be explained by low spin in the Blandford-Znajek mechanism.

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A Compton-thin Solution for the *Suzaku* X-ray Spectrum of the Seyfert 2 Galaxy Mkn 3

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Mkn 3 is a Seyfert 2 galaxy that is widely regarded as an exemplary Compton-thick AGN. We study the Suzaku X-ray spectrum using models of the X-ray reprocessor that self-consistently account for the Fe Kα fluorescent emission line and the associated Compton-scattered, or reflection, continuum. We find a solution in which the average global column density, $0.234^{+0.012}_{-0.010} \times 10^{24}$ cm^{-2}, is very different to the line-of-sight column density, $0.902^{+0.012}_{-0.013} \times 10^{24}$ cm^{-2}. The global column density is ~ 5 times smaller than that required for the matter distribution to be Compton-thick. Our model accounts for the profiles of the Fe Kα and Fe Kβ lines, and the Fe K edge remarkably well, with a solar abundance of Fe. The matter distribution could consist of a clumpy medium with a line-of-sight column density higher than the global average. A uniform, spherically-symmetric distribution alone cannot simultaneously produce the correct fluorescent line spectrum and reflection continuum. Previous works on Mkn 3, and other AGN, that assumed a reflection continuum from matter with an infinite column density could therefore lead to erroneous or "puzzling" conclusions if the matter out of the line-of-sight is really Compton-thin. Whereas studies of samples of AGN have generally only probed the line-of-sight column density, with simplistic, one-dimensional models, it is important now to establish the global column densities in AGN. It is the global properties that affect the energy budget in terms of reprocessing of X-rays into infrared emission, and that constrain population synthesis models of the cosmic X-ray background.

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X-ray spectral variability of Seyfert 2 galaxies

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Variability across the electromagnetic spectrum is a property of active galactic nuclei (AGN) that can help constrain the physical properties of these galaxies. Nonetheless, the way in which the changes happen and whether they occur in the same way in every AGN are still open questions. This is the third in a series of papers with the aim of studying the X-ray variability of different families of AGN. The main purpose of this work is to investigate the variability pattern(s) in a sample of optically selected Seyfert 2 galaxies. We use the 26 Seyfert 2s in the Véron-Cetty and Véron catalog with data available from *Chandra* and/or *XMM*–Newton public archives at different epochs, with timescales ranging from a few hours to years. All the spectra of the same source were simultaneously fitted, and we let different parameters vary in the model. Whenever possible, short-term variations from the analysis of the light curves and/or long-term UV flux variations were studied. We divided the sample into Compton-thick and Compton-thin candidates to account for the degree of obscuration. When transitions between Compton-thick and thin were obtained for different observations of the same source, we classified it as a changing-look candidate. Short-term variability at X-rays was studied in ten cases, but variations are not found. From the 25 analyzed sources, 11 show long-term variations. Eight (out of 11) are Compton-thin, one (out of 12) is Compton-thick, and the two changing-look candidates are also variable. The main driver for the X-ray changes is related to the nuclear power (nine cases), while variations at soft energies or related to absorbers at hard X-rays are less common, and in many cases these variations are accompanied by variations in the nuclear continuum. At UV frequencies, only NGC 5194 (out of six sources) is variable, but the changes are not related to the nucleus. We report two changing-look candidates, MARK 273 and NGC 7319. A constant reflection component located far away from the nucleus plus a variable nuclear continuum are able to explain most of our results. Within this scenario, the Compton-thick candidates are dominated by reflection, which suppresses their continuum, making them seem fainter, and they do not show variations (except MARK 3), while the Compton-thin and changing-look candidates do.

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Evidence for two spatially separated UV continuum emitting regions in the Cloverleaf broad absorption line quasar

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Testing the standard Shakura-Sunyaev model of accretion is a challenging task because the central region of quasars where accretion takes place is unresolved with telescopes. The analysis of microlensing in gravitationally lensed quasars is one of the few techniques that can test this model, yielding to the measurement of the size and of temperature profile of the accretion disc. We present spectroscopic observations of the gravitationally lensed broad absorption line quasar H1413+117, which reveal partial microlensing of the continuum emission that appears to originate from two separated regions: a microlensed region, corresponding the compact accretion disc; and a non-microlensed region, more extended and contributing to at least 30% of the total UV-continuum flux. Because this extended continuum is occulted by the broad absorption line clouds, it is not associated with the host galaxy, but rather with light scattered in the neighbourhood of the central engine. We measure the amplitude of microlensing of the compact continuum over the rest-frame wavelength range 1000-7000 Å. Following a Bayesian scheme, we confront our measurements to microlensing simulations of an accretion disc with a temperature varying as $T \propto R^{-1/\nu}$. We find a most likely source half-light radius of $R_{1/2} = 0.61 \times 10^{16}$ cm (i.e., 0.002 pc) at 0.18 μm, and a most-likely index of $\nu = 0.4$. The standard disc ($\nu = 4/3$) model is not ruled out by our data, and is found within the 95% confidence interval associated with our measurements. We demonstrate that, for H1413+117, the existence of an extended continuum in addition to the disc emission only has a small impact on the inferred disc parameters, and is unlikely to solve the tension between the microlensing source size and standard disc sizes, as previously reported in the literature.

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Simulations of the OzDES AGN Reverberation Mapping Project

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As part of the OzDES spectroscopic survey we are carrying out a large scale reverberation mapping study of ~500 quasars over five years in the 30 deg^2 area of the Dark Energy Survey (DES) supernova fields. These quasars have redshifts ranging up to 4 and have apparent AB magnitudes between $16.8 < r < 22.5$ mag. The aim of the survey is to measure time lags between fluctuations in the quasar continuum and broad emission line fluxes of individual objects in order to measure black hole masses for a broad range of AGN and constrain the radius-luminosity ($R-L$) relationship. Here we investigate the expected efficiency of the OzDES reverberation mapping campaign and its possible extensions. We expect to recover lags for ~35-45% of the quasars. AGN with shorter lags and greater variability are more likely to yield a lag, and objects with lags $\lesssim$6 months or ~1 year are expected be recovered the most accurately. The baseline OzDES reverberation mapping campaign is predicted to produce an unbiased measurement of the $R-L$ relationship parameters for Hβ, Mg II λ2798, and C IV λ1549. However, extending the baseline survey by either increasing the spectroscopic cadence, extending the survey season, or improving the emission line flux measurement accuracy will significantly improve the $R-L$ parameter constraints for all broad emission lines.

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Deconstructing the Narrow Line Region of the nearest obscured quasar

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We study the physical and kinematic properties of the narrow line region (NLR) of the nearest obscured quasar MRK 477 (z=0.037), using optical and near-infrared (NIR) spectroscopy. About 100 emission lines are identified in the optical+NIR spectrum (90 in the optical), including several narrow *optical* Fe^+ lines. To our knowledge, this is the first type 2 active galactic nucleus (AGN) with such a detection. The Fe^+ lines can be explained as the natural emission from the NLR photoionized by the AGN. Coronal line emission can only be confirmed in the NIR spectrum.

As in many other AGN, a significant correlation is found between the lines full width at half-maximum and the critical density $\log(n_{\rm crit})$. We propose that it is caused by the outflow. This could be the case in other AGNs.

The nuclear jet-induced ionized outflow has been kinematically isolated in many emission lines covering a broad range of ionization potentials and critical densities. It is concentrated within R ~few×100 pc from the central engine. The outflowing gas is denser ($n \geq$8 000 cm^{-3}) than the ambient non-perturbed gas (n ~400-630 cm^{-3}). This could be due to the compression effect of the jet induced shocks. Alternatively, we propose that the outflow has been triggered by the jet at $R \leq$220 pc (possibly at $\leq$30 pc) and we trace how the impact weakens as it propagates outwards following the radiation-pressure dominated density gradient.

The different kinematic behaviour of [FeII]λ1.644 μm suggests that its emission is enhanced by shocks induced by the nuclear outflow/jet and is preferentially emitted at a different, less reddened spatial location.

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Thesis Abstracts

On the variable nature of low luminosity AGN

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Active Galactic Nuclei (AGN) emit energies of the order of $10^{44} erg\ s^{-1}$ in very compact regions, being one of the most energetic phenomena in the Universe. Nowadays, the most accepted theory is that this phenomena is consequence of accretion of matter onto a super massive black hole.

This thesis is centered on the variability study of the low luminosity AGN (LLAGN), including LINERs (low ionization nuclear emission line regions) and the well known Seyferts. The behaviour of the AGN families are also compared. Whereas Seyfert nuclei were discovered in 1943 and are characterized because their nuclei produce high ionized spectral emission lines, it was not until 1980 that Heckman discovered LINERs and classified them as a subclass of AGN, whose optical spectra present a lower ionization state than Seyferts.

The study of AGN in X-rays is ideal because the nucleus is accessible in this frequency range and the obscuration effect is much smaller compared to the ultraviolet (UV), optical or near-infrared. That is why the data presented in this thesis are mainly in X-rays, although complemented with simultaneous information at UV frequencies.

Variability is a property characterizing powerful AGN, which show variations in the whole electromagnetic spectrum, and allows to infer their physical properties. While this is well established for Seyfert galaxies, it is not obvious for LINERs, for which it has been studied only in a small sample of type 1s and a sample at UV frequencies. Moreover, at the beginning of this thesis the physical mechanism that originates variations in this kind of AGN was unknown, being this one of the main objectives of this thesis.

To analyze the X-ray variability, we have developed a methodology which allows the study at short- and long-term variations. The long-term variations are analyzed by fitting all the data with the same model. The short-term variations are studied from the light curves using standard procedures. This allows us to estimate not only flux variations but also spectral variations, that serves to know the variability pattern and at the same time permits to infer the physical properties of these objects. For this study archival data from *Chandra* and *XMM*–Newton satellites at different dates have been used. Moreover, *XMM*–Newton allows to simultaneously obtain variability information at X-rays and UV frequencies. The methodology is explained in detail in Chapter 2 (see also Hernández-García et al. 2013).

First, the methodology was applied to a sample of 18 LINER nuclei, including type 1 (they are actually type 1.9) and 2 (see Chapter 2). The nuclei were classified as AGN (non-AGN) when a point-like source was observed (or not) in the 4.5–8.0 keV energy band, following the work by González-Martín et al. (2009b). From the entire sample, three LINERs were classified as non-AGN, all of them being *Compton*-thick candidates (i.e., they are obscured by very high column densities, larger than $10^{24} cm^{-2}$), none show variations in X-rays and two of them vary at UV. None of the nuclei show short-term variations (between hours and days), whereas more than a half of the AGN candidates show long-term variations (between months and years). These variations are mainly related to intrinsic changes of the sources, while only one galaxy shows column density variations – what would be directly related with changes in the density of the dusty torus or the broad line region (BLR). The study in the UV shows that this type of galaxies are variable at UV frequencies. Therefore, it is found that LINERs are variable objects both at X-rays and UV frequencies. Furthermore, according to their black hole masses, accretion rates, and variability timescales, we find that LINERs follow the same variability plane ($M_{BH} - L_{bol} - T_B$) as more powerful AGN in X-rays. We have also studied the accretion mechanism from the relation between the spectral index and the Eddington rate, where an anticorrelation is given, indicating that accretion could be inefficient (compared to the efficient accretion obtained for more powerful sources). The results derived from this study have been published in Hernández-García et al. (2014).

The same methodology was applied to a sample of 26 Seyfert 2s (Chapter 3). None of the nuclei show short-term variations. In this case, and additional analysis was performed to select *Compton*-thick candidates because, since these galaxies are observed through the dusty torus, we expect a fraction of them being highly obscured. We find that 12 sources are *Compton*-thick candidates. Among the *Compton*-thick candidates, only one shows long-term variations; the most reasonable explanation is that part of the continuum is still transmitted and thus we can observe variations. Among the remaining nuclei we find that

most of them are variable in timescales between months and years, the variability pattern being very similar to that found for LINERs: intrinsic changes of the energy source. Variations related to the column density were found only in four sources (30%). Finally, in contrast to that found for LINERs, none of the galaxies show variations at UV frequencies. The results of this study have been published in Hernández-García et al. (2015).

Therefore, the X-ray variability study in LLAGN shows that both AGN families are variable in timescales ranging from months to years, with amplitudes between 20% and 80% and a common variability pattern among them. At UV, in contrast, the variability study shows that LINERs are variable, but Seyfert 2s do not show changes at these frequencies, with the nucleus detected only in three cases. The fact that the nucleus varies in this frequency range might be because the dusty torus disappeared in LINERs, leaving the core uncovered, giving place to the observed variations. The work undertaken in this thesis shows that LINERs and Seyfert 2s spectrally behave similarly at X-ray frequencies. However, the analyzed Eddington ratios are consistent with different accretion mechanisms, which is efficient for Seyferts and inefficient for LINERs. This study is presented in Chapter 4.

This thesis is complemented by two chapters related to nuclear activity and the X-ray emission in extragalactic objects (Chapters 5 and 6). The first is a study about AGN in groups and clusters of galaxies using *XMM*–Newton and *Chandra* data, which includes the determination of the number of AGN on each cluster. We find from one to five AGN per galaxy cluster. The second is a study on the variability of ultraluminous X-ray sources (ULXs) using *XMM*–Newton data and applying Fourier techniques. We estimate non-linear variability of the ULX, which occurs in the same way as in black holes of different masses, and time lags that variations generate between two different energy bands.