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

# From the Editor

The Active Galaxies Newsletter is produced monthly. The deadline for contributions is the last friday of the month. 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 as editor of the newsletter I am very interested to hear any suggestions or feedback regarding the newsletter. So do not hesitate in emailing me your suggestions.

Many thanks for your continued subscription.

Rob Beswick

# Abstracts of recently accepted papers

## The Hard X-ray Spectrum as a Probe for Black-Hole Growth in Radio-Quiet Active Galactic Nuclei

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We study the hard-X-ray spectral properties of ten highly luminous radio-quiet (RQ) active galactic nuclei (AGNs) at $z = 1.3 - 3.2$, including new *XMM-Newton* observations of four of these sources. We find a significant correlation between the normalized accretion rate ($L/L_{\rm Edd}$) and the hard-X-ray photon index ($\Gamma$) for 35 moderate–high luminosity RQ AGNs including our ten highly luminous sources. Within the limits of our sample, we show that a measurement of $\Gamma$ and $L_{\rm X}$ can provide an estimate of $L/L_{\rm Edd}$ and black-hole (BH) mass ($M_{\rm BH}$) with a mean uncertainty of a factor of $\lesssim$3 on the predicted values of these properties. This may provide a useful probe for tracing the history of BH growth in the Universe, utilizing samples of X-ray-selected AGNs for which $L/L_{\rm Edd}$ and $M_{\rm BH}$ have not yet been determined systematically. It may prove to be a useful way to probe BH growth in distant Compton-thin type 2 AGNs. We also find that the optical–X-ray spectral slope ($\alpha_{\rm ox}$) depends primarily on optical–UV luminosity rather than on $L/L_{\rm Edd}$ in a sample of RQ AGNs spanning five orders of magnitude in luminosity and over two orders of magnitude in $L/L_{\rm Edd}$. We detect a significant Compton-reflection continuum in two of our highly luminous sources, and in the stacked X-ray spectrum of seven other sources with similar luminosities, we obtain a mean relative Compton reflection of $R = 0.9^{+0.6}_{-0.5}$ and an upper limit on the rest-frame equivalent width of a neutral Fe K$\alpha$ line of 105 eV. We do not detect a significant steepening of the X-ray power-law spectrum below rest-frame 2 keV in any of our highly

luminous sources, suggesting that a soft-excess feature, commonly observed in local AGNs, either does not depend strongly on $L/L_{\rm Edd}$, or is not accessible at high redshifts using current X-ray detectors. None of our highly luminous sources displays X-ray flux variations on timescales of $\sim$1 hr, supporting the idea that the timescale of X-ray variability depends inversely on $M_{\rm BH}$ and does not depend on $L/L_{\rm Edd}$.

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preprint available at http://arxiv.org/abs/0804.0803

## Long-Term Variability in the Optical Spectrum of the Seyfert Galaxy NGC 2992

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New spectra of NGC 2992 from the Cerro Tololo Inter-American Observatory show that this nearby AGN has changed its type classification to a Seyfert 2 in 2006. It was originally classified as a Seyfert 1.9, and has been previously seen as a Seyfert 1.5 with strong broad H$\alpha$ emission. A comparison of the reddening and equivalent hydrogen column density derived for the narrow-line region from these new data with those previously calculated for different regions closer to the nucleus shows them to be very similar, and suggests that these different regions are all being absorbed by the same opacity source, a large 100-pc scale dust lane running across the nucleus. However, obscuration by dust in this lane is probably not responsible for classification changes which occur in only a few years. It is more likely that NGC 2992's observed variations are due to a highly variable ionizing continuum. We therefore conclude that, although NGC 2992 was originally identified as a Seyfert 1.9, this was not because of an oblique viewing angle through the atmosphere of a central dusty torus, but because its active nucleus was identified when it was in a low continuum state.

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## The AMIGA sample of isolated galaxies. VII. Far-infrared and radio continuum study of nuclear activity

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CONTEXT. This paper is part of a series involving the AMIGA project (Analysis of the Interstellar Medium of Isolated GAlaxies). This project provides a statistically-significant sample of the most isolated galaxies in the northern sky.

AIMS. We present a study of the nuclear activity in a well-defined sample of the most isolated galaxies (total sample: n = 1050, complete subsample: n = 719) in the local Universe traced by their far-infrared (FIR) and radio continuum emission.

METHODS. We use the well-known radio continuum-FIR correlation to select radio-excess galaxies that are candidates to host an active galactic nucleus (AGN), as well as the FIR colours to find obscured AGN-candidates. We also used the existing information on nuclear activity in the Véron-Cetty catalogue and in the NASA Extragalactic Database.

RESULTS. A final catalogue of AGN-candidate galaxies has been produced that will provide a baseline for studies on the dependence of activity on the environment. Our sample is mostly radio quiet, consistent with its high content of late-type galaxies. At most $\sim$ 1.5% of the galaxies show a radio excess with respect to the radio-FIR correlation, and this fraction even goes down to less than 0.8% after rejection of back/foreground sources using FIRST. We find that the fraction of FIR colour selected AGN-candidates is $\sim$ 28% with a lower limit of $\sim$ 7% Our final catalogue contains 89 AGN candidates and is publicly available on the AMIGA web page (http://www.iaa.csic.es/AMIGA.html). A comparison with the results from the literature shows that the AMIGA sample has the lowest ratio of AGN candidates, both globally and separated into early and late types. Field galaxies as well as poor cluster and group environments show intermediate values, while the highest rates of AGN candidates are found in the central parts of clusters and in pair/merger dominated samples. For all environments, early-type galaxies show a higher ratio of radio-excess galaxies than late types, as can be expected, since massive elliptical

galaxies are the usual hosts of powerful radio continuum emission.

CONCLUSIONS. We conclude that the environment plays a crucial and direct role in triggering radio nuclear activity and not only via the density-morphology relation. Isolated, early-type galaxies show a particularly low level of activity at radio wavelengths hence constituting the most nurture-free population of luminous early-type galaxies.

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preprint available at http://arxiv.org/abs/0803.0335 and http://amiga.iaa.csic.es:8080/p/6-amiga-papers.htm

## Long-term variability of the optical spectra of NGC 4151: I. Light curves and flux correlations

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Results of a long-term spectral monitoring of the active galactic nucleus of NGC 4151 are presented (11 years, from 1996 to 2006). High quality spectra (S/N$>50$ in the continuum near H$\alpha$ and H$\beta$) were obtained in the spectral range $\sim 4000$ to 7500 Å, with a resolution between 5 and 15 Å, using the 6-m and the 1-m SAO's telescopes (Russia), the GHAO's 2.1-m telescope (Cananea, México), and the OAN-SPM's 2.1-m telescope (San-Pedro, México). The observed fluxes of the H$\alpha$, H$\beta$, H$\gamma$ and HeII$\lambda$4686 emission lines and of the continuum at the observed wavelength 5117Å, were corrected for the position angle, the seeing and the aperture effects.

We found that the continuum and line fluxes varied strongly (up to a factor 6) during the monitoring period. The emission was maximum in 1996-1998, and there were two minima, in 2001 and in 2005. As a consequence, the spectral type of the nucleus changed from a Sy1.5 in the maximum activity state to a Sy1.8 in the minimum state. The H$\alpha$, H$\gamma$ and He$\lambda$4686 fluxes were well correlated with the H$\beta$ flux. The line profiles were strongly variable, showing changes of the blue and red asymmetry. The flux ratios of the blue/red wings and of the blue (or red) wing/core of H$\alpha$ and H$\beta$ varied differently. We considered three characteristic periods during which the H$\beta$ and H$\alpha$ profiles were similar: 1996-1999, 2000-2001 and 2002-2006. The line to continuum flux ratios were different; in particular during the first period (1996-2001), the lines were not correlated with the continuum and saturated at high fluxes. In the third period (2002-2006), the H$\alpha$ and H$\beta$ fluxes were well correlated to the continuum flux, meaning that the ionizing continuum was a good extrapolation of the optical continuum. We thus consider that the values of the time lags – line lagging continuum ($0.81^{+1.55}_{-0.81}$ **days** for H$\alpha$ and $0.81^{+2.19}_{-0.81}$ **days** for H$\beta$) for the third period give a more realistic estimation of the dimension of the BLR than during the other periods. Moreover, the time lags obtained by binning intervals of three years within the whole monitoring period indicate the permanent presence of a small component of the BLR (0.3-0.7 light days)

We discuss the different responses of H$\beta$ and H$\alpha$ to the continuum during the monitoring period.

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## XMM-Newton observation of 2MASS 1049+5837

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Chandra observations of the type 1.8, low redshift (z=0.115) red ($J-K_S \sim 2$) quasar 2MASSJ 104943+583750 (2M1049+5837) indicated an unusually hard X-ray spectrum (HR$\sim$0.6), suggesting obscuration of $N_H \sim 4 \times 10^{22}$ cm$^{-2}$ and a flat $\Gamma \sim 0.4$ power law slope. A higher signal-to-noise *XMM-Newton* observation reported here reveals a more complex spectrum, being extremely hard above $\sim$2 keV, $\Gamma \sim -0.6$, with a well defined soft excess similar to the bright, nearby Seyfert 2 galaxy Mkn. Such extremely hard quasar spectra cannot be a dominant contributor to the Cosmic X-ray Background (CXRB, $\Gamma \sim 1.4$).

Modelling of 2M1049+5837 shows the observed 2−10 keV spectrum to be the sum of a strongly absorbed 'normal' $\Gamma \sim 1.8$ underlying quasar X-ray continuum, and a strong, cold reflection component (R$\sim$ 2). The strong attenuation of the intrinsic X-ray continuum by a sub-Compton-thick line-of-sight column, $N_H \sim 3.4 \times 10^{23}$ cm$^{-2}$, reveals a soft X-ray emission component whose spectrum indicates reprocessing/emission from, possibly extended, photoionized gas. The luminosity of the soft X-ray component is similar to Seyfert 2 galaxies, an order of magnitude less than comparable type 1 AGN, suggesting partial obscuration of core-bright emission.

The optical emission is complex with distinct red and blue scattered light components believed to originate in two extended regions visible in HST imaging data. The unusual combination of properties: optical and X-ray obscuration of the nuclear emission, partially obscured broad but unobscured narrow emission lines and partially obscured soft X-ray excess, implies an intermediate viewing angle, over or through the edge of an obscuring disk+wind or torus. 2M1049+5837 again demonstrates both the ambiguity of low signal-to-noise X-ray spectra/hardness ratios and the potential of 2MASS-selected red sources for exploring the complex obscuration and geometry of the nuclear regions in AGN.

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## New Indicators for AGN Power: The Correlation Between [O IV] $\lambda 25.89\mu$m and Hard X-ray Luminosity for Nearby Seyfert Galaxies

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**We have studied the relationship between the [O IV] $\lambda 25.89\mu$m emission line luminosities, obtained from *Spitzer* spectra, the X-ray continua in the 2-10 keV band, primarily from *ASCA*, and the 14-195 keV band obtained with the *SWIFT*/Burst Alert Telescope (BAT), for a sample of nearby (z < 0.08) Seyfert galaxies. For comparison, we have examined the relationship between the [O III] $\lambda$5007, the 2-10 keV and the 14-195 keV luminosities for the same set of objects. We find that both the [O IV] and [O III] luminosities are well-correlated with the BAT luminosities. On the other hand, the [O III] luminosities are better-correlated with 2-10 keV luminosities than are those of [O IV]. When comparing [O IV] and [O III] luminosities for the different types of galaxies, we find that the Seyfert 2's have significantly lower [O III] to [O IV] ratios than the Seyfert 1's. We suggest that this is due to more reddening of the narrow line region (NLR) of the Seyfert 2's. Assuming Galactic dust to gas ratios, the average amount of extra reddening corresponds to a hydrogen column density of $\sim$ few times $10^{21}$cm$^{-2}$, which is a small fraction of the X-ray absorbing columns in the Seyfert 2's. The combined effects of reddening and the X-ray absorption are the probable reason why the [O III] versus 2-10 keV correlation is better than the [O IV] versus 2-10 keV, since the [O IV] $\lambda 25.89\mu$m emission line is much less affected by extinction. We present a grid of photoionization models used to calculate the physical conditions present in the [O IV] region. We find that the [O IV] comes from higher ionization states and lower density regions than previous studies had determined for [O III]. Overall, we find the [O IV] to be an accurate and truly isotropic**

indicator of the power of the AGN. This suggests that it can be useful in deconvolving the contribution of the AGN and starburst to the spectrum of Compton-thick and/or X-ray weak sources.

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## The properties of powerful radio sources at 90 GHz

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We have observed a small sample of powerful double radio sources (radio galaxies and quasars) at frequencies around 90 GHz with the BIMA millimetre array, with the intention of constraining the resolved high-frequency spectra of radio galaxies. When combined with other sources we have previously observed and with data from the BIMA archive, these observations allow us for the first time to make general statements about the high-frequency behaviour of compact components of radio galaxies – cores, jets and hotspots. We find that cores in our sample remain flat-spectrum up to 90 GHz; jets in some of our targets are detected at 90 GHz for the first time in our new observations; and hotspots are found to be almost universal, but show a wide range of spectral properties. Emission from the extended lobes of radio galaxies is detected in a few cases and shows rough consistency with the expectations from standard spectral ageing models, though our ability to probe this in detail is limited by the sensitivity of BIMA. We briefly discuss the prospects for radio-galaxy astrophysics with ALMA.

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## The warm absorber in NGC 5548: The lean years

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We study the variability of the warm absorber and the gas responsible for the emission lines in the Seyfert 1 galaxy NGC 5548, in order to constrain the location and physical properties of these components. Using X-ray spectra taken with the *Chandra*−LETGS in 2002 and 2005, we study variability in the ionic column densities and line intensities. We find a lower [O VII] forbidden emission line flux in 2005, while the Fe K$\alpha$ line flux stays constant. The warm absorber is less ionized in 2005, allowing us to constrain its location to within 7 pc of the central source. Using both the observed variability and the limit on the FWHM of the [O VII] f line, we have constrained the location of the narrow line region to a distance of 1 pc from the central source. The apparent lack of variability of the Fe K$\alpha$ line flux does not allow for a unique explanation.

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# A Radio Study of the Starburst Galaxy, M82

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**Ph.D dissertation directed by: Prof. Alan Pedlar**

**Ph.D degree awarded: Dec. 2007**

**Radio observations of the prototypical starburst galaxy, M82, are presented. These provide the most sensitive, high-resolution observations of the discrete supernova remnants and HII regions in the central starburst to date. In addition, the first ever Global VLBI and MERLIN data combination has produced images of the detailed structure of the compact sources at 1.6 GHz.**

**MERLIN 5 GHz observations made over a period of 8 days have provided extremely sensitive images of the discrete sources within the M82 starburst with an rms noise level of $\sim$17$\mu$Jy beam$^{-1}$. In total 55 of the sources within M82 have been imaged with resolutions of $35-50$ mas. This has enabled direct comparison with previous MERLIN 5 GHz observations from 1992. As a result, expansion velocities have been measured for ten supernova remnants with values ranging from 1500 to 10500 km s$^{-1}$.**

**Global VLBI observations at a frequency of 1.6 GHz were performed using sixteen antennas across Europe and America. The combination of these observations with MERLIN 1.6 GHz data has provided the first ever Global VLBI and MERLIN combined image of M82 at this frequency. These data have been used to study the supernova remnants and HII regions using resolutions ranging from $20-130$ milliarcseconds.**

**Both the MERLIN 5 GHz and combined Global VLBI and MERLIN 1.6 GHz observations have been used to study the supernova remnant population, including measurement of the supernova rate and the star formation rate within M82.**

**The 1.6 GHz Global VLBI data form the most recent epoch of observations used to study the evolution of the most compact sources within M82. Comparison of this and previous epochs covering a 19 year timeline has enabled confirmation of the expansion of the SNR 43.31+59.2, with a velocity of $\sim$8000 km s$-1$, and study of the source 41.95+57.5, showing it to be unique of the sources observed within this galaxy.**

# Constraining the AGN Contribution in a Multiwavelength Study of Seyfert Galaxies

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**Ph.D degree awarded: May 2008**

**We have studied the relationship between high- and low-ionization mid-infrared emission lines with the aim of constraining the active galactic nuclei (AGN) and star formation contributions for a sample of 100 Seyfert galaxies. We investigated the correlation between the [O IV] $\lambda$25.89 $\mu$m emission line luminosities, obtained from *Spitzer* spectra, with the X-ray continua in the 14-195 keV band, obtained with the *SWIFT*/Burst Alert Telescope (BAT). We find the [O IV] to be an accurate and truly isotropic indicator of the power of the AGN. Consequently, we used the [O IV] to deconvolve the contributions of the AGN and star formation in the low-ionization [Ne II] $\lambda$12.81 $\mu$m emission line, and mid- and far-infrared continuum luminosities of Seyfert 1 and Seyfert 2 galaxies. We investigated the ionization state of the emission-line gas in Seyfert galaxies using the [O IV]/[Ne II] emission ratio. We find that Seyfert 2 galaxies have, on average, lower ratios than those of Seyfert 1 galaxies. This result suggests two possible scenarios: 1) Seyfert 2 galaxies have intrinsically weaker AGN, or 2) Seyfert 2 galaxies have relatively higher star formation rates than Seyfert 1 galaxies. Although we cannot dismiss the former, we find that Seyfert 1 and Seyfert 2 galaxies have similar luminosity distributions. Using [Ne II] as a tracer of star formation we find a higher average star formation rate for Seyfert 2 galaxies, $7.7 \pm 0.3 M_{\odot}$ yr$^{-1}$, than for Seyfert 1 galaxies, $5.0 \pm 0.4 M_{\odot}$ yr$^{-1}$. For comparison, we examined the mid- and far-infrared continua and find that Seyfert 1 and Seyfert 2 galaxies are dominated by hot dust and cool dust components, respectively. Overall, these results test the unified model of AGN, and suggest that the differences between Seyfert galaxies cannot be solely due to viewing angle dependence.**