Active Galaxies Newsletter	*An electronic publication dedicated to the observation and theory of active galaxies*
No. 83 — February 2004	Editor: Rob Beswick (rb@ast.man.ac.uk)

Abstracts - Thesis Abstracts - Jobs - Meetings

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.
Rob Beswick

Abstracts of recently accepted papers

I Zw 1 observed with *XMM-Newton*: Low-energy spectral complexity, iron lines, and hard X-ray flares

L. C. Gallo[1], Th. Boller[1], W. N. Brandt[2], A. C. Fabian[3], and S. Vaughan[4]

[1] Max-Planck-Institut für extraterrestrische Physik, Postfach 1312, 85741 Garching, Germany
[2] Department of Astronomy and Astrophysics, The Pennsylvania State University, 525 Davey Lab, University Park, PA 16802, USA
[3] Institute of Astronomy, Madingley Road, Cambridge CB3 0HA, UK
[4] X-ray and Observational Astronomy Group, Department of Physics and Astronomy, University of Leicester, Leicester LE1 7RH, UK

We present a 20 ks *XMM-Newton* observation of the prototypical Narrow-Line Seyfert 1 galaxy I Zw 1. The best-fit model to the data is a double blackbody plus a dominant power-law, on which complex soft absorption (possibly a blended edge or absorption lines) and/or OVII emission are superimposed, as well as strong Fe Kα emission. The iron feature in the high-energy spectra appears broad; however, on close examination of the EPIC pn data, there exists the possibility that the broad emission feature can be attributed to a neutral Fe Kα line in addition to a blend of He- and H-like Fe Kα lines. The light curve shows a strong, hard X-ray flare concentrated in the 3–12 keV band. The flare appears to induce spectral variability, showing spectral hardening to be occuring as the flare intensifies. A detailed examination suggests that the spectral variability is most likely due to an increase in the 3–12 keV flux relative to the soft flux during the flare. A difference spectrum and complete modelling of the flare and non-flare spectra show intrinsic changes only in the normalisation of the continuum components and not in their shape parameters. The timing results are consistent with the flare originating in the accretion disc corona. The iron emission line(s) do not appear to respond to changes in the continuum flux during the flare; the iron lines are stronger in equivalent width during the low-flux (non-flare) states, and weaker during the flare.

Accepted by A&A, 3 Dec 2003

E-mail contact: lgallo@mpe.mpg.de
preprint available at http://xxx.lanl.gov/abs/astro-ph/0312298

A Complete Sample of Soft X-ray Selected AGN: II. Statistical Analysis

Dirk Grupe[1]

[1] Astronomy Department, The Ohio State University, 140 W. 18th Av., Columbus, OH 43210, USA

Direct correlations and a Principal Component Analysis (PCA) are presented for a complete sample of 110 soft X-ray selected AGN of which about half are Narrow-Line Seyfert 1 galaxies (NLS1s). The direct correlation analyses show that narrower FWHM(Hβ) correlates with steeper X-ray spectrum, stronger optical FeII emission, weaker [OIII] emission and stronger short-term X-ray variability. This direct correlation analysis and the PCA confirm the Boroson & Green (1992) Eigenvector 1 relationship for AGN: FeII strength anti-correlates with [OIII] line strength. Eigenvector 1 is well-correlated with the Eddington luminosity ratio $L/L_{\rm Edd}$ while Eigenvector 2 shows a very good correlation with the mass of the central black hole $M_{\rm BH}$ and the mass accretion rate $\dot{M}$. The Eddington ratio $L/L_{\rm Edd}$ correlates with the X-ray spectral index $\alpha_{\rm X}$ and the black home mass $M_{\rm BH}$ anti-correlates with the X-ray variability χ^2/ν. The Eddington ration $L/L_{\rm Edd}$ may be interpreted as the age of an AGN: AGN with steep X-ray spectra, strong FeII, and weak [OIII] are AGN in an early phase of their evolution. In this hypothesis NLS1s are young AGN.

Accepted for publictation in AJ (April 2004)

E-mail contact: dgrupe@astronomy.ohio-state.edu, preprint available at http://arxiv.org/abs/astro-ph/0401167

Black-Hole Mass Measurements

M. Vestergaard[1,2]

[1] Department of Astronomy, The Ohio State University, 140 West 18th Avenue, Columbus, OH 43210
[2] Steward Observatory, University of Arizona, 933 N. Cherry Avenue, Tucson, AZ 85721

The applicability and apparent uncertainties of the techniques currently available for measuring or estimating black-hole masses in AGNs are briefly summarized.

Invited review, AGN Physics with the Sloan Digital Sky Survey, eds G. Richards & P. Hall (ASP Conf. Ser., 2004)

E-mail contact: mvestergaard@as.arizona.edu, preprint available at http://arxiv.org/abs/astro-ph/0401436

Evidence for Early or Efficient Black-Hole Growth

M. Vestergaard[1,2]

[1] Department of Astronomy, The Ohio State University, 140 West 18th Avenue, Columbus, OH 43210
[2] Steward Observatory, University of Arizona, 933 N. Cherry Avenue, Tucson, AZ 85721

Mass estimates, based on scaling relationships, are presented of central black holes in luminous quasars at a range of redshifts ($z < 0.5$, $1.2 \lesssim z \lesssim 6.3$). The data show that very massive ($\gtrsim 10^9 M_\odot$) black holes appear already at $z \approx 6$, indicating that they form very early or very fast.

Contribution to proceedings of the 'AGN Physics with the Sloan Digital Sky Survey' conference (July 2003), eds G. Richards & P. Hall (ASP Conf. Ser., 2004)

E-mail contact: mvestergaard@as.arizona.edu, preprint available at http://arxiv.org/abs/astro-ph/0401430

Multiwavelength scaling relations for nuclei of Seyfert galaxies

M. Salvato[1], **J. Greiner**[1] **and B. Kuhlbrodt**[1]

[1] Max Planck Institute for Extragalactic Physics, Giessenbachstrasse 1, 85478 Garching, Germany
[2] Hamburg Observatory, Gojenbergsweg 112, 21029 Hamburg, Germany

We analyze an X-ray flux-limited, complete sample of 93 AGN at z<0.1, selected from the ROSAT Bright Survey. Two thirds of the sample are Seyfert 1 galaxies (Sy1) and one third are Narrow-Line Seyfert 1 galaxies (NLSy1). We have obtained optical images of all objects. By modeling the host galaxy and the AGN central component we decompose the optical emission into nuclear, bulge and disk components, respectively. We find that the nuclear optical luminosity, thought to be associated with the accretion disk surrounding the active black hole, correlates with the X-ray luminosity, the radio luminosity and the black hole mass.

ApJL, 2004, 600, L31
E-mail contact: mara@mpe.mpg.de

Black Hole Demography from Nearby Active Galactic Nuclei

Luis C. Ho[1]

[1] The Observatories of the Carnegie Institution of Washington, 813 Santa Barbara St., Pasadena, CA 91101

A significant fraction of local galaxies show evidence of nuclear activity. I argue that the bulk of this activity, while energetically not remarkable, derives from accretion onto a central massive black hole. The statistics of nearby active galactic nuclei thus provide an effective probe of black hole demography. Consistent with the picture emerging from direct dynamical studies, the local census of nuclear activity strongly suggests that most, perhaps all, galaxies with a significant bulge component contain a central massive black hole. Although late-type galaxies appear to be generally deficient in nuclear black holes, there are important exceptions to this rule. I highlight two examples of dwarf, late-type galaxies that contain active nuclei powered by intermediate-mass black holes.

To appear in *Carnegie Observatories Astrophysics Series, Vol. 1: Coevolution of Black Holes and Galaxies*, ed. L. C. Ho (Cambridge: Cambridge Univ. Press), 2004, in press.

E-mail contact: lho@ociw.edu,
preprint available at http://xxx.lanl.gov/abs/astro-ph/0401527

What Can We Learn from Nearby AGNs?

Luis C. Ho[1]

[1] The Observatories of the Carnegie Institution of Washington, 813 Santa Barbara St., Pasadena, CA 91101

This contribution reviews the properties of nuclear activity in nearby galaxies, with emphasis on their implications for the demography of nuclear black holes and the nature of accretion flows in the regime of very low accretion rates.

To appear in *Multiwavelength AGN Surveys*, ed. R. Maiolino and R. Mujica (Singapore: World Scientific), 2004.

E-mail contact: lho@ociw.edu,
preprint available at http://xxx.lanl.gov/abs/astro-ph/0401528

The Stellar Populations of Low Luminosity Active Galactic Nuclei. I: Ground Based Observations

Roberto Cid Fernandes[1], **Rosa M. González Delgado,**[2], **Henrique Schmitt**[3], **Thaisa Storchi-Bergmann**[4], **Lucimara P. Martins**[5], **Enrique Pérez**[2], **Timothy Heckman**[6], **Claus Leitherer**[5], **and Daniel Schaerer**[7]

[1] Depto. de Física-CFM, Universidade Federal de Santa Catarina, C.P. 476, 88040-900, Florianópolis, SC, Brazil (cid@astro.ufsc.br)
[2] Instituto de Astrofísica de Andalucia (CSIC), P.O. Box 3004, 18080 Granada, Spain (rosa@iaa.es; eperez@iaa.es)
[3] National Radio Astronomy Observatory, PO Box 0, Socorro, NM 87801 (hschmitt@nrao.edu)
[4] Instituto de Física, Universidad Federal do Rio Grande do Sul, C.P. 15001, 91501-970, Poto Alegre, RS, Brazil (thaisa@if.ufrgs.br)
[5] Space Telescope Institute, 3700 San Martin Drive, Baltimore, MD 21218, USA (martins@stsci.edu; leitherer@stsci.edu)
[6] Department of Physics & Astronomy, JHU, Baltimore, MD 21218 (heckman@pha.jhu.edu)
[7] Observatoire de Geneve, 51, Ch. des Maillettes, CH-1290 Sauverny, Switzerland

We present a spectroscopic study of the stellar populations of Low Luminosity Active Galactic Nuclei (LLAGN). Our main goal is to determine whether the stars who live in the innermost (100 pc-scale) regions of these galaxies are in some way related to the emission line properties, which would imply a link between the stellar population and the ionization mechanism. High signal to noise, ground based long-slit spectra in the 3500–5500 Å interval were collected for 60 galaxies: 51 LINERs and LINER/HII Transition Objects, 2 Starburst and 7 non-active galaxies. In this paper, first of a series, we (1) describe the sample; (2) present the nuclear spectra; (3) characterize the stellar populations of LLAGN by means of an empirical comparison with normal galaxies; (4) measure a set of spectral indices, including several absorption line equivalent widths and colors indicative of stellar populations; (5) correlate the stellar indices with emission line ratios which may distinguish between possible excitation sources for the gas.

Our main findings are: (1) Few LLAGN have a detectable young ($\leq 10^7$ yr) starburst component, indicating that very massive stars do not contribute significantly to the optical continuum. In particular, no features due to Wolf-Rayet stars were convincingly detected. (2) High Order Balmer absorption lines of HI (HOBLs), on the other hand, are detected in $\sim 40\%$ of LLAGN. These features, which are strongest in 10^8–10^9 yr intermediate age stellar populations, are accompanied by diluted metal absorption lines and bluer colors than other objects in the sample. (3) These intermediate age populations are very common ($\sim 50\%$) in LLAGN with relatively weak [OI] emission ([OI]/H$\alpha \leq 0.25$), but rare ($\sim 10\%$) in LLAGN with stronger [OI]. This is intriguing since LLAGN with weak [OI] have been previously hypothesized to be "transition objects" in which both an AGN and young stars contribute to the emission-line excitation. Massive stars, if present, are completely outshone by intermediate age and old

stars in the optical. This happens in at least a couple of objects where independent UV spectroscopy detects young starbursts not seen in the optical. (4) Objects with predominantly old stars span the whole range of [OI]/Hα values, but (5) sources with significant young and/or intermediate age populations are nearly all ($\sim 90\%$) weak [OI] emitters.

These new findings suggest a link between the stellar populations and the gas ionization mechanism. The strong-[OI] objects are most likely true LLAGN, with stellar processes being insignificant. However, the weak-[OI] objects may comprise two populations, one where the ionization is dominated by stellar processes and another where it is either governed by an AGN or by a more even mixture of stellar and AGN processes. Possible stellar sources for the ionization include weak starbursts, supernova-remnants and evolved post-starburst populations. These scenarios are examined and constrained by means of complementary observations and detailed modeling of the stellar populations in forthcoming communications.

Accepted by ApJ

E-mail contact: rosa@iaa.es,
preprint available at http://www.iaa.csic.es/∼rosa/preprints/preprints.html

The Stellar Populations of Low Luminosity Active Galactic Nuclei. II: STIS Observations

Rosa M. González Delgado,[1], Roberto Cid Fernandes[2] Enrique Pérez[2], Lucimara P. Martins[5], Thaisa Storchi-Bergmann[4], Henrique Schmitt[3], Timothy Heckman[6], and Claus Leitherer[5]

[1] Instituto de Astrofísica de Andalucia (CSIC), P.O. Box 3004, 18080 Granada, Spain (rosa@iaa.es; eperez@iaa.es)
[2] Depto. de Física-CFM, Universidade Federal de Santa Catarina, C.P. 476, 88040-900, Florianópolis, SC, Brazil (cid@astro.ufsc.br)
[3] National Radio Astronomy Observatory, PO Box 0, Socorro, NM 87801 (hschmitt@nrao.edu)
[4] Instituto de Física, Universidad Federal do Rio Grande do Sul, C.P. 15001, 91501-970, Poto Alegre, RS, Brazil (thaisa@if.ufrgs.br)
[5] Space Telescope Institute, 3700 San Martin Drive, Baltimore, MD 21218, USA (martins@stsci.edu; leitherer@stsci.edu)
[6] Department of Physics & Astronomy, JHU, Baltimore, MD 21218 (heckman@pha.jhu.edu)

We present a study of the stellar population in Low Luminosity Active Galactic Nuclei (LLAGN). Our goal is to search for spectroscopic signatures of young and intermediate age stars, and to investigate their relationship with the ionization mechanism in LLAGN. The method used is based on the stellar population synthesis of the optical continuum of the innermost (20-100 pc) regions in these galaxies. For this purpose, we have collected high spatial resolution optical (2900-5700 Å) STIS spectra of 28 nearby LLAGN that are available in the *Hubble Space Telescope* archive. The analysis of these data is compared with a similar analysis also presented here for 51 ground-based spectra of LLAGN. Our main findings are: (1) No features due to Wolf-Rayet stars were convincingly detected in the STIS spectra. (2) Young stars contribute very little to the optical continuum in the ground-based aperture. However, the fraction of light provided by these stars is higher than 10% in most of the weak-[OI] ([OI]/H$\alpha \leq 0.25$) LLAGN STIS spectra. (3) Intermediate age stars contribute significantly to the optical continuum of these nuclei. This population is more frequent in objects with weak than with strong [OI]. Weak-[OI] LLAGN that have young stars stand out for their intermediate age population. (4) Most of the strong-[OI] LLAGN have predominantly old stellar population. A few of these objects also show a feature-less continuum that contributes significantly to the optical continuum. These results suggest that young and intermediate age stars do not play a significant role in the ionization of LLAGN with strong [OI]. However, the ionization in weak-[OI] LLAGN with young and/or intermediate age population could be due to stellar processes. A comparison of the properties of these objects with Seyfert 2 galaxies that harbor a nuclear starburst, suggests that weak-[OI] LLAGN are the lower luminosity counterparts of the Seyfert 2 composite nuclei.

Accepted by ApJ

E-mail contact: rosa@iaa.es,
preprint available at http://www.iaa.csic.es/∼rosa/preprints/preprints.html

The complex soft X-ray spectrum of NGC 4151

N.J. Schurch[1*], R.S. Warwick[2], R.E. Griffiths[1], S.M. Kahn[3]

[1]Department of Physics, Carnegie Mellon University, 5000 Forbes Avenue, Pittsburgh, PA 15213
[2]Department of Physics and Astronomy, University of Leicester, University Road, Leicester, LE1 7RH
[3] University of Columbia Astrophysics Laboratory, 550 West 120th Street, New York, 10027

We present a detailed analysis of the complex soft X-ray spectrum of NGC 4151 measured by the RGS instruments aboard *XMM-Newton*. The *XMM-Newton* RGS spectra demonstrate that the soft X-ray emission is extremely rich in X-ray emission lines and radiative recombination continua (RRC), with no clear evidence for any underlying continuum emission. Line emission, and the associated RRC, are clearly detected from hydrogen-like and helium-like ionization states of neon, oxygen, nitrogen and carbon. The measured lines are bl ueshifted with a velocity of between $\sim$100-1000 km s^{-1}, with respect to the systemic

velocity of NGC 4151, approximately consistent with the outflow velocities of the absorption lines observed in the UV spectrum of NGC 4151 (Kriss et al. 1995), suggestive of an origin for the UV and soft X-ray emission in the same material. Plasma diagnostics from the observed helium-like triplets, imply a range of electron temperatures of $\sim$1-5$\times 10^4$ K and electron densities of between 10^8-10^{10} cm^{-3}. The soft X-ray spectrum of NGC 4151 is extremely similar to that of NGC 1068, both in terms of the atomic species present and in terms of the relative strengths of the observed emission lines and RRC (Kinkhabwala et al. 2002), suggesting that the soft X-ray excesses observed in many Seyfert 2 galaxies may be composed of similar emission features. Modelling the RGS spectra in terms of emission from photoionized and photoexcited gas in an ionization cone reproduces all of the hydrogen-like and helium-like emission features observed in the soft X-ray spectrum of NGC 4151 *in detail* and confirms the correspondence between the soft X-ray emission in NGC 4151 and NGC 1068. NGC 4151 shows somewhat lower individual ionic column densities than those measured for NGC 1068 indicating that the material in the ionization cones of NGC 4151 may be somewhat more dense than the material in the ionization cones of NGC 1068.

Accepted for publication by MNRAS

E-mail contact: schurch@andrew.cmu.edu
preprint available at http://xxx.lanl.gov

High Resolution X-ray Spectroscopy of the Fe K complex in IC4329A

Barry McKernan[1], Tahir Yaqoob[2,3]

[1] Dept. of Astronomy, University of Maryland, College Park, MD 20742
[2] Dept. of Physics & Astronomy, Johns Hopkins University, Baltimore, MD 21218
[3] Laboratory for High Energy Astrophysics, NASA/Goddard Space Flight Center, Greenbelt, MD 20771

We report the detection of complex Fe K line emission from a *Chandra* High Energy Transmission Grating Spectrometer observation of the Seyfert 1 galaxy IC 4329A. The line emission is double-peaked, one peak centered at ~ 6.3 keV, and the other at ~ 6.9 keV in the source rest frame. When modeled by Gaussians, the lower energy peak is resolved by the HEG at $> 99\%$ confidence, whilst the higher energy peak is resolved at only $< 90\%$ confidence. The best-fitting widths are $\sim 21,000$ km s^{-1} and ~ 4000 km s^{-1} FWHM for the ~ 6.3 keV and ~ 6.9 keV peaks respectively. If the peaks correspond to two distinct emission lines, then the peak energies are redshifted with respect to the expected line energies of Fe I Kα and Fe XXVI Lyα by at least 650 kms^{-1} and 950 km s^{-1} respectively. Alternatively, the Fe K line profile may be due to a single line from a relativistic accretion disk. In that case the inclination angle of the disk is required to be 24^{+9}_{-1} degrees, the outer radius constrained to several tens of gravitational radii, and the radial line emissivity flatter than $r^{-0.7}$. Another possibility is that both peaks are due to distinct lines but each one relativistically broadened by a disk. In that case the lower energy peak could correspond to emission from Fe in a low ionization state, and the high-energy peak to Fe XXVI Lyα emission. Then, the inclination angle is even less, restricted to a few degrees. However, the radial emissivity law is allowed to be steeper ($\sim r^{-2.5}$) and the outer radius does not have to be fine-tuned. Yet another scenario is that the lower energy peak originates in a disk but the higher energy peak originates in more distant matter. The disk inclination angle is then intermediate between the last two cases but the emissivity is again required to be flat. We cannot rule out Fe XXV He-like absorption modifying the observed line profile. However, the data, and inferred emission-line parameters, are insensitive to the presence of a Compton reflection continuum. Including Compton reflection does, however, allow a steeper radial emissivity law for the relativistic line. Future missions such as *Astro-E2* will be able to break a lot of the degeneracy in the physically distinct models that can all account for the *Chandra* data. Since IC 4329A is one of the brightest Seyfert 1 galaxies it should be a good astrophysical laboratory for studying the ionization structure of accretion disks around supermassive black holes.

Accepted by ApJ.

E-mail contact: mckernan@astro.umd.edu