Active Galaxies Newsletter	*An electronic publication dedicated to the observation and theory of active galaxies*
No. 182 — MAY 2012	Editor: Melanie Gendre (agnews@manchester.ac.uk)

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From the Editor

The Active Galaxies Newsletter is produced monthly. The deadline for contributions is the last day 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.

Melanie Gendre

Abstracts of recently accepted papers

Radio spectra and polarisation properties of a bright sample of Radio-Loud Broad Absorption Line Quasars.

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The origin of broad-absorption-line quasars (BAL QSOs) is still an open issue. Accounting for $\sim 20\%$ of the QSO population, these objects present broad absorption lines in their optical spectra generated from outflows with velocities up to 0.2 c. In this work we present the results of a multi-frequency study of a well-defined radio-loud BAL QSO sample, and a comparison sample of radio-loud non-BAL QSOs, both selected from the Sloan Digital Sky Survey (SDSS).
We aim to test which of the currently-popular models for the BAL phenomenon - 'orientation' or 'evolutionary' - best accounts for the radio properties of BAL quasars. We also consider a third model in which BALs are due to polar jets driven by radiation pressure.
Observations from 1.4 to 43 GHz have been obtained with the VLA and Effelsberg telescopes, and data from 74 to 408 MHz have been compiled from the literature. The spectral indices give clues to the orientation of these objects, while the determination

of the peak frequency can constrain their age, and test the evolutionary scenario, in which BAL QSOs are young QSOs. The fractional polarisation and the rotation measure in part reflect the local magnetic field strength and particle density.
The fractions of resolved sources in the BAL and non-BAL QSO samples are similar (16% *vs* 12%). The resolved sources in the two samples have similar linear sizes (20 to 400 kpc) and morphology. There is weak evidence that the fraction of variable sources amongst BAL QSOs is lower. The fractions of candidate GHz-peaked sources are similar in the two samples (36±12% *vs* 23±8%), suggesting that BAL QSOs are not generally younger than non-BAL QSOs. BAL and non-BAL QSOs show a large range of spectral indices, including flat-spectrum and steep-spectrum sources, consistent with a broad range of orientations. There is weak evidence (91% confidence) that the spectral indices of the BAL QSOs are steeper than those of non-BAL QSOs, mildly favouring edge-on orientations. At a higher level of significance ($\geq$97%), the spectra of BAL QSOs are not flatter than those of non-BAL QSOs, which suggests that a polar orientation is not preferred. The distributions of fractional polarisation in the two samples are similar, median values 1-3%. The distributions of rotation measure are also similar, the only outlier being the BAL QSO 1624+37, with an extreme rest-frame Rotation Measure (from the literature) of -18350 ± 570 rad m^{-2}.

Accepted by A&A.

E-mail contact: bruni@ira.inaf.it,
preprint available at arxiv:1203.4509

Observations of Outflowing UV Absorbers in NGC 4051 with the Cosmic Origins Spectrograph

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We present new *Hubble Space Telescope (HST)*/Cosmic Origins Spectrograph observations of the Narrow-Line Seyfert 1 galaxy NGC 4051. These data were obtained as part of a coordinated observing program including X-ray observations with the *Chandra*/High Energy Transmission Grating (HETG) Spectrometer and *Suzaku*. We detected nine kinematic components of UV absorption, which were previously identified using the *HST*/Space Telescope Imaging Spectrograph. None of the absorption components showed evidence for changes in column density or profile within the $\sim$ 10 yr between the STIS and COS observations, which we interpret as evidence of 1) saturation, for the stronger components, or 2) very low densities, i.e., $n_{\mathrm{H}} < 1$ cm^{-3}, for the weaker components. After applying a +200 km s^{-1} offset to the HETG spectrum, we found that the radial velocities of the UV absorbers lay within the O VII profile. Based on photoionization models, we suggest that, while UV components 2, 5 and 7 produce significant O VII absorption, the bulk of the X-ray absorption detected in the HETG analysis occurs in more highly ionized gas. Moreover, the mass loss rate is dominated by high ionization gas which lacks a significant UV footprint.

Accepted by The Astrophysical Journal

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preprint available at arxiv:1204.2258

The 4 Ms Chandra Deep Field-South Number Counts Apportioned by Source Class: Pervasive Active Galactic Nuclei and the Ascent of Normal Galaxies

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We present 0.5–2 keV, 2–8 keV, 4–8 keV, and 0.5–8 keV (hereafter, soft, hard, ultra-hard, and full bands, respectively) cumulative and differential number counts ($\log N$–$\log S$) measurements for the recently completed ≈4 Ms *Chandra* Deep Field-South (CDF-S) survey, the deepest X-ray survey to date. We implement a new Bayesian approach, which allows reliable calculation of number counts down to flux limits that are factors of ≈1.9–4.3 times fainter than the previously deepest number-counts investigations. In the soft band, the most sensitive bandpass in our analysis, the ≈4 Ms CDF-S reaches a maximum source density of ≈27,800 deg^{-2}. By virtue of the exquisite X-ray and multiwavelength data available in the CDF-S, we are able to measure the number counts from a variety of source populations (active galactic nuclei [AGNs], normal galaxies, and Galactic stars) and subpopulations (as a function of redshift, AGN absorption, luminosity, and galaxy morphology), and test models that describe their evolution. We find that AGNs still dominate the X-ray number counts down to the faintest flux levels for all bands and reach a limiting soft-band source density of ≈14,900 deg^{-2}, the highest reliable AGN source density measured at any wavelength. We find that the normal-galaxy counts rise rapidly near the flux limits, and at the limiting soft-band flux, reach source densities of ≈12,700 deg^{-2} and make up 46 ± 5% of the total number counts. The rapid rise of the galaxy counts toward faint fluxes, and significant normal-galaxy contributions to the overall number counts, indicate that normal galaxies will overtake AGNs just below the ≈4 Ms soft-band flux limit and will provide a numerically significant new X-ray source population in future surveys that reach below the ≈4 Ms sensitivity limit. We show that a future ≈10 Ms CDF-S would allow for a significant increase in X-ray detected sources, with many of the new sources being cosmologically distant ($z > 0.6$) normal galaxies.

Accepted by ApJ

E-mail contact: blehmer@pha.jhu.edu,
preprint available at arXiv:1204.1977,
corresponding data are available at http://www2.astro.psu.edu/users/niel/cdfs/cdfs-chandra.html

The Nature of the Compton-thick X-ray Reprocessor in NGC 4945

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We present an exhaustive methodology for fitting Compton-thick X-ray reprocessor models to obscured active galactic nuclei (AGNs) and for interpreting the results. We focus on the MYTORUS model but also include some analysis from other models. The models are applied specifically to *Suzaku*, *BeppoSAX*, and *Swift* BAT spectra of the Seyfert 2 galaxy NGC 4945 but the basic methodology is applicable to other AGNs, including Compton-thin sources. The models overcome a major restriction of disk-reflection models, namely the assumption of an infinite column density. Finite column-density models produce a rich variety of spectral shapes and characteristics that cannot be produced by disk-reflection models, even for Compton-thin AGN with column densities in the range $\sim 10^{23}$–10^{24} cm^{-2}. In the Compton-thick regime we show that even though NGC 4945 is one of the brightest AGNs above 10 keV, there are significant spectral degeneracies that correspond to very different physical scenarios. The models that fit the data span nearly a factor of 3 in column density (~ 2 to 6×10^{24} cm^{-2}) and two orders of magnitude in the intrinsic 2–195 keV luminosity. Models in which the continuum above 10 keV is dominated by the direct (unscattered) continuum give the highest intrinsic luminosities and column densities. Models in which the Compton-scattered continuum dominates the spectrum above 10 keV give the lowest intrinsic luminosities and column densities. Utilizing variability information from other studies of NGC 4945, namely the fact that the Fe Kα emission line does not vary whilst the continuum above 10 keV varies significantly, we can select the solutions in which the direct continuum dominates above 10 keV. The data require that the Compton-scattered continuum and Fe Kα line emission come predominantly from the illuminated surfaces of the X-ray reprocessor, implying a clumpy medium with a global covering factor that is small enough that the Compton-scattered

continuum does not dominate the spectrum above 10 keV. The line of sight may be obscured by matter in the same distribution but a separate ring-like structure observed edge-on is not ruled out. The Fe Kα line-emitting region must be the same one recently reported to be spatially-resolved by *Chandra*, so it must be extended on a scale of ~ 30 pc or so. As found in previous studies of NGC 4945, the implied intrinsic bolometric luminosity is close to, or greater than, the Eddington luminosity. However, a scenario that is also consistent with the data and the models is that NGC 4945 is a strongly beamed AGN embedded in a shell of Compton-thick (but clumpy) matter, with a covering factor that needs less fine-tuning than the case of an isotropic intrinsic X-ray continuum. The intensity of the intrinsic X-ray continuum would be strongly aligned along or close to the line of sight, so that the true intrinsic luminosity could easily be an order of magnitude less than that deduced for an isotropic X-ray source. Beaming also appears to be consistent with recent radio and Fermi results for NGC 4945. Such beamed Compton-thick AGNs would be preferentially selected in hard X-ray surveys over unbeamed Compton-thick AGNs.

Accepted for publication by the Monthly Notices of the Royal Astronomical Society.

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preprint available at arxiv:1204.4196

Discovery of VHE γ-ray emission and multi-wavelength observations of the BL Lac object 1RXS J101015.9−311909

HESS Collaboration, A. Abramowski et al.

1RXS J101015.9−311909 is a galaxy located at a redshift of $z = 0.14$ hosting an active nucleus (called AGN) belonging to the class of bright BL Lac objects. Observations at high (HE, $E > 100\,\mathrm{MeV}$) and very high (VHE, $E > 100\,\mathrm{GeV}$) energies provide insights into the origin of very energetic particles present in such sources and the radiation processes at work. We report on results from VHE observations performed between 2006 and 2010 with the H.E.S.S. instrument, an array of four imaging atmospheric Cherenkov telescopes. H.E.S.S. data have been analysed with enhanced analysis methods, making the detection of faint sources more significant. VHE emission at a position coincident with 1RXS J101015.9−311909 is detected with H.E.S.S. for the first time. In a total good-quality livetime of about 49 hours, we measure 263 excess counts, corresponding to a significance of 7.1 standard deviations. The photon spectrum above 0.2 TeV can be described by a power-law with a photon index of $\Gamma = 3.08 \pm 0.42_{\mathrm{stat}} \pm 0.20_{\mathrm{sys}}$. The integral flux above 0.2 TeV is about 0.8% of the flux of the Crab nebula and shows no significant variability over the time reported. In addition, public *Fermi*/LAT data are analysed to search for high energy emission from the source. The *Fermi*/LAT HE emission in the 100 MeV to 200 GeV energy range is significant at 8.3 standard deviations in the chosen 25-month dataset. UV and X-ray contemporaneous observations with the *Swift* satellite in May 2007 are also reported, together with optical observations performed with the ATOM telescope located at the H.E.S.S. site. *Swift* observations reveal an absorbed X-ray flux of $F_{(0.3-7)\mathrm{keV}} = 1.04^{+0.04}_{-0.05} \times 10^{-11}\ \mathrm{erg\,cm^{-2}\,s^{-1}}$ in the $0.3 - 7\,\mathrm{keV}$ range. Finally, all the available data are used to study the multi-wavelength properties of the source. The spectral energy distribution (SED) can be reproduced using a simple one-zone Synchrotron Self Compton (SSC) model with emission from a region with a Doppler factor of 30 and a magnetic field between 0.025 and 0.16 G. These parameters are similar to those obtained for other sources of this type.

Accepted by Astronomy & Astrophysics

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preprint available at arxiv:1204.1964

Modeling the Fe K Line Profiles in Type I AGN with a Compton-Thick Disk Wind

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We have modeled a small sample of Seyfert galaxies that were previously identified as having simple X-ray spectra with little intrinsic absorption. The sources in this sample all contain moderately broad components of Fe K-shell emission and are ideal candidates for testing the applicability of a Compton-thick accretion-disk wind model to AGN emission components. Viewing angles through the wind allow the observer to see the absorption signature of the gas, whereas face-on viewing angles allow the observer to see the scattered light from the wind. We find that the Fe K emission line profiles are well described with a model of a Compton-thick accretion-disk wind of solar abundances, arising tens to hundred of gravitational radii from the central black hole. Further, the fits require a neutral component of Fe Kα emission that is too narrow to arise from the inner part of the wind, and likely comes from a more distant reprocessing region. Our study demonstrates that a Compton-thick wind can have a profound effect on the observed X-ray spectrum of an AGN, even when the system is not viewed through the flow.

Accepted by Astrophysical Journal

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Thesis Abstracts

Origin and Nature of Radio-Loud Broad Absorption Line Quasars

A multi-wavelength study

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The origin of Broad Absorption Line Quasars (BAL QSOs) is still an open issue. Accounting for $\sim 20\%$ of the QSO population, these objects present broad absorption lines in their optical spectra generated from outflows with velocities up to 0.2 *c*. There is still no consensus about the origin of the absorbing gas in BAL QSOs, the mechanism which accelerates it, or the relationship between BAL QSOs and the quasar population as a whole.

Nowadays, the hypotheses about their nature are principally related to orientation or evolutionary scenarios. In the first one, absorption lines are produced by outflows originated by the accretion disk, basically present in all QSOs, but seen only when they intercept the line of sight. In the second hypothesis, BAL QSOs would be young or recently re-fueled QSOs, still ejecting their dust cocoon. In this case orientation would not play a role, since the absorption features would be produced by spherically ejected matter.

In this work we present the results of a multi-frequency study of a Radio-Loud BAL QSO sample, and a comparison sample of Radio-Loud non-BAL QSOs, both selected from the Sloan Digital Sky Survey (SDSS). We performed observations in the radio band, to sample the SED in the GHz range and study the characteristics of the synchrotron emission, aiming at collecting indications about the age and the orientation of the central radio source, as well as the polarisation properties. The comparison with the non-BAL QSO sample allows us to conclude that no particular orientation is present in BAL QSOs. Nevertheless, similar fractions of GHz-peaked sources in the two sample ($36\pm12\%$ *vs* $23\pm8\%$) does not seem to suggest a young age for BAL QSOs, and this conclusion is favoured by the presence, in some cases, of low-frequency, presumably old components in the radio spectrum.

Through the VLBI technique, it was possible to study the pc-scale radio-morphology of half the sample. About 80% of sources present a resolved structure, with projected linear sizes comprised between tens and hundreds of pc. This fraction is comparable with previous results from literature. The missing flux density with respect to observations at kpc-scale resolution suggests a low frequency, diffuse component in some cases. The variety of morphologies does not support a particular orientation.

We also investigated the dust grey-body emission at mm-wavelengths, to verify whether BAL QSOs are dust-rich, physical condition requested by the evolutionary model. Only 7% of the sources present a clear dust contribution at 250 GHz. Not being dust rich, BAL QSOs should not present an high star-formation rate. Thus, again, they should not be a particularly young class of objects.

Finally, using a sample of optically-bright Radio-Loud and Radio-Quiet QSOs, we collected spectra in the Near-Infrared band, to estimate the central black hole mass, the Eddington ratio, and the Broad Line Region radius, in order to underline differences induced by the Radio-Loud phase. From an analysis of the SDSS DR7 QSO catalogue, the Eddington ratio is the only physical quantity found to be significantly different in Radio-Loud BAL QSOs, 26% of these objects being super-Eddington, while only 13% of Radio-Quiet BAL QSOs show the same property. Even a bigger difference has been found between BAL and non-BAL QSOs as a whole (13% *vs* 2%).