Active Galaxies Newsletter	*An electronic publication dedicated to the observation and theory of active galaxies*
No. 76 — July 2003	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

A multiband study of Hercules A. II. Multifrequency VLA imaging

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We have mapped the powerful radio galaxy Hercules A at six frequencies spanning 1295 to 8440 MHz using the VLA in all four configurations. Here we discuss the structure revealed in total intensity, spectral index, polarization, and projected magnetic field. Our observations clearly reveal the relation between the bright jets, radio source. The jets and rings form a coherent structure with a dramatically flatter spectrum than the surrounding lobes and bridge, strongly suggesting that they represent a recently renewed outburst from the active nucleus. The spectrum of the lobes is also steeper than in typical radio sources, and steepens further towards the centre. The compact core is optically thin and also has a remarkably steep spectrum ($\alpha \sim -1.2$). There is some evidence that the old lobe material has been swept up and compressed ahead of the new outburst. We interpret the dramatic asymmetry in the bright structure, and more subtle differences between diffuse lobe structures, in terms of relativistic beaming combined with front-to-back light-travel delays which mean that we view the two lobes at different stages of the outburst. After correcting for Faraday rotation the projected magnetic field closely follows the edge of the lobes, the jets, and the rings; the field pattern in the two lobes is broadly similar. We confirm a strong asymmetry in depolarization and Faraday rotation, with the jet side the less depolarized and the flatter spectrum, consistent with general correlations between these asymmetries. The spectral index asymmetry is clearly present in the 'old' lobe material and so, at least in this case, is not due to beaming; but it can be understood in terms of the light-travel delay.

Accepted for publication in MNRAS

Preprint available at http://uk.arxiv.org/abs/astro-ph/0305600
Associated jpeg files are also available at http://www.jb.man.ac.uk/ jpl/hera/

The Ionized Gas and Nuclear Environment in NGC 3783 III. Detection of a Decreasing Radial Velocity in an Intrinsic UV Absorber

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We report an intrinsic absorber with decreasing outflow velocity in the Seyfert 1 galaxy NGC 3783. This is the first detection of a change in radial velocity in an outflow associated with a Seyfert galaxy. These results are based on measurements from 18 observations with the Space Telescope Imaging Spectrograph aboard the *Hubble Space Telescope*, obtained between 2000 February and 2002 January. In two intervals separated by ~ 13 and 9 months, the absorption lines in the kinematic component with highest outflow velocity exhibited mean redward velocity shifts of ~ 35 and 55 km s^{-1}, respectively. The rate of velocity decrease was 2.2 ± 0.6 times more rapid in the second interval. No variations in absorption velocities were detected in the other kinematic components. We explore potential interpretations of the observed velocity shifts: radial deceleration of the UV absorber due to a change in either the speed or direction of motion of the outflow, and the evolution of a continuous flow across our line of sight to the emission source.

Accepted by The Astrophysical Journal

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preprint available at astro-ph/0306201

Escape probability methods versus "exact" transfer for modelling the X-ray spectrum of Active Galactic Nuclei and X-ray binaries

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In the era of XMM-Newton and Chandra missions, it is crucial to use codes able to compute correctly the line spectrum of X-ray irradiated thick media (Thomson thickness of the order of unity), in order to build models for the structure and the emission of the central regions of Active Galactic Nuclei (AGN), or of X-ray binaries. In all photoionized codes except in our code Titan, the line intensities are computed with the so-called "escape probability approximation". In its last version, Titan solves the transfer of a thousand lines and of the continuum with the "Accelerated Lambda Iteration" method, which is one of the most efficient and at the same time the most secure for line transfer. We first review the escape probability formalism and mention various reasons why it should lead to wrong results concerning the line fluxes. Then we check several approximations commonly used instead of line transfer in photoionization codes, by comparing them to the full transfer computation. We find that for conditions typical of the AGN or X-ray binary emission medium, all approximations lead to an overestimation of the emitted X-ray line spectrum, which can reach more than one order of magnitude. We show that it is due mainly to the local treatment of line photons, implying a delicate balance between excitations of X-ray transitions by the very intense underlying

diffuse X-ray continuum (which are not taken properly into account in escape probability approximations) and the net rate of excitations by the diffuse line flux. The most affected lines are those in the soft X-ray range. Such processes are much less important in cooler and thinner media (like the Broad Line Region of AGN), as the most intense lines lie in the optical and near ultraviolet range where the diffuse continuum is small. We conclude that it is very important to treat correctly the transfer of the continuum to get the best results for the line spectrum. On the other hand the approximations used for the escape probabilities have a relatively small influence on the computed thermal and ionization structure of the surface layers, but in the deep layers, they lead to an overestimation of the ionization state. As a consequence the computed continuum emitted by the back (non-irradiated) side is not correct, and might be strongly overestimated in the EUV range.

Accepted by Astron. J. , astro-ph/0306298

Accretion disk wind in the AGN broad-line region: Spectroscopically resolved line profile variations in Mrk 110

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Detailed line profile variability studies of the narrow line Seyfert 1 galaxy Mrk 110 are presented. We obtained the spectra in a variability campaign carried out with the 9.2m Hobby-Eberly Telescope at McDonald Observatory. The integrated Balmer and Helium (He I, II) emission lines are delayed by 3 to 33 light days to the optical continuum variations respectively. The outer wings of the line profiles respond much faster to continuum variations than the central regions.The comparison of the observed profile variations with model calculations of different velocity fields indicates an accretion disk structure of the broad line emitting region in Mrk 110. Comparing the velocity-delay maps of the different emission lines among each other a clear radial stratification in the BLR can be recognized. Furthermore, delays of the red line wings are slightly shorter than those of the blue wings. This indicates an accretion disk wind in the BLR of Mrk 110. We determine a central black hole mass of M = $1.8 \cdot 10^7 M_\odot$. Because of the poorly known inclination angle of the accretion disk this is a lower limit only.

Accepted by A&A

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The Host Galaxies of Narrow-Line Seyfert 1s: Evidence for Bar-Driven Fueling

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We present a study of the host-galaxy morphologies of narrow- and broad-line Seyfert 1 galaxies (NLS1s and BLS1s) based on broad-band optical images from the *Hubble Space Telescope* archives. We find that large-scale stellar bars, starting at ∼1 kpc from the nucleus, are much more common in NLS1s than BLS1s. Furthermore, the fraction of NLS1 spirals that have bars increases with decreasing full-width at half-maximum (FWHM) of the broad component of Hβ. These results suggest a link between the large-scale bars, which can support high fueling rates to the inner kpc, and the high mass-accretion rates associated with the supermassive black holes in NLS1s.

Accepted by The Astronomical Journal, astro-ph/0306404

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A relativistic jet in the radio-quiet quasar PG1407+263

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We present the results of a multi-epoch radio monitoring campaign measuring the milliarcsecond structure of the jet in the radio-quiet quasar PG1407+263. This is the highest-sensitivity, highest-resolution multi-year study of a distant active galaxy. The observations are naturally explained in terms of a beamed relativistic jet, some of whose fluctuations in flux density can be ascribed to interaction with the narrow-line region of the quasar. The optical properties of PG1407+263, in particular the

low equivalent widths of the emission lines, may be related to the fact that we are viewing this quasar almost pole-on, giving us a direct view into its broad-line region.

Accepted by ApJLett, astro-ph/0306109

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Fe XXV and Fe XXVI Diagnostics of the Black Hole and Accretion Disk in Active Galaxies: Chandra Time-Resolved Spectroscopy of NGC 7314

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We report the detection of Fe XXV and Fe XXVI $K\alpha$ emission lines from a *Chandra* High Energy Grating Spectrometer (*HETGS*) observation of the narrow-line Seyfert 1 galaxy NGC 7314, made simultaneously with *RXTE.* The lines are redshifted ($cz \sim$ 1500 km s^{-1}) relative to the systemic velocity and unresolved by the gratings. We argue that the lines originate in a near face-on ($< 7^{\circ}$) disk having a radial line emissivity flatter than r^{-2}. Line emission from ionization states of Fe in the range $\sim$ Fe I a up to Fe XXVI is observed. The ionization balance of Fe responds to continuum variations on timescales less than 12.5 ks, supporting an origin of the lines close to the X-ray source. We present additional, detailed diagnostics from this rich data set. These results identify NGC 7314 as a key source to study in the future if we are to pursue reverberation mapping of space-time near black-hole event horizons. This is because it is first necessary to understand the ionization structure of accretion disks and the relation between the X-ray continuum and Fe Kα line emission. However, we also describe how our results are suggestive of a means of measuring black-hole spin without a knowledge of the relation between the continuum and line emission. Finally, these data emphasize that one *can* study strong gravity with narrow (as opposed to very broad) disk lines. In fact narrow lines offer higher precision, given sufficient energy resolution.

Accepted by the Astrophysical Journal.

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preprint available from astro-ph (0306428)

A Possible New Population of Sources with Extreme X-Ray / Optical Ratios

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We describe a possible new class of X-ray sources that have robust detections in ultra-deep *Chandra* data, yet have no detections at all in our deep multi-band GOODS *Hubble Space Telescope* (*HST*) ACS images, which represent the highest quality optical imaging obtained to date on these fields. These extreme X-ray / Optical ratio sources (*"EXO"*s) have values of Fx/Fopt at least an order of magnitude above those generally found for other AGN, even those that are harbored by reddened hosts. We thus infer two possible scenarios: (1) if these sources lie at redshifts $z \lesssim 6$, then their hosts need to be exceedingly underluminous, or more reddened, compared with other known sources; (2) if these sources lie above $z \sim 6 - 7$, such that even their Lyman-α emission is redshifted out of the bandpass of our ACS z_{850} filter, then their optical and X-ray fluxes can be accounted for in terms of relatively normal $\sim L_*$ hosts and moderate-luminosity AGN.

Accepted by Ap. J. Lett.

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A First Close Look at the Balmer Edge Behavior of the Quasar Big Blue Bump

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We have found for the first time a Balmer edge feature in the polarized flux spectrum of a quasar (Ton 202). The edge feature is seen as a discontinuity in the slope, rather than as a discontinuity in the absolute flux. Since the polarized flux contains essentially no broad emission lines, it is considered to arise interior to the broad emission line region, showing the spectrum with all the emissions outside the nucleus scraped off and removed. Therefore, the polarized flux spectrum is likely to reveal features intrinsic to the Big Blue Bump emission. In this case, the existence of the Balmer edge feature, seen in absorption in the shorter wavelength side, indicates that the Big Blue Bump is indeed thermal and optically thick.

Accepted by MNRAS.

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GMRT detection of HI 21 cm associated absorption towards the z=1.2 red quasar 3C 190

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We report the GMRT detection of associated HI 21 cm-line absorption in the z=1.1946 red quasar 3C 190. Most of the absorption is blue-shifted with respect to the systemic redshift. The absorption, at ~ 647.7 MHz, is broad and complex, spanning a velocity width of ~ 600 kms^{-1}. Since the core is self-absorbed at this frequency, the absorption is most likely towards the hotspots. Comparison of the radio and deep optical images reveal linear filaments in the optical which overlap with the brighter radio jet towards the south-west. We therefore suggest that most of the HI 21 cm-line absorption could be occurring in the atomic gas shocked by the south-west jet.

To appear in Journal of Astrophysics and Astronomy, 2003, Vol. 24, p 37

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Full paper available at http://www.ias.ac.in/jaa/

Fe II/Mg II Emission Line Ratio in High Redshift Quasars

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We present results of the analysis of near infrared spectroscopic observations of 6 high-redshift quasars ($z \gtrsim 4$), emphasizing the measurement of the ultraviolet Fe II/ Mg II emission line strength in order to estimate the beginning of intense star formation in the early universe. To investigate the evolution of the Fe II/Mg II ratio over a wider range in cosmic time, we measured this ratio for composite quasar spectra which cover a redshift range of $0 \lesssim z \lesssim 5$ with nearly constant luminosity, as well as for those which span ~ 6 orders of magnitude in luminosity. A detailed comparison of the high-redshift quasar spectra with those of low-redshift quasars with comparable luminosity shows essentially the same Fe II/Mg II emission ratios and very similar continuum and line spectral properties, i.e. a lack of evolution of the relative iron to magnesium abundance of the gas in bright quasars since $z \simeq 5$. Current nucleosynthesis and stellar evolution models predict that α-elements like magnesium are produced in massive stars ending in type II SNe, while iron is formed predominantly in SNe of type Ia with intermediate mass progenitors. This results in an iron enrichment delay of ~ 0.2 to 0.6 Gyr. We conclude that intense star formation activity in the host galaxies of $z \gtrsim 4$ quasars must have started already at an epoch corresponding to $z_f \simeq 6$ to 9, when the age of the universe was ~ 0.5 Gyr ($H_o = 72$ km s^{-1} Mpc^{-1}, $\Omega_M = 0.3$, $\Omega_\Lambda = 0.7$). This epoch corresponds well to the re-ionization era of the universe.

Accepted by Astrophys.Journal.

Eddington Accretion and QSO Emission Lines at $z \sim 2$

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Broad Absorption Line (BAL) QSOs have been suggested to be youthful super-accretors based on their powerful radiatively driven absorbing outflows and often reddened continua. To test this hypothesis, we observed near IR spectra of the Hβ region for 11 bright BAL QSOs at redshift $z \sim 2$. We measured these and literature spectra for 6 BAL QSOs, 13 radio-loud and 7 radio-quiet non-BAL QSOs. Using the luminosity and Hβ broad line width to derive black hole mass and accretion rate, we find that both BAL and non-BAL QSOs at $z \sim 2$ tend to have higher $L/L_{\rm Edd}$ than those at low z – probably a result of selecting the brightest QSOs. However, we find that the high z QSOs, in particular the BAL QSOs, have extremely strong Fe II and very weak [O III], extending the inverse relationship found for low z QSOs. This suggests that, even while radiating near $L_{\rm Edd}$, the BAL QSOs have a more plentiful fuel supply than non-BAL QSOs. Comparison with low z QSOs shows for the first time that the inverse Fe II – [O III] relationship is indeed related to $L/L_{\rm Edd}$, rather than black hole mass.

Accepted by Astron. J. Letters

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Relativistic and slowing down: the flow in the hotspots of powerful radio galaxies and quasars.

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Pairs of radio emitting jets with lengths up to several hundred kiloparsecs emanate from the central region (the 'core') of radio loud active galaxies. In the most powerful of them, these jets terminate in the 'hotspots', compact high brightness regions, where the jet flow collides with the intergalactic medium (IGM). Although it has long been established that in their inner (∼parsec) regions these jet flows are relativistic, it is still not clear if they remain so at their largest (hundreds of kiloparsec) scales. We argue that the X-ray, optical and radio data of the hotspots, despite their at-first-sight disparate properties, can be unified in a scheme involving a relativistic flow upstream of the hotspot that decelerates to the sub-relativistic speed of its inferred advance through the IGM and viewed at different angles to its direction of motion. This scheme, besides providing an account of the hotspot spectral properties with jet orientation, it also suggests that the large-scale jets remain relativistic all the way to the hotspots.

Accepted by Ap. J.

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