Active Galaxies Newsletter	*An electronic publication dedicated to the observation and theory of active galaxies*
No. 3 — December 1996	Editor: Anthony Holloway (ajh@ast.man.ac.uk)

From the Editor

This month we have another new addition to the newsletter, details of conference proceedings. This conference has all the papers on-line to read or download as postscript files. The newsletter mailing list is increasing in size, now with 309 subscribers, but still with room for more if you know someone who you think would like to receive it. The deadline for the next issue will be 26th January.

Merry Christmas and a happy new year!

Ant.

Conference Proceedings

Jet-cloud interactions in active galaxies

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A workshop on 'Jet-cloud interactions in active galaxies' was held at the University of Sheffield on 8th July 1996. The workshop was a resounding success, with a number of fascinating talks and lively debate. Both theoretical and observational aspects of jet-cloud interactions in radio galaxies and seyfert galaxies were presented and discussed in the course of the workshop.

The proceedings of this workshop are now available on-line, at http://www.shef.ac.uk/~phys/research/astro/conf/

Abstracts of recently accepted papers

A Study of Cores in a Complete Sample of Radio Sources

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The high resolution provided by the Parkes-Tidbinbilla real-time interferometer (PTI) has been used to measure the core flux density for a complete sample of radio sources. Lower resolution maps are already available for most of these objects

together with optical (spectroscopic) data. The new data show that an inverted spectral index ($\alpha \sim -0.3, S \propto \nu^{-\alpha}$) could be characteristic of *all* the nuclei, going from low-luminosity radio galaxies to powerful quasars. Taking this spectral index into account, the measured flux density does not change very much, going from a scale of tens of kpc (corresponding to the low-resolution observations) to the (sub)kpc scale of the new observations. Thus, most of the flux observed in the central region originates in a sub-kpc area.

With the new PTI data we obtain a better estimate of the radio core dominance (R), i.e. the ratio between the core and the extended radio flux. This parameter is claimed to be a good indicator of the orientation of the beamed radiation with respect to the line of sight and hence a very important parameter for testing 'unified schemes' for active galactic nuclei (AGN). Using this parameter, together with optical spectroscopic information, we find that the radio core dominance shows different distributions for different radio and optical characteristics. A statistically significant difference in the distribution of R is observed between FR I and FR II radio galaxies, supporting the idea that low-power sources are less affected by beaming because they have, on average, a lower Lorentz factor. Among the FR II radio galaxies, NLRGs (narrow-line radio galaxies) show the lower value of R while the BLRGs (broad-line radio galaxies) have the largest R. Moreover, the median value of R for BLRGs is lower than for steep-spectrum quasars (SSQ) even after a number of selection effects are taken into account. This result can be explained in the framework of unified schemes for AGN assuming that in the BLRGs we are seeing more directly into the nucleus, although not as much as in SSQs.

Accepted by MNRAS

E-mail contact: rmorgant@atnf.csiro.au, preprint available at http://www.atnf.csiro.au/~toosterl/2jy/pti-html/pti-html.html (html) and ftp://ftp.atnf.csiro.au/pub/people/toosterl/www/pti-paper.ps.gz (gzipped postscript)

Radio, optical and X-ray observations of PKS2250-41: a jet/galaxy collision?

N.E. Clark[1], C.N. Tadhunter[1], R. Morganti[2,3], N.E.B. Killeen[3], R.A.E. Fosbury[4], R.N. Hook[4], W. Siebert[5], and M. Shaw[1]

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New optical, radio and X-ray observations are used to investigate the morphology, ionization and kinematics of extended structures in the host galaxy of the radio source PKS2250-41 ($z = 0.308$). The data provide compelling evidence for a powerful interaction between the radio jets and the ambient interstellar medium. Not only do [OIII] emission-line images show spectacular extended arc structures associated with the radio lobes on both sides of the galaxy nucleus on a scale of 40 – 65 kpc ($H_0 = 50$ km s^{-1} Mpc^{-1}, $q_0 = 0.0$ used throughout, giving an angular scale of 6.0 kpc arcsec^{-1}), but there is also large depolarization in the western radio lobe at the position of the western emission-line arc. Optical long-slit spectra of the extended emission-line regions provide the first convincing evidence that the radio jets have a role in ionizing the warm gas in powerful radio galaxies: while the low ionization [NII] and [SII] lines are broad (FWHM $\sim 300 - 500$ km s^{-1}) across the entire emission-line nebulosity, the higher ionization [OIII] lines are much narrower in the western emission-line arc (FWHM $= 240 \pm 10$ km s^{-1}). This anti-correlation between linewidth and ionization is difficult to explain in terms of central source photoionization, but is entirely consistent with ionization by fast shocks driven by the radio jets. Further evidence for shocks is provided by the minimum in the ionization state at the position of the radio lobes, and by [OIII]4363/(5007+4959) and HeII/Hβ diagnostic ratios which are more consistent with shocks than with photoionization. The spectacular nature of the jet/cloud interaction in this object is best explained in terms of a direct collision between the radio jet and a companion galaxy in the surrounding group. This model is supported by the detection of a blue continuum source in the western arc with a colour and luminosity characteristic of late-type spiral galaxies.

Accepted by MNRAS

E-mail contact: n.e.clark@sheffield.ac.uk, preprint available as HTML
(http://wwwatnf.atnf.csiro.au/Preprints/1996oct/1996oct0002/1996oct0002.html) and gzipped postscript
(ftp://ftp.atnf.csiro.au/pub/preprints/1996oct/1996oct0002.ps.gz)

Coronal lines in active galactic nuclei

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Recent observations show that the coronal line region (CLR) is small (a few ×10 pc), has large column densities ($N \approx 10^{22}$

cm^{-2}), lies close to and is probably photoionized by the AGN. Coronal lines give information on Ne, Mg, Si, S, Ca, Fe, abundances, on the dust content and on the dynamics of the CLR, and can be used to trace hidden AGN. If photoionized, coronal lines could be used to reconstruct the AGN spectrum at 100-400 eV. However, a proper understanding of the results require a careful use of photoionization codes, since the ionization parameter at the inner face is probably meaningless for CLR models, and a settlement of the 'highly variable' atomic parameters for coronal lines. A shock model for the CLR in NGC1068 needs collisional ionization of $\geq$600 $M_\odot$/yr of dense ($n > 10^4$ cm^{-3}) gas within <30 pc. Maintaining a shock excited CLR for a sensible time requires a total fuel of $> 10^{10}$ $M_\odot$ which must be continuously supplied to the CLR.

To appear in *IAU Colloq. 159, Emission Lines in Active Galaxies: New Methods and Techniques*, ed. B. M. Peterson, F.-Z. Cheng, & A. S. Wilson (San Francisco: ASP).

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Jet Cocoons and the Formation of Narrow Line Clouds in Seyfert Galaxies

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We present non-adiabatic hydrodynamic simulations of a supersonic light jet propagating into a fully ionized medium of uniform density on a scale representative of the narrow line region (NLR) in Seyfert galaxies with associated radio jets. In this regime the cooling distance of the swept up gas in the bowshock of the jet is of the same order as the transverse extent of the jet bowshock, as opposed to the more extreme regimes found for more powerful adiabatic large scale jets or the slow galactic jets which have been simulated previously. We calculate the emissivity for the Hα line and radio synchrotron emission. We find that the structure of the line emitting cold envelope of the jet cocoon is strongly dependent on the non-stationary dynamics of the jet head as it propagates through the ambient medium. We observe the formation of cloud-like high density regions which we associate with NLR clouds and filaments. We find that some of these clouds might be partially neutral and represent sites of jet induced star formation. The calculated Hα flux and the spectral line width are consistent with NLR observations. The simulation of the radio-optical emission with radiative cooling confirms the basic result of the geometric bowshock model developed by Taylor et al (1989) that the start of noticeable optical line emission can be significantly offset from the hotspot of the radio emission. However, the time-dependent nature of the jet dynamics implies significant differences from their geometric bowshock model.

Accepted by Monthly Notices of the Royal Astronomical Society, MNRAS

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A ROSAT observation of the warm-absorbed soft X-ray spectrum of NGC 4051

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We present and analyze a pointed ROSAT PSPC observation of the Seyfert galaxy NGC 4051. The X-ray spectrum consists of a powerlaw modified by absorption edges and an additional soft excess during the high-state in source flux. Modeling the spectrum in terms of warm absorption yields a large column density of the ionized material of $\log N_{\rm w} = 22.7$ and an ionization parameter of $\log U = 0.4$. These properties are essentially constant throughout the observation, whereas the luminosity changes by more than a factor of 4. The underlying powerlaw is in its steepest observed state, with a photon index $\Gamma_{\rm x} = -2.3$. Consulting information from optical observations, evidence for a separate EUV bump component in NGC 4051 is provided. The impact of several parameters on the deduced properties of the ionized material is critically assessed. In particular, the influence of dust mixed with the warm gas is explored and shown to constrain the history or density of the absorber. The absorber-intrinsic optical-UV emission (and absorption) line spectrum is predicted and the possibility of a warm absorber origin of one of the observed emission line regions in NGC 4051 is investigated. Consequences for the narrow-line Seyfert 1 character of NGC 4051 are discussed.

Accepted by Astronomy & Astrophysics

E-mail contact: skomossa@rosat.mpe-garching.mpg.de, preprint available at astro-ph@babbage.sissa.it, astro-ph/9612038

Origin of the viewing-angle dependence of the optical continuum emission in quasars

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The orientation-dependence of the optical continuum emission in radio-loud quasars is investigated using a new, complete sample of low-frequency-selected quasars, the Molonglo Quasar Sample (MQS). The optical continuum is found to be highly anisotropic, brightening continuously from lobe- to core-dominated quasars by 3–5 mag. It is argued that aspect-dependent extinction, rather than relativistic boosting as has been previously proposed, provides the simplest explanation consistent with the data. The reddening hypothesis is supported by both the steeper optical slopes and the larger Balmer decrements found in lobe-dominated quasars, as well as the stronger anisotropy seen at blue wavelengths. The dust responsible is shown to be physically associated with the quasar, lying mostly at radii between the broad and narrow-line regions in a clumpy distribution. Such a geometry is reminiscent of a torus. However, substantial numbers of dust clouds must lie within the torus opening angle, contributing to an increasing average optical depth with increasing viewing angle away from the jet axis, θ. In addition, the ratio of [O III] $\lambda\lambda$4959,5007 to [O II] λ3727 line flux is shown to be aspect dependent, and is consistent with partial obscuration of [O III] at large θ. Trends of broad-line equivalent widths with R are also presented, including evidence for the luminosity dependence of W_λ (Mg II λ2798).

Accepted by MNRAS

E-mail contact: jcb@mrao.cam.ac.uk, preprint available at http://xxx.soton.ac.uk/abs/astro-ph/9611202

Differences in emission line spectrum in maximum and minimum of the nucleus brightness of Seyfert galaxy NGC 7469

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We have compiled the data on relative intensities, fluxes and profiles of emission lines of the NGC 7469 nucleus spectrum observed in the optical region by many authors during 1966 – 1986. The aim of our investigation is to reveal differences in the characteristics of the emission lines in maxima and minima of the nucleus brightness. The distinction was revealed for relative intensities, fluxes and profiles. During the extreme maxima profiles of H_γ, H_β and H_α lines, colour indices of the nucleus and its high level of accretion rate are resemble those of QSOs. On the other hand, during the deep minimum 1989 the nucleus had the properties of Sy2 type. There is a relation between variable fluxes of H_β and [OIII] λ 5007Å lines which is different for minima and maxima of the nucleus brightness. The fluxes of the [OIII] λ 5007Å line during the minima of the nucleus brightness are systematically higher than those in maxima. Above mentioned peculiarities of the emission lines in the NGC 7469 nucleus can be understood in terms of increasing of electron temperature, electron density and velocities of the nucleus gas from minima to maxima.

Accepted by Astrphys.Space Sci

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Thesis Abstracts

Jet-cloud interactions in powerful radio galaxies

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Extended emission line regions are observed in a large fraction of powerful radio galaxies, and are found to be preferentially aligned along the axes of the extended radio emission. The two main models which have been proposed to explain this alignment

effect are: a) illumination of ambient gas by an anisotropic central continuum source; and b) jet-cloud interactions. The relative effect of these two competing physical processes on the properties of the extended line-emitting gas is currently uncertain.

This thesis is based on a detailed optical spectroscopic study of four powerful radio galaxies: PKS 2250−41 ($z = 0.308$), 3C 171 ($z = 0.238$), 4C 29.30 ($z = 0.0647$) and Coma A ($z = 0.0858$). The effects of jet-cloud interactions upon the morphology, physical conditions, kinematics and ionization of the extended line-emitting gas in these four sources is investigated. From this study it is clear that jet-induced shocks can have a dramatic effect on the line-emitting gas over a range of spatial scales and radio powers. The evidence for jet-induced shocks includes: close radio-optical associations; high pressures in the extended gas; low ionization states and ionization minima associated with the radio hot spots; line-splitting, and large line widths and velocity gradients; an anti-correlation between line width and ionization state; and high [OIII] temperatures and low HeII/Hβ ratios consistent with shock ionization. Pronounced UV continuum excesses are also observed associated with the extended line emission in all four sources, and it is found that a large proportion of this UV excess is due to nebular continuum emission from the shocked clouds.

Although the sample studied here is small, there are many similarities between these four sources and the powerful radio galaxies observed at high redshifts. This implies that jet-induced shocks are also important in high redshift radio galaxies.

PhD thesis, submitted June 1996

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Jobs

Meetings

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