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Abstracts - Thesis Abstracts - Jobs - Meetings

From the Editor

Thank-you to those who submitted abstracts. 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.
Matt Redman

Abstracts of recently accepted papers

The radio properties of radio-quiet quasars

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Although radio-quiet quasars (RQQs) constitute $\gtrsim 90\%$ of optically-identified quasar samples their radio properties are only poorly understood. In this paper we present the results of a multi-frequency VLA study of 27 low-redshift RQQs. We detect radio emission from 20 objects, half of which are unresolved ($\leq 0.24''$). In cases where significant structure can be resolved, double, triple and linear radio sources on scales of a few kpc are found. The radio emission (typically) has a steep spectrum ($\alpha \sim 0.7$, where $S \propto \nu^{-\alpha}$), and high brightness temperatures ($T_B \geq 10^5$ K) are measured in some of the radio components. The RQQs form a natural extension to the radio luminosity - absolute magnitude distribution of nearby Seyfert 1s. We conclude that a significant fraction of the radio emission in RQQs originates in a compact nuclear source directly associated with the quasar. There are no significant differences between the radio properties of RQQs with elliptical hosts and those in disc galaxies within the current sample.

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Broad P V Absorption in the BALQSO, PG 1254+047: Column Densities, Ionizations and Metal Abundances in BAL Winds

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This paper discusses the detection of PV $\lambda\lambda$1118,1128 and other broad absorption lines (BALs) in archival *HST* spectra of the low-redshift BALQSO, PG 1254+047. The PV identification is secured by excellent redshift and profile coincidences with the

other BALs, such as CIV $\lambda\lambda$1548,1550 and SiIV $\lambda\lambda$1393,1403, and by photoionization calculations showing that other lines near this wavelength, e.g. FeIII λ1123, should be much weaker than PV. The observed BAL strengths imply that either 1) there are extreme abundance ratios such as [C/H] $\geq +1.0$, [Si/H] $\geq +1.8$ and [P/C] $\geq +2.2$, or 2) at least some of the lines are much more optically thick than they appear.

I argue that the significant presence of PV absorption indicates severe line saturation, which is disguised in the observed (moderate-strength) BALs because the absorber does not fully cover the continuum source(s) along our line(s) of sight. The variety of observed BAL strengths and profiles results from a complex mixture of ionization, optical depth and coverage fraction effects, making useful determinations of the abundance ratios impossible without a specific physical model. Computed optical depths for all UV resonance lines show that the observed BALs are consistent with *solar* abundances if 1) the ionization parameter is at least moderately high, $\log U \geq -0.6$, 2) the total hydrogen column density is $\log N_{\rm H}({\rm cm}^{-2}) \geq 22.0$, and 3) the optical depths in strong lines like CIV and OVI $\lambda\lambda$1032,1038 are $\gtrsim$25 and $\gtrsim$80, respectively. These optical depths and column densities are at least an order of magnitude larger than expected from the residual intensities in the BAL troughs, but they are consistent with the large absorbing columns derived from X-ray observations of BALQSOs. In particular, a nominal X-ray column density of $\log N_{\rm H}({\rm cm}^{-2}) \sim 23$ could produce the observed BAL spectrum if $+0.4 \leq \log U \leq +0.7$ in a simple one-zone medium. The outflowing BALR, at velocities from $-15{,}000$ to $-27{,}000$ km s^{-1} in PG 1254+047, is therefore a strong candidate for the X-ray absorber in BALQSOs.

In Press with The Astrophysical Jounal.

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Broad NeVIII λ774 Emission From Quasars

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NeVIII λ774 is an important tracer of the high-ionization gas in QSOs. We examine the NeVIII emission-line properties using new *HST*-FOS spectra of four sources, mean spectra derived from two QSO samples in the *HST* archives, and new photoionization calculations. The results support our previous claim that broad NeVIII lines are common in QSOs, with an average flux of $\sim$42% of OVI λ1034 and velocity widths that are $\sim$2 to 5 times larger than OVI, CIV λ1549 and other broad lines in the same spectra. The strongest and most reliably measured NeVIII λ774 lines (in two sources) have FWHM $\sim$ 14,500 km s^{-1}. Line profile fits in these cases show that the unusually large widths might be caused by blending with emission from NIV λ765 and OIV λ789. However, standard photoionization calculations indicate that NIV, OIV and all other lines near this wavelength should be too weak, leaving (very broad) NeVIII as the only viable identification for the $\sim$774 Å feature. (This conclusion might be avoided if there are large radial velocity dispersions [$\gtrsim$1000 km s^{-1}] in the emitting region and the resonant absorption of continuum photons enhances the flux in weaker lines.) The calculations also indicate that the NeVIII emitting regions have ionization parameters in the range $5 \leq U \leq 30$, total hydrogen column densities of $10^{22} \leq N_{\rm H} \leq 3\times10^{23}$ cm^{-2}, and an average covering factor of $\gtrsim$30% (for solar abundances and a nominal QSO continuum shape). The NeVIII emitting region is therefore more extensive, more highly ionized, and has much higher velocities than the rest of the broad emission line region (BELR). This highly-ionized BELR component would be a strong X-ray "warm" absorber if it lies along our line-of-sight to the X-ray continuum source.

In Press with The Astrophysical Jounal

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The variability of the broad component of HeIIλ4686 line in NGC4151

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We present the results of the observations of NGC4151 obtained from 1986 to 1990 with the TV scanner of the 6-meter telescope of the Special Astrophysical Observatory. Spectra averaged over periods of 2 - 3 months show changes in the asymmetry of the broad component of HeII λ4686 line over this observing period. The broad component of Hγ however does not show similar variations. We discuss the reasons which could be responsible for these observations.

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ASCA Observations of the Ionized Gas in the Seyfert Galaxy NGC 3783

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We present the results from *ASCA* observations of NGC 3783 carried out during 1993 and 1996. Variability is observed both between the two epochs and within the individual observations, the latter due to a non-stationary process.

We find the spectra at both epochs to contain features due to absorption by ionized material, predominantly due to OVII and OVIII. We find the opacity for such material to decrease by a factor ~2 in the ~ 0.7–1.0 keV band between the epochs while the photoionizing flux increases by ~25%. By comparison with detailed photoionization models we show this behaviour is inconsistent with that expected from a single-zone of photoionized gas. A deficit in the data compared to such models, consistent with excess absorption by OVIII, supports the suggestion that the material consists of two or more zones

Significant Fe K-shell emission is also observed during both epochs. We show this emission is dominated by the asymmetric line profile expected from the innermost regions of the accretion flow. We find no evidence that the Fe emission varied in either shape or equivalent width between the two epochs.

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Detecting Compton Reflection and a Broad Iron Line in MCG−5-23-16 with *RXTE*

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We report the detection with the Rossi X-ray Timing Explorer of a Compton reflection signature in the Seyfert galaxy MCG−5-23-16. *RXTE* also resolves the Fe Kα fluorescence line with FWHM ~ 48,000 km s^{-1}. This measurement provides the first *independent* confirmation of *ASCA* detections in Seyfert galaxies of broad Fe Kα lines that are thought to be the signature of emission from the inner regions of an accretion disk orbiting a black hole. Under the assumption that reflection arises from an isotropic source located above a neutral accretion disk, and using a theoretical model that accounts for the dependence of the reflected spectrum on inclination angle, we derive a 90% confidence range for the disk inclination of $i = 50° - 81°$. The large inclination is consistent with that expected from the unified model for MCG−5-23-16 based on its Seyfert 1.9 classification. If we assume that the high-energy cutoff in the incident spectrum lies at energies larger than a few hundred keV, then the equivalent width of the Fe Kα line is much larger than predicted for the amount of reflection. This implies either an enhanced iron abundance, a covering factor of reflecting material $c_f > 0.5$, or a cutoff in the incident spectrum at energies between ~60 and ~200 keV.

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Kinematics of the Dusty Circum-nuclear Ring in the Barred Seyfert Galaxy NGC4151

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We present optical and neutral hydrogen observations of the central ~2 kpc in NGC4151, and examine the distribution and

kinematics of neutral hydrogen in the vicinity of the optical circumnuclear dust 'ellipse'. The V-I colour map, derived from broad-band images obtained using TAURUS II in imaging mode, shows clearly the red arcs which delineate the $11'' \times 18''$ dust ellipse detected previously.

The new, high resolution ($\sim 6'' \times 5''$) HI image reveals two arcs of HI emission, which lie on the inner edges of the main bar and coincide closely with the optical arcs. The peak column densities in the HI arcs, of $\sim 1.8 \times 10^{21}$ cm^{-2} and $\sim 0.7 \times 10^{21}$ cm^{-2}, imply optical extinctions of $A_v \sim$1.16 and 0.45 in the northern and southern arcs respectively, which are comparable with those derived from broad-band imaging.

The kinematics of the HI, measured along the two arcs, are presented. The first order circular fit to the velocity curve yields a value of $22\pm5°$ for the PA of the line of nodes, which agrees well with that of the galaxy. If the HI is associated with the optical ellipse, the PA of the spatial major axis of the ellipse ($\sim$48°) is offset from its kinematic major axis ($\sim$22°), providing evidence of non-circular orbits and suggesting that ring is not an inclined circular disk, but is intrinsically elliptical and lies in the plane of the galaxy.

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A Note on the Viability of Gaseous Ionization in Active Galaxies by Fast Shocks

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Morphological and spectroscopic evidence suggest that shocks may affect the spatial and velocity distributions of gas in the narrow line region (NLR) and extended NLR of some active galaxies. It thus seemed plausible that shocks may also energize the NLR. The observed emission line ratios strongly favor photoionization as the heating source for this gas, but it is not clear whether the ionizing radiation is generated in the NLR by "photoionizing shocks" or whether the ionizing radiation originates at the central continuum source. Here I point out that shocks are highly inefficient in producing line emission. Shocks in the NLR can convert at most $\sim 10^{-6}$ of the rest mass to ionizing radiation, compared with a maximum conversion efficiency of $\sim 10^{-1}$ for the central continuum source. The required mass flow rate through "photoionizing shocks" in the NLR is thus a few orders of magnitude higher than the mass accretion rate required to power the NLR by the central continuum source. Since gravity appears to dominate the NLR cloud dynamics, shocks must lead to an inflow, and the implied high inflow rates can be ruled out in most active galaxies.

NLR dynamics driven by a thermal wind or by some jet configurations may produce the mass flux through shocks required for photoionizing shocks to be viable, but the mass flux inward from the NLR must be kept $\sim$ 100-1000 times smaller.

Photoionizing shocks are a viable mechanism in very low luminosity active galaxies if they are highly sub-Eddington ($\lesssim 10^{-4}$) and if they convert mass to radiation with a very low efficiency ($\lesssim 10^{-4}$).

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Balmer Line Variations in the Radio-Loud AGN PG 1512+370

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We present spectroscopic observations of the quasar PG 1512+370, covering the Hβ line spectral range and collected at moderate resolution (2-7ÅFWHM) from 1988 to 1996. The observations show that the blue wing of the Hβ broad profile component (H$\beta_{\rm BC}$) has changed significantly in flux and shape between 1988 and 1990 and between 1995 and 1996. A displaced pead on the H$\beta_{\rm BC}$ profile, visible in 1988, but not in the 1990-1995 spectra, is revealed again in a 1996 spectrum obtained at the Asiago observatory. The peak (in both the 1988 and 1996 spectra) is centered at $\Delta V_r \approx -3000^{+500}_{-500}$ km s^{-1} from the rest frame defined by narrow component of Hβ, and the [O III] $\lambda\lambda$4959,5007 lines.
We discuss several conflicting interpretations of the data. We find that the variability of the H$\beta_{\rm BC}$ blue wing is consistent with Balmer line emission from regions whose motion is predominantly radial, if variations of the blue wing are a response

to continuum changes. Alternatively, we note that observed $H\beta_{BC}$ line profile variations are consistent with a variable line component as in a "binary black hole" scenario. More fequent observations of $H\beta_{BC}$ are needed to elect one of these suggestions.

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A Comparative Study of the Microvariability Properties in Radio Loud and Radio Quiet Quasars

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We have performed photometric optical observations of a sample of 17 core dominated radio loud quasars (CRLQ) and 17 radio quiet quasars (RQQ). The aims were to confirm the existence of ficrovariations in strictly radio quiet objects, and to compare the properties of the variations in both types of quasars. Great care was taken to avoid selection effects and spurious biases in the samples. We present a new observational and statistical procedure for searching for microvariablility, based on the Analysis of Variance. The results show that microvariations in RQQ may be as frequent as in CRLQ. The implications for the physical models for microvariations are briefly discussed.

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On the Origin of Broad FeKα & HI Hα Lines in AGN

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We examine the properties of the Fe emission lines that arise near 6.4 keV in the ASCA spectra of AGN. Our emphasis is on the Seyfert 1 galaxies where broad and apparently complex Fe Kα emission is observed. We consider various origins for the line but focus on the pros and cons for line emitting accretion disk models. We develop a simple model of an illuminated disk capable of producing both X-ray and optical lines from a disk. The model is able to reproduce the observed Fe Kα FWHM ratio as well as the radii of maximum emissivity implied by the profile redshifts. The overall profile shapes however do not fit well the predictions of our disk illumination model nor do we derive consistent disk inclinations for the two lines. We conclude that the evidence for and against an accretion disk origin of the Fe Kα emission is equal at best. The bulk of the data requires a very disparate set of line fits which shed little light on a coherent physical model. We briefly consider alternatives to disk emission models and show that a simple bicone model can reproduce the Fe Kα line profiles equally well.

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On Uncertainties in Cross-Correlation Lags and the Reality of Wavelength-Dependent Continuum Lags in Active Galactic Nuclei

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We describe a model-independent method of assessing the uncertainties in cross-correlation lags determined from AGN light curves, and use this method to investigate the reality of lags between UV and optical continuum variations in well-studied AGNs. Our results confirm the existence of such lags in NGC 7469. We find that the continuum variations at 1825 Å, 4845 Å, and 6962 Å follow those at 1315 Å by $0.22^{+0.12}_{-0.13}$ days, $1.25^{+0.48}_{-0.35}$ days, and $1.84^{+0.93}_{-0.94}$ days, respectively, based on the centroids of the cross-correlation functions; the error intervals quoted correspond to 68% confidence levels, and each of these lags is greater than zero at no less than 97% confidence. We do not find statistically significant interband continuum lags in NGC 5548, NGC

3783, or Fairall 9. Wavelength-dependent continuum lags may be marginally detected in the case of NGC 4151. However, on the basis of theoretical considerations, wavelength-dependent continuum lags in sources other than NGC 7469 are not expected to have been detectable in previous experiments. We also confirm the existence of a statistically significant lag between X-ray and UV continuum variations in the blazar PKS 2155−304.

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preprint available at astro-ph/9802103

Optical Continuum and Emission-Line Variability of Seyfert 1 Galaxies

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We present the light curves obtained during an eight-year program of optical spectroscopic monitoring of nine Seyfert 1 galaxies: 3C 120, Akn 120, Mrk 79, Mrk 110, Mrk 335, Mrk 509, Mrk 590, Mrk 704, and Mrk 817. All objects show significant variability in both the continuum and emission-line fluxes. We use cross-correlation analysis to derive the sizes of the broad Hβ-emitting regions based on emission-line time delays, or lags. We successfully measure time delays for eight of the nine sources, and find values ranging from about two weeks to a little over two months. Combining the measured lags and widths of the variable parts of the emission lines allows us to make virial mass estimates for the active nucleus in each galaxy. The virial masses are in the range $10^{7-8}\ M_{\odot}$.

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A *Hubble Space Telescope* Imaging Survey of Nearby Active Galactic Nuclei

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We have obtained WFPC2 images of 256 of the nearest ($z \leq 0.035$) Seyfert 1, Seyfert 2, and starburst galaxies. Our 500-second broadband (F606W) exposures reveal much fine-scale structure in the centers of these galaxies, including dust lanes and patches, bars, rings, wisps and filaments, and tidal features such as warps and tails. Most of this fine structure cannot be detected in ground based images. We have assigned qualitative classifications for these morphological features, a Hubble type for the inner region of each galaxy, and also measured quantitative information such as 0.18 and 0.92 arcsecond aperture magnitudes, position angles and ellipticities where possible.

There is little direct evidence for unusually high rates of interaction in the Seyfert galaxies. Slightly less than 10% of all the galaxies show tidal features or multiple nuclei. The incidence of inner starburst rings is about 10% in both classes of Seyfert galaxies. In contrast, galaxies with H II region emission line spectra appear substantially more irregular and clumpy, because of their much higher rates of current star formation per unit of galactic mass.

The presence of an unresolved central continuum source in our *HST* images is a virtually perfect indicator of a Seyfert 1 nucleus as seen by ground-based spectroscopy. Fifty-two percent (52%) of these Seyfert 1 point sources are saturated in our images; we use their wings to estimate magnitudes ranging from 15.8 to 18.5. The converse is not universally true, however, as over a third of Seyferts with direct spectroscopic evidence for broad Balmer wings show no nuclear point source. These 34 resolved Seyfert 1's have fainter nonstellar nuclei, which appear to be more extinguished by dust absorption. Like the Seyfert 2's, they have central surface brightnesses consistent with those expected for the bulges of normal galaxies.

The rates for the occurrences of bars in Seyfert 1's and 2's and non-Seyferts are the same. We found one significant morphological difference between the host galaxies of Seyfert 1 and Seyfert 2 nuclei. The Seyfert 2 galaxies are significantly more likely to show nuclear dust absorption, especially in lanes and patches which are irregular or reach close to the nucleus. A few simple tests show that the difference cannot be explained by different average redshifts or selection techniques. It is confirmed by our galaxy morphology classifications, which show that Seyfert 1 nuclei reside in earlier type galaxies than Seyfert 2 nuclei. If, as we believe, this is an intrinsic difference in host galaxy properties, it would undermine one of the postulates of the strong

unification hypothesis for Seyfert galaxies, that they merely appear different due to the orientation of their central engine. The excess galactic dust we see in Seyfert 2's may cause substantial absorption which obscures their hypothesized broad-emission-line regions and central nonstellar continua. This galactic dust could produce much of the absorption in Seyfert 2 nuclei which had instead been attributed to a thick dusty accretion torus forming the outer part of the central engine.

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A disk of shocked molecular hydrogen around the active nucleus of NGC 3079.

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A high resolution image of the nuclear regions of the active galaxy NGC 3079 has been obtained in the H_2 1–0 S(1) emission line (rest $\lambda = 2.1218$ μm) with the IRCAM3 camera on the 3.8–m UKIRT telescope. An ≈ 35 pc diameter elongated core within a more diffuse, 300 pc long, region of most likely shock–excited H_2 is shown to surround the active nucleus and be embedded within what could be an extended region of enhanced star formation. A disk of molecular gas could be present which shapes the emission of relativistic gas away from the plane of the galaxy. This nuclear H_2 1–0 S(1) emitting gas (of total mass $\approx 10^3$ $M_\odot$) is within a central dip in the distribution of cool, CO emitting, molecular gas (of total mass $\approx 10^{10}$ $M_\odot$) which extends much further from the nucleus. The distributions of both the hot and cool molecular gases are likely to be clumpy.

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Gamma-ray to radio activity and ejection of a VLBI component in the jet of the S5-quasar 0836+710

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Broad-band (gamma to radio) variations of the flux density were observed in the first half of 1992 in the luminous high redshift ($z = 2.172$) quasar S5 0836+710. VLBI monitoring observations during 1993 – 1996 performed at 86 GHz, 22 GHz, 15 GHz, and 8 GHz show the ejection of a new jet component, which most probably is directly related to a quasi simultaneous gamma–, X-ray, optical flaring activity which was observed in February 1992. During the period 1992 – 1993 the flaring propagated through the radio spectrum. From several quasi-simultaneous radio spectra taken during this phase of activity, we determine the time evolution of the spectral turnover of the radio spectrum in the S_m-ν_m diagram. The data indicate a correlation of the jet activity with the variability of the broad-band electromagnetic spectrum of the source. The observational findings are discussed in the framework of relativistic shock models.

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Announcements

The International AGN Watch

The AGN Watch is a consortium of astronomers who are studying the inner structure of active galactic nuclei (AGNs) through continuum and emission-line variability. As a group, we carry out large-scale multiwavelength monitoring programs using both space-based and ground-based facilities. AGN Watch data are intended to be available to anyone who is interested in studying AGN variability and the origin of the emission-lines and the continuum emission. At the present time, nearly all our published light curves and spectra (from IUE, HST, and ground-based telescopes) are available to download from a web site:

http://www.astronomy.ohio-state.edu/ agnwatch/

The site also contains details, including abstracts, of papers published by the AGN Watch, and by others using AGN Watch data. If you have or wish to use AGN Watch data and your paper is not referenced, then please let us know.

Intensive Blazar Monitoring Campaign: Ground Based Observations Sought

The blazar 3C279 will be observed every day, from 4 March to 15 June 1998 with the X-ray observatory RXTE. These X-ray observations provide us with the best opportunity to date of determining the lag between the X-ray and lower energy (optical/ir/mm) emission which is the crucial diagnostic of the X-ray emission mechanism in blazars. Photometry in any bands from the optical to millimetre throughout this period are strongly encouraged.

After 15 June we will continue to observe 3C279 at 3 day intervals until at least November 1998 and so observations in that period are also encouraged.

The coordinates (1950) are:

12 53 35.8 -05 31 08

The source typically varies between R=14 and 15.5; K 10 mJy. An optical finding chart can be found at

ftp://axp3.ast.man.ac.uk/outgoing/mpr/agn/finder.ps.gz

Please pass on any measurements to Ian McHardy who can be contacted for further information if required.

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The Active Galaxies Newsletter is available on the World Wide Web. You can access it via the University of Manchester home page :- http://www.ast.man.ac.uk/∼mpr/agn