| Active Galaxies Newsletter | *An electronic publication dedicated to the observation and theory of active galaxies* |
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*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. Currently the newsletter has over 500 subscribers. Latest editions and back issues are available for download in various formats from the webpage:– http://www.ast.man.ac.uk/~rb/agn/

Rob Beswick

# Abstracts of recently accepted papers

## X-ray vs. Optical Variations in the Seyfert 1 Nucleus NGC 3516: A Puzzling Disconnectedness

**Dan Maoz[1], Alex Markowitz[2], Rick Edelson[2] & Kirpal Nandra[3]**

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We present optical broadband (B and R) observations of the Seyfert 1 nucleus NGC 3516, obtained at Wise Observatory from March 1997 to March 2002, contemporaneously with X-ray 2-10 keV measurements with RXTE. With these data we increase the temporal baseline of this dataset to 5 years, more than triple to the coverage we have previously presented for this object. Analysis of the new data does not confirm the 100-day lag of X-ray behind optical variations, tentatively reported in our previous work. Indeed, excluding the first year's data, which drive the previous result, there is no significant correlation at any lag between the X-ray and optical bands. We also find no correlation at any lag between optical flux and various X-ray hardness ratios. We conclude that the close relation observed between the bands during the first year of our program was either a fluke, or perhaps the result of the exceptionally bright state of NGC 3516 in 1997, to which it has yet to return. Reviewing the results of published joint X-ray and UV/optical Seyfert monitoring programs, we speculate that there are at least two components or mechanisms contributing to the X-ray continuum emission up to 10 keV: a soft component that is correlated with UV/optical variations on timescales ¿1 day, and whose presence can be detected when the source is observed at low enough energies (about 1 keV), is unabsorbed, or is in a sufficiently bright phase; and a hard component whose variations are uncorrelated with the UV/optical.

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## The X-ray Reflectors in the Nucleus of the Seyfert Galaxy NGC 1068

**Edward J. M. Colbert[1,2,3,4], Kimberly A. Weaver[1,4], Julian H. Krolik[4], John S. Mulchaey[5] & Richard F. Mushotzky[1]**

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Based on observations of the Seyfert nucleus in NGC 1068 with ASCA, RXTE and BeppoSAX, we report the discovery of a flare (increase in flux by a factor of $\sim 1.6$) in the 6.7 keV Fe K line component between observations obtained four months apart, with no significant change in the other (6.21, 6.4, and 6.97 keV) Fe K$\alpha$ line components. During this time, the continuum flux *decreased* by $\sim$20%. The RXTE spectrum requires an Fe K absorption edge near 8.6 keV (Fe XXIII $-$ XXV). The spectral data indicate that the 2$-$10 keV continuum emission is dominated ($\sim 2/3$ of the luminosity) by reflection from a previously unidentified region of warm, ionized gas located $\lesssim$0.2 pc from the AGN. The remaining $\sim 1/3$ of the observed X-ray emission is reflected from optically thick, neutral gas. The coronal gas in the inner Narrow-Line Region (NLR) and/or the cold gas at the inner surface of the obscuring "torus" are possible cold reflectors. The inferred properties of the warm reflector are: size (diameter) $\lesssim$0.2 pc, gas density $n \gtrsim 10^{5.5}$ cm$^{-3}$, ionization parameter $\xi \approx 10^{3.5}$ erg cm s$^{-1}$, and covering fraction 0.003 $(L_0/10^{43.5}$ erg s$^{-1})^{-1} < (\Omega/4\pi) < 0.024$ $(L_0/10^{43.5}$ erg s$^{-1})^{-1}$, where $L_0$ is the intrinsic 2$-$10 keV X-ray luminosity of the AGN. We suggest that the warm reflector gas is the source of the (variable) 6.7 keV Fe line emission, and the 6.97 keV Fe line emission. The 6.7 keV line flare is assumed to be due to an increase in the emissivity of the warm reflector gas from a *decrease* (by 20$-$30%) in $L_0$. The properties of the warm reflector are most consistent with an intrinsically X-ray weak AGN with $L_0 \approx 10^{43.0}$ erg s$^{-1}$. The optical and UV emission that scatters from the warm reflector into our line of sight is required to suffer strong extinction, which can be reconciled if the line-of-sight skims the outer surface of the torus. Thermal bremsstrahlung radio emission from the warm reflector may be detectable in VLBA radio maps of the NGC 1068 nucleus.

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preprint available at http://xxx.arxiv.org/abs/astro-ph/0208158

## Continuum and Emission Line Strength Relations for a large Active Galactic Nuclei Sample

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We report on the analysis of a large sample of 744 type 1 Active Galactic Nuclei, including quasars and Seyfert 1 galaxies across the redshift range from $0 \leq z \leq 5$ and spanning nearly 6 orders of magnitude in continuum luminosity. We discuss correlations of continuum and emission line properties in the rest-frame ultraviolet and optical spectral ranges. The well established Baldwin Effect is detected for almost all emission lines from O VI$\lambda$1034 to [O III] $\lambda$5007. Their equivalent widths are significantly anti-correlated with the continuum strength, while they are nearly independent of redshift. This is the well known Baldwin Effect. Its slope $\beta$, measured as $\log W_\lambda \propto \beta \log \lambda L_\lambda(1450\text{Å})$, shows a tendency to become steeper towards higher luminosity. The slope of the Baldwin Effect also increases with the ionization energy needed to create the individual lines. In contrast to this general trend, the N V$\lambda$1240 equivalent width is nearly independent of continuum luminosity and remains nearly constant. The overall line behaviors are consistent with softer UV continuum shapes and perhaps increasing gas metallicity in more luminous Active Galactic Nuclei.

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## An Unexpectedly High Fraction of Active Galactic Nuclei in Red Cluster Galaxies

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As part of a program to study the evolution of active galactic nuclei (AGN) in clusters of galaxies, we present our results for Abell 2104. A deep Chandra observation of this massive, $z = 0.154$ cluster reveals a significant X-ray point source excess over the expectations of blank fields, including eight X-ray counterparts with $R < 20$ mag. Our spectroscopy shows that all six X-ray sources associated with red counterparts are cluster members and their X-ray properties are consistent with all of them being AGN. Only one of the six has the emission lines characteristic of optically selected AGN; the remaining five would not have been classified as AGN based on their optical spectra. This suggests the existence of a large population of obscured, or at least optically unremarkable, AGN in clusters of galaxies. These six sources correspond to a lower limit of ∼5% of the AGN fraction in cluster galaxies with $R < 20$ mag (rest-frame $M_V = -19.5$ mag) and is comparable to the blue galaxy fraction in the cluster. Such an obscured AGN population in clusters of galaxies has many implications for cluster galaxy evolution, the hidden growth of their central, supermassive black holes, estimates of the star formation rate at far-infrared and radio wavelengths, and the observed variance in the hard X-ray background.

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## Optical and Near-Infrared Imaging of the IRAS 1-Jy Sample of Ultraluminous Infrared Galaxies: I. The Atlas.

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An imaging survey of the *IRAS* 1-Jy sample of 118 ultraluminous infrared galaxies was conducted at optical (R) and near-infrared (K') wavelengths using the University of Hawaii 2.2m telescope. The methods of observation and data reduction are described. An R and K' atlas of the entire sample is presented along with some of the basic astrometric and photometric parameters derived from these images. A more detailed analysis of these data is presented in a companion paper (Veilleux, Kim, & Sanders 2002; astro-ph/0207401)

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preprint available at http://www.astro.umd.edu/∼veilleux/pubs/paper1.tar.gz (also astro-ph/0207373)

## Optical and Near-Infrared Imaging of the IRAS 1-Jy Sample of Ultraluminous Infrared Galaxies: II. The Analysis.

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An $R$ & $K'$ atlas of the *IRAS* 1-Jy sample of 118 ultraluminous infrared galaxies (ULIGs) was presented in a companion paper (Kim, Veilleux, & Sanders 2002; Paper I). The present paper discusses the results from the analysis of these images supplemented with new spectroscopic data obtained at Keck. All but one object in the 1-Jy sample show signs of a strong tidal interaction/merger. Multiple mergers involving more than two galaxies are seen in no more than 5 of the 118 (< 5%) systems. None of the 1-Jy sources is in the first-approach stage of the interaction, and most (56%) of them harbor a single disturbed nucleus and are therefore in the later stages of a merger. Seyfert galaxies (especially those of type 1), warm ULIGs ($f_{25}/f_{60} > 0.2$) and the more luminous systems ($> 10^{12.5}\ L_\odot$) all show a strong tendency to be advanced mergers with a single nucleus.

The individual galaxies in the binary systems of the 1-Jy sample show a broad distribution in host magnitudes (luminosities) with a mean of $-21.02 \pm 0.76$ mag. ($0.85 \pm ^{0.86}_{0.43}\ L^*$) at $R$ and $-23.98 \pm 1.25$ mag. ($0.90 \pm ^{1.94}_{0.61}\ L^*$) at $K'$, and a $R$- or $K'$-band luminosity ratio generally less than $\sim 4$. Single-nucleus ULIGs also show a broad distribution in host magnitudes (luminosities) with an average of $-21.77 \pm 0.92$ mag. ($1.69 \pm ^{2.25}_{0.97}\ L^*$) at $R$ and $-25.03 \pm 0.94$ mag. ($2.36 \pm ^{3.24}_{1.38}$) at $K'$. These distributions

overlap considerably with those of quasars. The same statement applies to $R - K'$ colors in ULIG and quasar hosts.

An analysis of the surface brightness profiles of the host galaxies in single-nucleus sources reveals that about 73% of the $R$ and $K'$ surface brightness profiles are fit adequately by an elliptical-like $R^{1/4}$-law. These elliptical-like 1-Jy systems have luminosity and $R$-band axial ratio distributions that are similar to those of normal (inactive) intermediate-luminosity ellipticals and follow with some scatter the same $\mu_e - r_e$ relation, giving credence to the idea that some of these objects may eventually become intermediate-luminosity elliptical galaxies if they get rid of their excess gas or transform this gas into stars. These elliptical-like hosts are most common among merger remnants with Seyfert 1 nuclei (83%), Seyfert 2 optical characteristics (69%) or mid-infrared (*ISO*) AGN signatures (80%). The mean half-light radius of these ULIGs is $4.80 \pm 1.37$ kpc at $R$ and $3.48 \pm 1.39$ kpc at $K'$, typical of intermediate-luminosity ellipticals. These values are in excellent agreement with recent quasar measurements obtained at $H$ with *HST*, but are systematically lower than other *HST* measurements derived at $R$. The reason for this discrepancy between the two quasar datasets is not known.

In general, the results from the present study are consistent with the merger-driven evolutionary sequence "cool ULIGs → warm ULIGs → quasars." However, many exceptions appear to exist to this simple picture (e.g., 46% of the 41 advanced mergers show no obvious signs of Seyfert activity). This underlines the importance of using a large homogeneous sample like the 1-Jy sample to draw statistically meaningful conclusions; the problems of small sample size and/or inhomogeneous selection criteria have plagued many studies of luminous infrared galaxies in the past.

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## The Apparent Host Galaxy of PKS 1413+135: *HST*, *ASCA* and VLBA Observations

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PKS 1413+135 ($z = 0.24671$) is one of very few radio-loud AGN with an apparent spiral host galaxy. Previous authors have attributed its nearly exponential infrared cutoff to heavy absorption but have been unable to place tight limits on the absorber or its location in the optical galaxy. In addition, doubts remain about the relationship of the AGN to the optical galaxy given the observed lack of re-emitted radiation. We present new *HST*, *ASCA* and *VLBA* observations which throw significant new light on these issues. The *HST* observations reveal that the active nucleus of PKS 1413+135 has an extremely red color: $V - H = 6.9$ mag, requiring both a spectral turnover at a few microns due to synchrotron aging and a giant molecular cloud-sized absorbing region. Combining constraints from the *HST* and *ASCA* data we derive an intrinsic column $N_H = 4.6^{+2.1}_{-1.6} \times 10^{22}$ cm$^{-2}$ and covering fraction $f = 0.12^{+0.07}_{-0.05}$. The spin temperature of the molecular absorption lines found by previous authors suggests that the cloud is located in the disk of the optical galaxy, making our sightline rather unlikely ($P \sim 2 \times 10^{-4}$). The properties of this region appear typical of large giant molecular clouds in our own galaxy. The HI absorber appears centered 25 milliarcseconds away from the nucleus, while the X-ray and nearly all of the molecular absorbers must cover the nucleus, implying a rather complicated geometry and cloud structure, in particular requiring a molecular core along our line of sight to the nucleus. Interestingly, the *HST*/NICMOS data require the AGN to be decentered relative to the optical galaxy by $13 \pm 4$ milliarcseconds. This could be interpreted as suggestive of an AGN location far in the background compared to the optical galaxy, but it can also be explained by obscuration and/or nuclear structure, which is more consistent with the observed lack of multiple images.

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preprint available at http://www.arXiv.org/astro-ph/0208167

## The Kinematics and Physical Conditions of the Ionized Gas in Markarian 509. I. *Chandra* High-Energy Grating Spectroscopy

**Tahir Yaqoob[1,2], Barry McKernan[2], Steven B. Kraemer [3,4], D. Michael Crenshaw[5], Jack R. Gabel[3,4], Ian M. George[2,6] & T. Jane Turner[2,6]**

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We observed the Seyfert 1 galaxy Mrk 509 for $\sim$ 59 ks with the *Chandra* High-Energy Transmission Gratings, simultaneously with *HST*/STIS and *RXTE*. Here we present a detailed analysis of the soft X-ray spectrum observed with *Chandra*. We measure strong absorption lines from He-like Ne and Mg, and from H-like N, O, and Ne. Weaker absorption lines may also be present. The lines are unresolved except for Ne X Ly$\alpha$ ($\lambda 12.134 Å$) and Ne IX $1s^2 - 1s2p$ ($\lambda 13.447 Å$), which appear to be marginally resolved. The profiles are blueshifted with respect to the systemic velocity of Mrk 509, indicating an outflow of $\sim -200$ km s$^{-1}$. There is also a hint that the profiles may have a velocity component near systemic. The soft X-ray spectrum can be described in remarkable detail with a simple, single-zone photoionized absorber having an equivalent neutral Hydrogen column density of $2.06^{+0.39}_{-0.45} \times 10^{21}$ cm$^{-2}$ and an ionization parameter of $\log \xi = 1.76^{+0.13}_{-0.14}$ (or $\log U = 0.27$). Although the photoionized gas almost certainly is comprised of matter in more than one ionization state and may consist of several kinematic components, data with better spectral resolution and signal-to-noise would be required to justify a more complex model. The UV data, on the other hand, have a velocity resolution of $\sim$ 10 km s$^{-1}$ and can easily detect eight kinematic components, covering roughly the same velocities as the X-ray absorption profiles. Even though the X-ray and UV absorbers share the same velocity space, the UV absorbers have a much smaller column density and ionization state. We show that models of the X-ray data do not predict significant UV absorption and are therefore consistent with the UV data. Finally, we do not detect any soft X-ray emission lines.

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## The Kinematics and Physical Conditions of the Ionized Gas in Markarian 509. II. STIS Echelle Observations.

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We present observations of the UV absorption lines in the luminous Seyfert 1 galaxy Mrk 509, obtained with the medium resolution ($\lambda/\Delta\lambda \approx 40{,}000$) echelle gratings of the Space Telescope Imaging Spectrograph on the *Hubble Space Telescope*. The spectra reveal the presence of eight kinematic components of absorption in Ly$\alpha$, C IV, and N V, at radial velocities of $-422$, $-328$, $-259$, $-62$, $-22$, $+34$, $+124$, and $+$ 210 km s$^{-1}$ with respect to an emission-line redshift of z = 0.03440, seven of which were detected in an earlier *Far Ultraviolet Spectrographic Explorer (FUSE)* spectrum. The component at $-22$ km s$^{-1}$ also shows absorption by Si IV. The covering factor and velocity width of the Si IV lines were lower than those of the higher ionization lines for this component, which is evidence for two separate absorbers at this velocity. We have calculated photoionization models to match the UV column densities in each of these components. Using the predicted O VI column densities, we were able to match the O VI profiles observed in the *FUSE* spectrum. Based on our results, none of the UV absorbers can produce the X-ray absorption seen in simultaneous *Chandra* observations; therefore, there must be more highly ionized gas in the radial velocity ranges covered by the UV kinematic components.

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## The Structure and Energetics of Active Galactic Nuclei

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The black-hole/accretion-disk paradigm for active galactic nuclei (AGNs) is now reasonably secure, but there are still important unresolved issues, some of which will require the capabilities of an 8 to 10 m class ultraviolet/optical space-based telescope. Imaging spectroscopy with a diffraction-limited large telescope will be required to measure AGN black-hole masses from stellar dynamics for direct comparison with reverberation mapping-based masses. High spectral resolution in the ultraviolet (UV) is required to determine the mass and kinetic energy of the outflows observed in the absorption spectra of AGNs and to understand the energetics of the accretion process. As with ground-based astronomy, however, effective use of a large UV/optical space telescope requires complementary smaller facility instruments; a meter-class UV spectroscopic telescope, for example, can fit into a Medium Explorer budget.

An invited presentation to appear in *Hubble's Science Legacy: Future Optical–Ultraviolet Astronomy from Space*, ed. K. Sembach, J.C. Blades, G.D. Illingworth, & R.C. Kennicutt (San Francisco: Astronomical Society of the Pacific)

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## Steps Toward Determination of the Size and Structure of the Broad-Line Region in Active Galactic Nuclei. XVI. A Thirteen-Year Study of Spectral Variability in NGC 5548

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We present the final installment of an intensive 13-year study of variations of the optical continuum and broad H$\beta$ emission line in the Seyfert 1 galaxy NGC 5548. The data base consists of 1530 optical continuum measurements and 1248 H$\beta$ measurements. The H$\beta$ variations follow the continuum variations closely, with a typical time delay of about 20 days. However, a year-by-year analysis shows that the magnitude of emission-line time delay is correlated with the mean continuum flux. We argue that the data are consistent with the simple model prediction between the size of the broad-line region and the ionizing luminosity, $r \propto L_{\rm ion}^{1/2}$. Moreover, the apparently linear nature of the correlation between the H$\beta$ response time and the nonstellar optical continuum $F_{\rm opt}$ arises as a consequence of the changing shape of the continuum as it varies, specifically $F_{\rm opt} \propto F_{\rm UV}^{0.56}$.

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# Meetings

## Invitation to a Workshop in The Neutral ISM in Starburst Galaxies

Gothenburg, Sweeden
June 25-28, 2003

**First announcement:**

**Scientific Organizing Comittee:**

**S. Aalto, A. Pedlar, S. Huttemeister, K. Wills, W. Baan, N. Scoville, T. Heckman, R. Booth, M. Ward**

Recent development in mm and cm aperture synthesis, as well as sub-mm single dish technology has led to a flood of new observations of the neutral ISM in nearby and distant starburst galaxies. Molecular and atomic hydrogen lines from many starburst galaxies can now be observed on arcsecond and even subarcsecond scales. This development enables new approaches to, and a deeper understanding of, the structure, dynamics and physical conditions of the nuclear ISM in UltraLuminous Galaxies (ULIRGs) and starbursts. The neutral ISM is particularly important in the inner regions of starbursts where it dominates the mass of the interstellar medium (and in some cases may even dominate the total central mass). Thus, observing and modelling the neutral ISM is essential for understanding the onset and evolution of the burst of starformation as well as its terminating mechanisms.

SPECIFIC ISSUES TO BE ADDRESSED INCLUDE:

**Recent developments in the modelling of structure and physical conditions of unresolved cloud ensembles. Fitting ISM models to observational data.**

- Mass distribution between diffuse (unbound) molecular gas and self-gravitating gas in compact and extended starbursts.
- Mass distribution between atomic and molecular gas — the role and origin of the two phases. Mass and temperature distribution of the dust - is there evidence of cold dust?

**Limiting star formation rates in starbursts and ULIRGs —**
**Can we relate the properties of the ISM to starformation rates?**
**Are the enormous IR fluxes in ULIRGs caused by extremely effective or unusual star formation?**
**Are other processes than star formation significantly adding to the IR flux?**

- Observation and formation of massive star clusters
- Starburst feedback and self-regulation

**The dynamics of the ISM and the rate of star formation - preventing or encouraging star formation?**

- The role of bars in enhancing star formation rates.
- Shocks as triggers of star formation.
- Holes/bubbles in the neutral gas - the footprints of earlier starformation?

The workshop will consist of half-hour review talks followed by 3-4 contributed talks (10-15 minutes each). There will also be a poster session. For more information, and to be put on the mailing list for the second announcement, or preregistration, contact:

**Susanne Aalto**, email: susanne@oso.chalmers.se, fax: +46-300-35590, phone: +46-300-35506.

We are working on a website for the workshop where you can register and where more information on venue, costs, invited speakers etc can be found.

Website:**www.oso.chalmers.se/workshop/**

It will be fully available at the time for the second announcement.

Intended number of participants: 50
Conference fee: 250 Euros (incl. Proceedings, conference dinner and excursions)

*We plan to hold a second workshop in 2004 in Bochum, Germany. There will be more information on this later.*

# Jobs

## POSTDOCTORAL POSITION IN EXTRAGALACTIC ASTRONOMY

UNIVERSITY OF HERTFORDSHIRE
FACULTY OF NATURAL SCIENCES
DEPARTMENT OF PHYSICAL SCIENCES

We wish to appoint a postdoctoral research assistant to support a major research project on Active Galactic Nuclei. The underlying aim of this project is to understand the structure of the unresolved nucleus and in particular, the geometry and kinematics of the broad emission-line region and the distribution of the surrounding scattering and obscuring material. This work is largely based on optical and near-IR imaging polarimetry and spectropolarimetry, but other techniques are also used. In the near future we aim to extend the project by taking advantage of new opportunities afforded by the continuing development of the Gemini telescopes and full UK participation in the European Southern Observatory. The observational programme is supported by extensive computer modelling.

Applicants should either hold a PhD in astronomy/astrophysics, or expect to be awarded one within the next few months. The successful candidate will be capable of working as a member of a research group, as well as on their own. Candidates with experience in any branch of observational astronomy are invited to apply. Applicants with experience in imaging polarimetry, spectropolarimetry and/or spectroscopy are particularly welcome.

This post is **available from 1 October, 2002**, and will be for 18 months in the first instance. The salary will be in the range 18,681 to 22,236 UKP depending on skills and experience.

Informal enquiries to Dr Andy Robinson (telephone: +44-1707 286072; e-mail ar@star.herts.ac.uk), or Prof Jim Hough (telephone: +44-1707 284500; e-mail jhh@star.herts.ac.uk). Additional information on the University of Hertfordshire Astrophysics Research Group can be found at http://strc.herts.ac.uk/.

Application forms can be obtained from the Personnel Department at the University of Hertfordshire, College Lane, Hatfield, Herts AL10 9AB, United Kingdom, or telephone 01707 284802, quoting reference number H6027). The completed application forms (accompanied by a full CV and personal statement of plans for future research) should be returned to the Personnel Department.

**Closing date for applications to be received is September 15, 2002.**

The University is an Equal Opportunity Employer

E-mail contact: Dr Andy Robinson: ar@star.herts.ac.uk

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/~rb/agn/
If you move or your e-mail address changes, please send the editor your new address. If the Newsletter repeatedly bounces back from an address then that address is deleted from the mailing list.