Active Galaxies Newsletter	*An electronic publication dedicated to the observation and theory of active galaxies*
No. 102 — September 2005	Editor: Rob Beswick (rb@ast.man.ac.uk)

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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 *Chandra* X-Ray Survey of Ultraluminous Infrared Galaxies

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We present results from *Chandra* observations of 14 ultraluminous infrared galaxies (ULIRGs; $\log(L_{IR}/L_{\odot}) \geq 12$) with redshifts between 0.04 and 0.16. The goals of the observations were to investigate any correlation between infrare d color or luminosity and the properties of the X-ray emission and to attempt to determine whether these objects are powered by starbursts or active galactic nuclei (AGNs). The sample contains approximately the same number of high and low luminosity obj ects and "warm" and "cool" ULIRGs. All 14 galaxies were detected by *Chandra*. Our analysis shows that the X-ray emission of the two Seyfert 1 galaxies in our sample are dominated by AGN. The remaining 12 sources are too faint for conventional spectral fitting to be applicable. Hardness ratios were used to estimate the spectral properties of these faint sources. The photon indices, Γ's, for our sample plus the *Chandra*–observed sample from Ptak et al.(2003) peak in the range of 1 .0–1.5, consistent with expectations for X-ray binaries in a starburst, an absorbed AGN, or hot bremsstrahlung from a starburst or AGN. The values of Γ for the objects in our sample classified as Seyferts (type 1 or 2) are larger than 2, while th ose classified as HII regions or LINERs tend to be less than 2. The hard X-ray to far-infrared ratios for the 12 weak sources are similar to those of starbursts, but we cannot rule out the possibility of absorbed, possibly Compton-thick, AGNs in some of these objects. Two of these faint sources were found to have X-ray counterparts to their double optical and infrared nuclei.

Accepted by the Astrophysical Journal

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The High Energy Spectrum of NGC 4151

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We present the first *INTEGRAL* observations of the type 1.5 Seyfert galaxy NGC 4151. Combining several *INTEGRAL* observations performed during 2003, totaling ~ 400 ks of exposure time, allows us to study the spectrum in the $2 - 300$ keV range. The measurements presented here reveal an overall spectrum from X-rays up to soft gamma-rays that can be described by an absorbed ($N_{\rm H} = 6.9 \times 10^{22}\,{\rm cm}^{-2}$) model based on a Compton continuum from a hot electron population ($kT_e = 94\,{\rm keV}$) from an optically thick ($\tau = 1.3$) corona, reflected on cold material ($R = 0.7$), consistent with earlier claims. The time resolved analysis shows little variation of the spectral parameters over the duration of the *INTEGRAL* observations. The comparison with *CGRO*/OSSE data shows that the same spectral model can be applied over a time span of 15 years, wit h flux variations of the order of a factor of 2 and changes in the underlying continuum reflected by the temperature of the electron population ($kT_e = 50 - 100\,{\rm keV}$). When modeled with an exponentially cut-off power law plus Compton reflection this results in photon indices ranging from $\Gamma = 1.5$ to $\Gamma = 1.9$ and a cut-off energy in the range $100 - 500\,{\rm keV}$.

Accepted by ApJ

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The X-ray Spectral Properties of SCUBA Galaxies

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Deep SCUBA surveys have uncovered a large population of massive submillimeter emitting galaxies (SMGs; $f_{850\mu m} \gtrsim$ 4 mJy) at $z \gtrsim 1$. Although it is generally believed that these galaxies host intense star-formation activity, there is growing evidence that a substantial fraction also harbor an Active Galactic Nucleus [AGN; i.e., an accreting super-massive black hole (SMBH)]. We present here possibly the strongest evidence for this viewpoint to date: the combination of ultra-deep X-ray observations (the 2 Ms *Chandra* Deep Field-North) and deep Keck spectroscopic data of SMGs with radio counterparts. We find that the majority ($\approx 75\%$) of these radio-selected spectroscopically identified SMGs host AGN activity; the other $\approx 25\%$ have X-ray properties consistent with star formation (X-ray derived star-formation rates of $\approx$ 1300–2700 $M_\odot$ yr^{-1}). The AGNs have properties generally consistent with those of nearby luminous AGNs ($\Gamma \approx 1.8 \pm 0.5$, $N_{\rm H} \approx 10^{20}$–$10^{24}$ cm^{-2}, and $L_{\rm X} \approx 10^{43}$–$10^{44.5}$ erg s^{-1}) and the majority ($\approx 80\%$) are heavily obscured ($N_{\rm H} \gtrsim 10^{23}$ cm^{-2}). We construct composite rest-frame 2–20 keV spectra for three different obscuration classes ($N_{\rm H} < 10^{23}$ cm^{-2}, $N_{\rm H}$ = 1–5 $\times 10^{23}$ cm^{-2}, and $N_{\rm H} > 5 \times 10^{23}$ cm^{-2}) which reveal features not seen in the individual X-ray spectra. An $\approx$ 1 keV equivalent width Fe Kα emission line is seen in the composite X-ray spectrum of the most heavily obscured AGNs, suggesting Compton-thick or near Compton-thick absorption. Even taking into account the effects of absorption, we find that the average X-ray to far-infrared luminosity ratio of the AGN-classified SMGs ($\frac{L_{\rm X}}{L_{\rm FIR}} = 0.004$) is approximately one order of magnitude below that found for typical quasars. This result suggests that intense star-formation activity (of order ≈ 1000 $M_\odot$ yr^{-1}) dominates the bolometric output of these SMGs. However, we also explore the possibility that the X-ray to far-infrared luminosity ratio of the AGN components is intrinsically less than that found for typical quasars and postulate that some SMGs may be AGN dominated. We investigate the implications of our results for the growth of massive black holes,discuss the prospects for deeper X-ray observations, and explore the scientific potential offered by the next generation of X-ray observatories.

Accepted by Astrophys. J.

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Rapid Growth of Black Holes in Massive Star-Forming Galaxies

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The tight relationship between the masses of black holes and galaxy spheroids in nearby galaxies implies a causal connection between the growth of these two components. Optically luminous quasars host the most prodigious accreting black holes in the Universe and can account for $\gtrsim 30$ % of the total cosmological black-hole growth. As typical quasars are not, however, undergoing intense star formation and already host massive black holes ($> 10^8$ $M_\odot$), there must have been an earlier pre-quasar phase when these black holes grew (mass range $\approx 10^6$–10^8 $M_\odot$). The likely signature of this earlier stage is simultaneous black-hole growth and star formation in distant (i.e., $z > 1$; > 8 billion light years away) luminous galaxies. Here we report ultra-deep X-ray observations of distant star-forming galaxies that are bright at submillimetre wavelengths. We find that the black holes in these galaxies are growing almost continuously throughout periods of intense star formation. This activity appears to be more tightly associated with these galaxies than any other coeval galaxy populations. We show that the black-hole growth from these galaxies is consistent with that expected for the pre-quasar phase.

Nature, 434, 738

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On the X-ray Properties of OH Megamaser Sources: Chandra Snapshot Observations

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We present *Chandra* snapshot observations for a sample of 7 sources selected from the Arecibo OH megamaser (OHM) survey at $z \approx 0.13 - 0.22$ and with far-infrared luminosities in excess of 10^{11} $L_\odot$. In contrast with the known H_2O megamasers, which are mostly associated with powerful Active Galactic Nuclei (AGN), the situation is far less clear for OHMs, which have been poorly studied in the X-ray band thus far. All of the observed sources are X-ray weak, with only one OHM, IRAS FSC 03521+0028 ($z = 0.15$), being detected by *Chandra* (with 5 counts). The results from this pilot program indicate that the X-ray emission, with luminosities of less than $\approx 10^{42}$ erg s^{-1}, is consistent with that from star formation (as also suggested in some cases by the optical spectra) and low-luminosity AGN emission. If an AGN is present, its contribution to the broad-band emission of OHM galaxies is likely modest. Under reasonable assumptions about the intrinsic X-ray spectral shape, the observed count distribution from stacking analysis suggests absorption of $\approx 10^{22}$ cm^{-2}.

Accepted by MNRAS

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Sub-arcsecond imaging of the radio continuum and neutral hydrogen in the Medusa merger

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We present sub-arcsecond, Multi-Element Radio Linked Interferometer (MERLIN) observations of the decimetre radio continuum structure and neutral hydrogen (HI) absorption from the nuclear region of the starburst galaxy NGC 4194 (the Medusa Merger). The continuum structure of the central kiloparsec of the Medusa has been imaged, revealing a pair of compact radio components surrounded by more diffuse, weak radio emission. Using the constraints provided by these observations and those within the literature we conclude that the majority of this radio emission is related to the ongoing star-formation in this merger system.

With these observations we also trace deep HI absorption across the detected radio continuum structure. The absorbing HI gas structure exhibits large variations in column densities. The largest column densities are found toward the south of the nuclear radio continuum, co-spatial with both a nuclear dust lane and peaks in ^{12}CO (1→0) emission. The dynamics of the HI absorption, which are consistent with lower resolution ^{12}CO emission observations, trace a shallow north-south velocity gradient of $\sim$320 km s^{-1} kpc^{-1}. This gradient is interpreted as part of a rotating gas structure within the nuclear region. The HI and CO velocity structure, in conjunction with the observed gas column densities and distribution, is further discussed in the context of the fuelling and gas physics of the ongoing starburst within the centre of this merger.

Accepted by Astronomy & Astrophysics

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The Radio Quiescence of Active Galaxies with High Accretion Rates

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We present 6 cm Very Large Array observations of the Greene & Ho (2004) sample of 19 low-mass active galaxies with high accretion rates. This is one of the only studies of a uniform sample of narrow-line Seyfert 1 (NLS1) galaxies with such high sensitivity and resolution. Although we detect only one source, the entire sample is very radio-quiet down to strong limits. GH10 was found to have a radio power of 8.5 $\times 10^{21}$ W Hz^{-1}, and a ratio $R \equiv f_{\rm 6cm}/f_{4400\ \text{Å}}$ of 2.8. The 3 σ upper limits for the remaining nondetections correspond to radio powers from 3×10^{20} to 8×10^{21} W Hz^{-1}and $0.47 < R < 9.9$. Stacking all nondetections yields an even stronger upper limit of $R \leq 0.27$. An assessment of existing observations in the literature confirms our finding that NLS1s are consistently radio-quiet, with a radio-loud fraction of 0%–6%, which is significantly lower than the 10%–20% observed in the general quasar population. By analogy with stellar-mass black holes, we argue that AGNs undergo a state transition at $L_{\rm bol}/L_{\rm Edd} \approx 0.01$. Below this value a radiatively inefficient accretion flow effectively drives an outflow, which disappears when the flow turns into an optically thick, geometrically thin disk, or a radiation pressure-dominated slim disk at still higher $L_{\rm bol}/L_{\rm Edd}$.

Accepted by *The Astrophysical Journal*

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Estimating Black Hole Masses in Active Galaxies Using the Hα Emission Line

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It has been established that virial masses for black holes in low-redshift active galaxies can be estimated from measurements of the optical continuum strength and the width of the broad Hβ line. Under various circumstances, however, both of these quantities can be challenging to measure or can be subject to large systematic uncertainties. To mitigate these difficulties, we present a new method for estimating black hole masses. From analysis of a new sample of broad-line active galactic nuclei, we find that Hα luminosity scales almost linearly with optical continuum luminosity and that a strong correlation exists between Hα and Hβ line widths. These two empirical correlations allow us to translate the standard virial mass system to a new one

based solely on observations of the broad Hα emission line.

To appear in *The Astrophysical Journal*

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preprint available at http://arxiv.org/abs/astro-ph/0508335