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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

Statistical Properties of Radio Emission from the Palomar Seyfert Galaxies

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We have carried out an analysis of the radio and optical properties of a statistical sample of 45 Seyfert galaxies from the Palomar spectroscopic survey of nearby galaxies. We find that the space density of bright galaxies (-22 mag $\leq M_{B_T} \leq -18$ mag) showing Seyfert activity is $(1.25 \pm 0.38) \times 10^{-3}$ Mpc^{-3}, considerably higher than found in other Seyfert samples. Host galaxy types, radio spectra, and radio source sizes are uncorrelated with Seyfert type, as predicted by the unified schemes for active galaxies. Approximately half of the detected galaxies have flat or inverted radio spectra, more than expected based on previous samples. Surprisingly, Seyfert 1 galaxies are found to have somewhat stronger radio sources than Seyfert 2 galaxies at 6 and 20 cm, particularly among the galaxies with the weakest nuclear activity. We suggest that this difference can be accommodated in the unified schemes if a minimum level of Seyfert activity is required for a radio source to emerge from the vicinity of the active nucleus. Below this level, Seyfert radio sources might be suppressed by free-free absorption associated with the nuclear torus or a compact narrow-line region, thus accounting for both the weakness of the radio emission and the preponderance of flat spectra. Alternatively, the flat spectra and weak radio sources might indicate that the weak active nuclei are fed by advection-dominated accretion disks.

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preprint available at http://xxx.lanl.gov/abs/astro-ph/0105373

X-ray outbursts from nearby 'normal' and active galaxies
a review, new radio observations, and an X-ray search for further tidal disruption flares

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In the last few years, giant-amplitude, non-recurrent X-ray flares have been observed from several non-active galaxies (NGC 5905, RXJ1242-11, RXJ1624+75, RXJ1420+53, RXJ1331-32). All of them share similar properties, namely: extreme X-ray softness in outburst, huge peak luminosity (up to $\sim 10^{44}$ erg/s), and the absence of optical signs of Seyfert activity. Tidal disruption of a star by a supermassive black hole is the favored explanation of these unusual events.

We present a review of the previous results, a search for radio emission from all outbursters, based on the NVSS database, and dedicated radio observations of NGC 5905 carried out with the VLA. These provide important constraints on the presence of an (obscured) active nucleus (AGN) at the center of each flaring galaxy.

We rigorously explore AGN scenarios to account for the unusual X-ray outbursts from the optically 'normal' galaxies and find AGN-related models highly unlikely. We conclude that the previously favored scenario – tidal disruption of a star by a supermassive black hole at the center of each of the outbursters – provides the best explanation for the X-ray observations.

Finally, we present results from our on-going search for further X-ray flares, in a first step from a sample of ∼140 nearby active and non-active galaxies, using the *ROSAT* data base. nearby galaxies also includes active galaxies. While we do not find another X-ray flaring normal galaxy among this sample – entirely consistent with the predictions of the tidal disruption scenario – several highly variable *active* galaxies are detected. Their variability is not linked to tidal disruption, but best explained in terms of absorption or accretion-disk-related models.

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MERLIN imaging of the maser flare in Markarian 348

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MERLIN images of Mrk 348 at 22 GHz show H_2O maser emission at 0.02 – 0.11 Jy, within ~ 0.8 pc of the nucleus. This is the first direct confirmation that molecular material exists close to the Seyfert 2 nucleus. Mrk 348 was observed in 2000 May one month after Falcke et al. (2000) first identified the maser in single-dish spectra. The peak maser flux density has increased about threefold. The masing region is ≤ 0.6 pc in radius. The flux density of radio continuum emission from the core has been rising for about 2 years. The maser-core separation is barely resolved but at the 3σ significance level they are not coincident along the line of sight. The masers lie in the direction of the northern radio lobes and probably emanate from material shocked by a jet with velocity close to c. The correlation between the radio continuum increase and maser flare is explained as arising from high level nuclear activity through a common excitation mechanism although direct maser amplification of the core by masers tracing a Keplerian disc is not completely ruled out.

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A NICMOS imaging study of high-z quasar host galaxies

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We present the first results from a major Hubble Space Telescope programme designed to investigate the cosmological evolution of quasar host galaxies from $z \sim 2$ to the present day. Here we describe J and H-band NICMOS imaging of two quasar samples at redshifts of 0.9 and 1.9 respectively. Each sample contains equal numbers of radio-loud and radio-quiet quasars, selected to lie within the same narrow range of optical absolute magnitude ($-24 > M_V > -25$). Filter and target selection were designed to ensure that at each redshift the images sample the same part of the object's rest-frame spectrum, avoiding potential contamination by [OIII]λ5007 and Hα emission lines. At $z = 1$ the hosts of both radio-loud and radio-quiet quasars lie on the same Kormendy relation described by 3CR radio galaxies at comparable redshift. There is some evidence for a gap of ~ 1 mag between the host luminosities of RLQs and RQQs, a difference that cannot be due to emission-line contamination given the design of our study. However, within current uncertainties, simple passive stellar evolution is sufficient to link these galaxies with the elliptical hosts of low-redshift quasars of comparable nuclear output, implying that the hosts are virtually fully assembled by $z = 1$. At $z = 2$ the luminosity gap appears to have widened further to ~ 1.5 mag. Thus while the hosts of radio-loud quasars remain consistent with a formation epoch of $z > 3$, allowing for passive evolution implies that the hosts of radio-quiet quasars are $\sim 2 - 4$ times less massive at $z = 2$ than at low z.

If the relationship between black-hole and spheroid mass is unchanged out to redshift $z = 2$, then our results rule out any model of quasar evolution which involves a substantial component of luminosity evolution. Rather, this study indicates that at $z = 2$ there is a substantial increase in the number density of active black holes, along with a moderate increase in the fueling efficiency of a typical observed quasar. The fact that this latter effect is not displayed by the radio-loud objects in our sample might be explained by a selection effect arising from the fact that powerful radio sources are only produced by the most massive black holes.

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The cores of Local Group galaxies at X-rays

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The *ROSAT* Public Archive was used to include a substantial fraction of all Local Group galaxies in a search for low-level active nuclei. Being the nearest galaxies, these objects offer the best spatial resolution and can be examined till the lowest luminosity levels. The *ROSAT* data for the centers of 18 Local Group members have been analysed, in 13 cases for the first time. For another 6 (mostly major) Local Group galaxies the *ROSAT* data have been discussed extensively in the literature and these results are included in the subsequent Discussion. Positive or possible detections occur only in four of the major Local Group members, three of which are Spirals. Another two sources in smaller, Irregular galaxies are close to the formal optical positions of the systems but it is doubtful that these refer to proper nuclei and the two sources are considered "suspicious". The Galactic Center source Sgr A* still represents the lowest level of nuclear activity within the Local Group. Since the four detections refer to the (five) optically most luminous members of the Local Group, galaxies appear to need at least $L_B \gtrsim 10^8\ L_{B,\odot}$ for hosting a core with some level of activity. The four central X-ray sources are candidate massive black holes. Supporting evidence from data at other wavelengths or from dynamical analyses exists for most of these. There could thus be up to four massive black holes immediately around us. The remaining systems (Irregular and smaller spheroidal galaxies) do not seem to contain massive central black holes.

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A complete sample of Seyfert galaxies selected at 1/4 keV

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We have used the *ROSAT* Bright Source Catalogue to extract a complete sample of sources selected in the band from 0.1–0.4 keV. This 1/4 keV-selected sample is comprised of 54 Seyfert galaxies, 25 BL Lacertae objects, 4 clusters and 27 Galactic stars or binaries. Seyfert-type galaxies with "ultrasoft" X-ray spectra can very often be classed optically as Narrow-line Seyfert 1s (NLS1s). Such objects are readily detected in 1/4 keV surveys; the sample reported here contains 20 NLS1s, corresponding to a 40% fraction of the Seyferts. Optical spectra of the Seyfert galaxies were gathered for correlative analysis, which confirmed the well-known relations between X-ray slope and optical spectral properties (e.g., [O III]/Hβ ratio; Fe II strength, Hβ width). The various intercorrelations are most likely driven, fundamentally, by the shape of the photoionising continuum in Seyfert nuclei. We argue that a steep X-ray spectrum is a better indicator of an "extreme" set of physical properties in Seyfert galaxies than is the narrowness of the optical Hβ line.

The correlation studies were also used to isolate a number of Seyfert galaxies with apparently "anomalous" properties. Of particular interest are the six objects with relatively weak permitted line emission (Hβ and Fe II) and weak optical continua. Such objects are rare in most surveys, but two of these (IC 3599 and NGC 5905) are known to be transient active galactic nuclei in which the X-ray flux has faded by factors ~100. If the other four objects also turn out to be transient, this would demonstrate that 1/4 keV surveys provide an efficient way of finding an interesting class of object.

Finally, the luminosity function of the 1/4 keV-selected Seyfert galaxies was determined and broken down into subsamples to investigate the relative space densities of Seyferts when separated on the basis of either X-ray slope or Hβ line width.

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Chandra Observations and the Nature of the Anomalous Arms of NGC 4258 (M 106)

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This paper presents high resolution X-ray observations with Chandra of NGC 4258 and infers the nature of the so called "anomalous arms" in this galaxy. The anomalous arms dominate the X-ray image; diffuse X-ray emission from the "plateaux" regions, seen in radio and Hα imaging, is also found. X-ray spectra have been obtained at various locations along the anomalous arms and are well described by thermal (mekal) models with kT in the range 0.37 - 0.6 keV. The previously known kpc-scale radio jets are surrounded by cocoons of hot X-ray emitting gas for the first 350 pc of their length.

The radio jets, seen in previous VLBA and VLA observations, propagate perpendicular to the compact nuclear gas disk (imaged in water vapor maser emission). The angle between the jets and the rotation axis of the galactic disk is 60°. The jets shock the normal interstellar gas along the first 350 pc of their length, causing the hot, X-ray emitting cocoons noted above. At a height of z = 175 pc from the disk plane, the jets exit the normal gas disk and then propagate though the low density halo until they reach "hot spots" (at 870 pc and 1.7 kpc from the nucleus), which are seen in radio, optical line and X-ray emission. These jets must drive mass motions into the low density halo gas. This high velocity halo gas impacts on the dense galactic gas disk and shock heats it along and around a "line of damage", which is the projection of the jets onto the galactic gas disk as viewed down the galaxy disk rotation axis. However, because NGC 4258 is highly inclined ($i = 64°$), the "line of damage" projects on the sky in a different direction to the jets themselves. We calculate the expected p.a. of the "line of damage" on the sky and find that it coincides with the anomalous arms to within 2°. It is, therefore, proposed that the anomalous arms, which are known to lie in the galactic disk, represent disk gas which has been shocked by mass motions driven by the out-of-plane radio jets. In the inner (< 1 kpc from the nucleus) regions of the galactic gas disk, the disk gas is sufficiently dense and tightly bound that it is heated to X-ray emitting temperatures, but not blown out of the disk. Thus, in this inner region, the anomalous arms are straight. Further away from the nucleus (> 1 kpc), some of the disk gas is blown out of the disk plane towards the halo on the opposite side of the disk from the relevant radio jet; this effect causes the arms to curve and is also responsible for the so called "plateaux" emission. An alternative is that the jet directions were different in the past, so they projected onto the disk in different directions. Our picture accounts for: (1) the diffuse character of the anomalous arms, 2) the inferred ionization of the optical line-emitting gas by shock waves, (3) the angle between the anomalous arms and the radio jets, (4) the sharp brightness gradients along the outer edges of the anomalous arms (these edges represent the standing shock where the high velocity, jet-driven halo gas meets the disk), (5) the existence of the "plateaux", and (6) the wide range of radial velocities observed in the "plateaux".

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Evidence for Accretion Disk Reprocessing in QSO 0957+561

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We use archival g and r–band photometry of the gravitational lens system QSO 0957+561A, B to estimate the quasars intrinsic variability during 1996 February–June. The lightcurves span 234 days with temporal resolutions of about 2.5 days. Both lightcurves display a single large amplitude event, of ~ 0.1 mag. (max-to-min) in about 100 days, followed by small amplitude variations of ~ 0.02 mag. on timescales of tens of days. We find the r–band variations lag those at g by $3.4^{+1.5}_{-1.4}$ days for the

large amplitude event. This lag is greater than zero at no less than 98% confidence. The delayed coupling of the rest-frame UV intrinsic variations strongly suggests the existence of a stratified reprocessing region extending $\sim$ light days from the putative central black hole source. The observed lag is consistent with that expected from a reverberation within an irradiated accretion disk structure. However, any definitive statement requires further detailed theoretical modelling and high quality, signal-to-noise ratio of about 100, optical/IR simultaneous monitoring with about 3 day resolution for approximately 6 months.

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Characteristic UV/Optical Time Scales in Active Galactic Nuclei?

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The UV/optical light curves of active galactic nuclei (AGN) may be roughly characterized by aperiodic fractional flux variations of $\sim 10\%$ on time scales of one month. The physical mechanism(s) responsible remain ill-defined. We present a structure function analysis, i.e., measure the power distribution over a range of time scales τ, of 13 AGN to constrain the origin of UV/optical emission. On time scales $\tau \sim$ 5–60 days, the mean UV and optical power-density spectra (PDS) are equivalent. This may suggest the underlying energy generating mechanism is identical. The combined UV/optical PDS is $P(f) \propto f^{-\alpha}$ with $\alpha = 2.13^{+0.22}_{-0.06}$. For sources with measured X-ray PDS indices, we find they are indistinguishable from their UV/optical counterparts. This supports scenarios whereby X-rays are generated via Compton upscattering of UV photons, to later radiatively drive optical variations. At the same time, we present evidence for characteristic variability time scales $\tau_{\rm char}$ of $\sim$ 5–100 days in ten sources. These variability time scales combined with reverberation based masses M suggest a M–$\tau_{\rm char}$ relationship; higher mass systems have larger characteristic time scales. The UV $\tau_{\rm char}$ may possibly reflect dynamical or accretion disk thermal time scales. We find suggestive evidence for a dichotomy, at $\tau \sim 30$ days and $M \sim 10^7\ M_\odot$, between short and long time scale optical variations. These optical variations may be attributable to dynamical and accretion disk thermal or starburst activity time scales, respectively.

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Multiwavelength Monitoring of the Narrow-Line Seyfert 1 Galaxy Akn 564. II. Ultraviolet Continuum and Emission-line Variability

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We present results of an intensive two-month campaign of approximately daily spectrophotometric monitoring of the narrow-line Seyfert 1 galaxy Akn 564 with the *Hubble Space Telescope* (*HST*). The fractional variability amplitude of the continuum variations between 1365–3000 Å is $\sim 6\%$, about a factor 3 less than that found in typical Seyfert 1 galaxies over a similar period of time. However, large amplitude, short time-scale flaring behavior is evident, with trough-to-peak flux changes of about 18% in approximately 3 days. We present evidence for wavelength-dependent continuum time delays, with the variations at 3000 Å lagging behind those at 1365 Å by about 1 day. These delays may be interpreted as evidence for a stratified continuum

reprocessing region, possibly an accretion-disk structure. The Lyα λ1216 emission-line exhibits flux variations of about 1% amplitude. These variations lag those at 1365Å by $\lesssim 3$ days, and combining this with the line width yields a virial black-hole mass limit of $\lesssim 8 \times 10^6\ M_{\odot}$. We caution, the low amplitude Lyα λ1216 variations may indicate the bulk of the emission region is at larger radii. This scenario affects the veracity of our black hole mass upper limit in an uncertain manner due to the unknown nature of the gas velocity field. Our mass estimate is thus unreliable, however, it is consistent with the independent estimate $M \sim 1 \times 10^7\ M_{\odot}$ of Pounds et al. (2001), based on a fluctuation power spectrum analysis of X-ray variability in Akn 564. The black-hole mass and 5100 Å luminosity of Akn 564 are consistent with the hypothesis that, relative to Seyfert 1 galaxies, NLS1s have lower black hole masses and higher accretion rates. Other strong emission lines, e.g., C IV λ1549 and He II λ1640, are constrained to vary with amplitudes of $< 5\%$. This low-level of emission-line variability is different from most Seyfert 1 galaxies, which characteristically display variations of $\sim 10\%$ on similar time scales.

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