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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.
Matt Redman

Abstracts of recently accepted papers

On the peculiar X–ray properties of the bright nearby radio-quiet quasar PDS 456.

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BeppoSAX and ASCA observations of the nearby (z = 0.184), high–luminosity, radio-quiet quasar PDS 456 are presented. The X–ray spectrum is characterized by a prominent ionized edge at 8–9 keV (originally discovered by RXTE, Reeves et al. 2000) and by a soft excess below 1.5 keV. The lack of any significant iron Kα emission line suggests for the edge an origin from line–of–sight material rather than from reflection from a highly ionized accretion disc. The hard X–ray continuum is indeed well modelled by transmission through a highly-ionized medium with a large column density ($N_{\rm H_{warm}} \sim 4.5 \times 10^{24}$ cm^{-2}) plus an additional cold absorber with a lower column density ($N_{\rm H_{cold}} \sim 2.7 \times 10^{22}$ cm^{-2}).

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The Multitude of Unresolved Continuum Sources at 1.6 microns in Hubble Space Telescope images of Seyfert Galaxies

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We examine 112 Seyfert galaxies observed by the Hubble Space Telescope (HST) at 1.6μm. We find that $\sim$ 50% of the Seyfert 2.0 galaxies which are part of the Revised Shapeley-Ames (RSA) Catalog or the CfA redshift sample contain unresolved continuum sources at 1.6μm. All but a couple of the Seyfert 1.0–1.9 galaxies display unresolved continuum sources. The unresolved sources

have fluxes of order a mJy, near-infrared luminosities of order 10^{41} erg/s and absolute magnitudes $M_H \sim -16$. Comparison non-Seyfert galaxies from the RSA Catalog display significantly fewer ($\sim 20\%$), somewhat lower luminosity nuclear sources, which could be due to compact star clusters. We find that the luminosities of the unresolved Seyfert 1.0-1.9 sources at 1.6μm are correlated with [OIII]5007Å and hard X-ray luminosities, implying that these sources are non-stellar. similar to that of a Seyfert 2 galaxy, we estimate that a few percent of local spiral galaxies contain black holes emitting as Seyferts at a moderate fraction, $\sim 10^{-1}$–10^{-4}, of their Eddington luminosities. fluxes and hard X-ray or [OIII] 5007Å fluxes for the pure Seyfert 2.0 galaxies. These galaxies also tend to have lower 1.6μm luminosities compared to the Seyfert 1.0-1.9 galaxies of similar [OIII] luminosity. Either large extinctions ($A_V \sim 20 - 40$) are present towards their continuum emitting regions or some fraction of the unresolved sources at 1.6μm are compact star clusters. increasing Seyfert type the fraction of unresolved sources detected at 1.6μm and the ratio of 1.6μm to [OIII] fluxes tend to decrease. These trends are consistent with the unification model for Seyfert 1 and 2 galaxies.

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The Gaseous Environment of Seyfert Galaxies

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The VLA has been used to image HI in a heterogeneous sample of nine Seyferts as part of a continuing investigation of the role of galactic host gas in the triggering and fuelling of nuclear activity. Where previous observations indicated complex, poorly understood kinematics, improved angular resolution and sensitivity reveal tidal tails and intragroup gas, distinguish dwarfs from main disks and resolve non-linear gas dynamical features such as shocks in bars. Seyferts may be abnormally gas-rich, but a larger, statistically significant comparison of HI properties of normal and active galaxies is now required.

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Chandra X-ray Observations of Pictor A: High Energy Cosmic Rays in a Radio Galaxy

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We report X-ray observations of the nearby, powerful radio galaxy Pictor A with the Chandra Observatory and optical and near uv observations of its western radio hot spot with the Hubble Space Telescope. X-ray emission is detected from the nucleus, a $1\farcm9$ (110 kpc) long jet to the west of the nucleus, the western radio hot spot some $4\farcm2$ (240 kpc) from the nucleus, and the eastern radio lobe. The morphology of the western hot spot is remarkably similar to that seen at radio and optical wavelengths, where the emission is known to be synchrotron radiation. The X-ray spectrum of the hot spot is well described by an absorbed power law with photon index $\Gamma = 2.07 \pm 0.11$. The X-ray jet coincides with a weak radio jet and is laterally extended by $\simeq 2\farcs0$ (1.9 kpc). The observed jet is up to $\simeq 15$ times brighter in X-rays than any counter jet, a difference ascribed to relativistic boosting as the western radio lobe is probably the closer. The jet's spectrum is well modelled by an absorbed power law with $\Gamma = 1.94^{+0.43}_{-0.49}$ and poorly fitted by a Raymond-Smith thermal plasma model.

The emission processes responsible for the X-rays are discussed in detail. The radio-optical spectrum of the hot spot breaks or turns down at 10^{13-14} Hz, and its X-ray spectrum is not a simple extension of the radio-optical spectrum to higher frequencies. Thermal models for the hot spot's X-ray emission are ruled out. Synchrotron self-Compton models involving scattering from the *known* population of electrons give the wrong spectral index for the hot spot's X-ray emission and are also excluded. A composite synchrotron plus synchrotron self-Compton model can match the X-ray observations but requires similar contributions from the two components in the Chandra band. We show that the hot spot's X-ray emission could be synchrotron self-Compton emission from a hitherto unobserved population of electrons emitting at low radio frequencies, but do not favor this model in view of the very weak magnetic field required. For the jet, inverse Compton models require a magnetic field a factor of $\simeq 30$ below equipartition, and ad hoc conditions to explain why the radio lobes are fainter than the jet in X-rays, but brighter in the radio.

Synchrotron radiation is the favored process for the X-ray emission. The expected synchrotron spectrum from relativistic electrons accelerated by strong shocks and subject to synchrotron radiation losses is in very good agreement with that observed

for both the hot spot and jet. The possibility that the relativistic electrons result via photo-pion production by high energy protons accelerated in shocks (a 'proton induced cascade') is briefly discussed.

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Variable Iron Kα Lines in Seyfert 1 Galaxies

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We find that variability of the iron Kα line is common in Seyfert 1 galaxies. Using data from the *ASCA* archive for objects that have been observed more than once during the mission, we study the time-averaged spectra from individual observations, thereby probing variability on timescales that range from days to years. Since the statistics of the data do not warrant searches for line variability in terms of a complex physical model, we use a simple Gaussian to model the gross shape of the line, and then use the centroid energy, intensity and equivalent width as robust indicators of changes in the line profile. We find that ~70% of Seyfert 1s (ten out of fifteen) show variability in at least one of these parameters: the centroid energy, intensity, and equivalent width vary in six, four, and eight sources respectively. Due to the low S/N, limited sampling and time averaging, we consider these results to represent lower limits to the rate of incidence of variability. In most cases changes in the line do not appear to track changes in the continuum. In particular, we find no evidence for variability of the line intensity in NGC 4151, suggesting an origin in a region larger than the putative accretion disk, where most of the iron line has been thought to originate. Mkn 279 is investigated on short timescales. The time-averaged effective line energy (as measured by the Gaussian center energy, which is weighted by emission in the entire line profile) is 6.5 keV in the galaxy rest frame. As the continuum flux increases by 20% in a few hours, the Fe K line responds within ~10,000 seconds, with the effective line energy increasing by 0.22 keV (~10,500 km s^{-1}). We also examine the *Rosat* PSPC spectrum of Mkn 279 but find inconsistencies with *ASCA*. Problems with the *ASCA* and *Rosat* calibration that affect simultaneous spectral fits at low energies are discussed in an appendix.

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Heavy X-ray Absorption in Soft X-ray Weak Active Galactic Nuclei

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Recent *ROSAT* studies have identified a significant population of Active Galactic Nuclei (AGN) that are notably faint in soft X-rays relative to their optical fluxes. Are these AGN intrinsically X-ray weak or are they just highly absorbed? Brandt, Laor & Wills have systematically examined the optical and UV spectral properties of a well-defined sample of these soft X-ray weak (SXW) AGN drawn from the Boroson & Green sample of all the Palomar Green AGN with $z < 0.5$. We present *ASCA* observations of three of these SXW AGN: PG 1011–040, PG 1535+547 (Mrk 486), and PG 2112+059. In general, our *ASCA* observations support the intrinsic absorption scenario for explaining soft X-ray weakness; both PG 1535+547 and PG 2112+059 show significant column densities ($N_{\rm H} \approx 10^{22}$–$10^{23}$ cm^{-2}) of absorbing gas. Interestingly, PG 1011–040 shows no spectral evidence for X-ray absorption. The weak X-ray emission may result from very strong absorption of a partially covered source, or this AGN may be intrinsically X-ray weak. QSO, and we find it to have the highest X-ray flux known of this class. It shows a typical power-law X-ray continuum above 3 keV; this is the first direct evidence that BAL QSOs indeed have normal X-ray continua underlying their intrinsic absorption. Finally, marked variability between the *ROSAT* and *ASCA* observations of PG 1535+547 and PG 2112+059 suggests that the soft X-ray weak designation may be transient, and multi-epoch 0.1–10.0 keV X-ray observations are required to constrain variability of the absorber and continuum.

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Evidence of thick obscuring matter revealed in the X-ray spectrum of the Z=4.28 quasar RXJ1028.6-0844

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We report the discovery of an unambiguous, substantial low-energy cutoff in the broad band X-ray spectrum of the radio quasar RX J1028.6-0844 at a redshift of 4.276 obtained with the ASCA satellite, which we preferably explained as indication of excess X-ray absorption. The equivalent hydrogen column density of the absorbing matter, depending on the redshift and metallicity, ranges from $2.5\ 10^{21}\,\mathrm{cm^{-2}}$ for local absorption up to $2.1\ 10^{23}\,\mathrm{cm^{-2}}$ (solar metallicity) or $1.6\ 10^{24}\,\mathrm{cm^{-2}}$ (10% solar metallicity) for absorption at the quasar redshift. Such a value is among the largest found for high-redshift radio quasars. The absorption, if interpreted as being produced close to the quasar, may indicate the presence of a remarkably large amount of obscuring matter in the quasar environment in the early universe. Implications of the result for the possible origins of the absorbing matter are discussed, concerning especially galactic intervening matter, cool intracluster gas, and ambient medium around the quasar jet. The quasar itself has an enormous apparent luminosity of at least about $2.6\ 10^{47}\,\mathrm{erg\,s^{-1}}$ ($H_0 = 50\,\mathrm{km\,s^{-1}\,Mpc^{-1}}$, $q_0 = 0.5$) and a power law photon index of $1.67(^{+0.07}_{-0.04})$ in the 2–50 keV band in the source rest frame.

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The Nuclear and Circum-nuclear Stellar Population in Seyfert 2 Galaxies: Implications for the Starburst-AGN Connection

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We report the results of a spectroscopic investigation of a sample of 20 of the brightest type 2 Seyfert nuclei. Our goal is to search for the direct spectroscopic signature of massive stars, and thereby probe the role of circumnuclear starbursts in the Seyfert phenomenon. The method used is based on the detection of the higher order Balmer lines and HeI lines in absorption and the Wolf-Rayet feature at ∼4680 Å in emission. These lines are strong indicators of the presence of young (a few Myrs) and intermediate-age (a few 100 Myrs) stellar populations. In over half the sample, we have detected HeI and/or strong stellar absorption features in the high-order (near-UV) Balmer series together with relatively weak lines from an old stellar population. In three others we detect a broad emission feature near 4680 Å that is most plausibly ascribed to a population of Wolf-Rayet stars (the evolved descendants of the most massive stars). We therefore conclude that the blue and near-UV light of over half of the sample is dominated by young and/or intermediate age stars. The "young" Seyfert 2's have have larger far-IR luminosities, cooler mid/far-IR colors, and smaller [OIII]/Hβ flux ratios than the "old" ones. These differences are consistent with a starburst playing a significant energetic role in the former class. We consider the possibility that there may be two distinct sub-classes of Seyfert 2 nuclei ("starbursts" and "hidden BLR"). However, the fact that hidden BLRs have been found in three of the "young" nuclei argues against this, and suggests that nuclear starbursts may be a more general part of the Seyfert phenomenon.

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Nuclear Gas and Dust Disks in Nearby 3CR Elliptical Galaxies

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Using WFPC2 V, R, I, and Hα+[N II] images, we examine the morphologies, environments, colors, and line emission of dust and gas disks located in the cores of seven low-redshift elliptical galaxies hosting 3C radio sources : NGC 383 (3C 31)/NGC 382, NGC 547 (3C 40), NGC 3862 (3C 264), NGC 4261 (3C 270), NGC 5532 (3C 296), NGC 7720 (3C 465)/NGC 7720A, and UGC 12064 (3C 449). The color maps are generally consistent with absorption by dust in flattened configurations viewed at intermediate inclinations. In most cases, the disks are non-uniform in continuum light and are surrounded by arcs, filaments, and diffuse absorbing clumps, suggesting the dust in the cores of these galaxies is not dynamically settled. Extended, clumpy or smooth Hα+[N II] line emission is detected in all four cases (NGC 383, NGC 3862, UGC 12064, and NGC 7720) for which narrow-band images are available. Line emission is found at projected locations from the nuclei to the edges of the disks.

The major axes of the disks and their hosts are preferentially aligned, with the degree of alignment uncorrelated with disk size. As projected on the sky, all the disks are more flattened than their host galaxies. Three of the hosts have boxy isophotes, and the remainder are normal in shape. The two boxiest galaxies, NGC 4261 and NGC 5532, show significant displacements between their nuclear and isophotal centers.

The mass of the disk in NGC 4261 is estimated using radiative transfer calculations. Scattering into the line of sight is included in the approximation that the dust is isotropically-illuminated by surrounding stars. The observed colors and surface brightness are shown to be matched by a thin layer of dust which lies in front of three-quarters (eastern edge) to one-quarter (western edge) of the starlight. When a Galactic opacity curve is used, the mass determined is an order of magnitude larger than that found assuming the dust lies in a foreground screen. The opacity falls more steeply towards the infrared than do those of Galactic and Magellanic Cloud grains, suggesting that the dust is not unprocessed material from a merger with a spiral or irregular galaxy.

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Thesis abstract

Quasar Formation and Evolution and Cosmological Constraints

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This thesis is a contribution to the understanding of the phenomenon of quasar formation and evolution. It approaches several theoretical and observational aspects as well as the problem of the construction of large quasar samples, in the long-term aim of combining everything in a geometrical cosmological test, in order to determine the values of the cosmological parameters, Ω and Λ.

During this thesis, the V/V_{max} test has been applied on the Large Bright Quasar Survey sample, showing that 1) the sample was biased due to the selection criteria and 2) the (simple) Pure Luminosity Evolution law was not a good approximation for all redshifts but that it described in a good way the phenomenon of quasar evolution, up to a redshift of ~ 2. For these two reasons a quasar candidate selection technique, efficient at all redshifts, was established and some theoretical models on quasar formation and evolution were developed.

The quasar candidate selection technique, developed for the needs of the VIRMOS (Visible and InfraRed Multi-Object Spectroscopy) project, consists in comparing the observed spectral energy distribution to the one calculated for some quasar model spectra and a series of real stellar spectra. The best fit allows the classification of an object either as a star candidate or as a quasar candidate, providing, at the same time, en estimation of the photometric redshift.

For the theoretical part of this PhD, two quasar formation and evolution models have been developed. An analytical model that has been developed in collaboration with the University of Barcelona, is about to be operational. In this code, which initially was created in order to study the formation and evolution of galaxies, we introduced a model of accretion around the central black holes, inspired by the Dopita "truly Unified Model" (1997). In parallel, I developed an analytical model that brings together the large scale structure formation theory and the phenomenon of accretion disk instabilities. The hypothesis of a linear relation between the black hole mass and the dark matter halo mass was rejected and constraints on the exponent, n, of the power spectrum, $P(k)$, were imposed.