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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.

Rob Beswick

The Active Galaxies Newsletter is also avalible on the World Wide Web at
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Abstracts of recently accepted papers

Characterising the complex absorber in NGC 4151

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We present a detailed analysis of the complex absorption apparent in the 2–6 keV X-ray spectrum of the bright nearby Seyfert galaxy NGC 4151. We first utilize the large bandpass and medium spectral resolution afforded by *BeppoSAX* data to construct a 1–100 keV spectral template, which assumes the absorption arises in both warm (*i.e.* partially photoionized) and cold gas present in the line of sight to the active nucleus of the source. Application of this spectral model to an *ASCA* "long-look" observation of NGC 4151 reveals a partial correlation between the underlying continuum flux and the ionization state of the warm absorber. Such a correlation is an intrinsic property of a warm absorber and argues strongly in favour of this interpretation for the complex absorbing column over alternative partial covering models.

The warm absorber in NGC 4151 has a column density of $\sim 2 \times 10^{23}$ cm^{-2} with ionization parameter in the range $\log(\xi) \approx 2.4 - 2.7$. The inferred relatively low density ($\sim 10^5$ cm^{-3}) for the warm gas, implies an equilibration timescale for the dominant ions of the same order or longer than the timescale of the continuum variability. It follows that the warm component will invariably be observed in a non-equilibrium ionization state. The warm absorber in NGC 4151 may be identified as a multi-temperature wind produced by evaporation from the inner edge of an obscuring torus as discussed in a recent paper by Krolik & Kriss (2001). The unusually complex character of the absorption seen in NGC 4151 may then be explained in terms of a fortuitous line of sight which grazes the top edge of the obscuring torus so as to intercept a substantial column of both the warm and cold gas.

We also find that (i) the reported hardening of the spectrum of NGC 4151 as the continuum level falls may be simply due to the presence of an underlying (hard and relatively constant) Compton-reflection component and (ii) the iron Kα line has

a relatively narrow Gaussian profile and a line flux that remains constant over both short (days) and long (months to years) timescales - a relativistically broadened iron Kα feature was not required in our modelling.

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preprint available at astro-ph/0204057

Chandra and XMM-Newton Observations of the Highest Redshift Quasars: X-rays from the Dawn of the Modern Universe

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We review X-ray studies of the highest redshift ($z > 4$) quasars, focusing on recent advances enabled largely by the capabilities of *Chandra* and *XMM-Newton*. Included are discussions of basic X-ray population studies, X-ray spectroscopy, high-redshift AGN in X-ray surveys, and future prospects.

X-ray Spectroscopy of AGN with Chandra and XMM-Newton, ed. Th. Boller, S. Komossa, S. Kahn, H. Kunieda (MPE Press, Garching), in press

E-mail contact: niel@astro.psu.edu,
preprint and list of $z > 4$ X-ray detections available at http://www.astro.psu.edu/users/niel/papers/papers.html

High-resolution X-ray imaging and spectroscopy of the core of NGC 4945 with *XMM-Newton* and *Chandra*

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We utilize the complimentary capabilities of *XMM-Newton* and *Chandra* , to conduct a detailed imaging and spectral study of the nearby galaxy NGC 4945 focussing on its nucleus and immediate surroundings (within ~ 1 kpc of the nucleus). A complex morphology is revealed including a predominantly hard, but partially resolved, nuclear source plus a spectrally soft, conically shaped X-ray "plume", which extends $30''$ (500 pc) to the northwest. In NGC 4945 our direct view of the active galactic nucleus (AGN) is blocked below ~ 10 keV by extremely heavy line-of-sight absorption and the observed X-ray spectrum is dominated by multi-temperature thermal emission associated with the nuclear starburst and the X-ray plume. Nevertheless the signature of the AGN is present in the form of a neutral Compton reflection component and a 6.4 keV fluorescent iron Kα line. We conjecture that the site of the continuum reprocessing is the far wall of a highly inclined molecular torus, a geometry which is consistent with the presence of H_2O megamaser emission in this source. The soft spectrum (~ 0.6 keV) and limb-brightened appearance of the X-ray plume suggest an interpretation in terms of a mass-loaded superwind emanating from the nuclear starburst.

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The Luminosity Dependence of Ultraviolet Absorption in Active Galactic Nuclei

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We describe the results of a survey of the UV absorption properties of the Boroson & Green sample of AGN, which extends from the Seyfert ($M_V \simeq -21$) to the luminous quasar ($M_V \simeq -27$) level. The survey is based mostly on *HST* archival data available for $> 1/2$ of the 87 sample objects. Our main result is that soft X-ray weak quasars (SXWQs, 10 AGN with $\alpha_{ox} \leq -2$) show the strongest UV absorption at a given luminosity, and their maximum outflow velocity, $v_{\max}$, is strongly correlated with M_V ($r_S = -0.95$). This suggests that $v_{\max}$ is largely set by the luminosity, as expected for radiation-pressure driven outflows. Luminous SXWQs have preferentially low [O III] luminosity, which suggests they are physically distinct from unabsorbed AGN, while non-SXWQs with UV absorption are consistent with being drawn from the unabsorbed AGN population. We also find an indication that $v_{\max}/v_{\rm BLR}$ increases with $L/L_{\rm Edd}$, as expected for radiation-pressure driven outflows. This relation and the $v_{\max}$ vs. M_V relation may indicate that the radiation-pressure force multiplier increases with luminosity, and that the wind launching radius in non-SXWQs is ~ 10 times larger than in SXWQs.

The Astrophysical Journal, 569, 641–654

E-mail contact: laor@physics.technion.ac.il, UV spectra of the 56 PG AGN and their corresponding SM plotting files are available at http://www.astro.psu.edu/users/niel/laorbrandtdata/laorbrandtdata.html

The far-infrared energy distributions of Seyfert and starburst galaxies in the Local Universe: ISO photometry of the 12μm active galaxy sample

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New far-infrared photometry with ISOPHOT, onboard the *Infrared Space Observatory*, is presented for 58 galaxies with homogeneous published data for another 32 galaxies all belonging to the 12μm galaxy sample. In total 29 Seyfert 1's, 35 Seyfert 2's and 12 starburst galaxies, about half of the 12μm active galaxy sample, plus 14 normal galaxies for comparison. The ISO and the IRAS data are used to define color-color diagrams and spectral energy distributions (SED). Thermal dust emission at two temperatures (one cold at 15-30K and one warm at 50-70K) can fit the 60–200μm SED, with a dust emissivity law proportional to the inverse square of the wavelength. Seyfert 1's and Seyfert 2's are indistinguishable longward of 100μm, while, as already seen by IRAS, the former have flatter SEDs shortward of 60μm. A mild anti-correlation is found between the [200 - 100] color and the "60μm excess". We infer that this is due to the fact that galaxies with a strong starburst component, and thus a strong 60μm flux, have a steeper far-infrared turnover. In non-Seyfert galaxies, increasing the luminosity corresponds to increasing the star formation rate, that enhances the 25 and 60μm emission. This shifts the peak emission from around 150μm in the most quiescent spirals to shorter than 60μm in the strongest starburst galaxies. To further quantify these trends, we identified with the IRAS colors three idealized infrared SED: that of pure quiescent disk emission, pure starburst emission, and pure Seyfert nucleus emission. Even between 100 and 200μm, the quiescent disk emission remains much cooler than the starburst component. Seyfert galaxies have 100–200μm SED ranging from pure disks to pure starbursts, with no apparent contribution from their active nuclei at those wavelengths.

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Mass Outflow in Active Galactic Nuclei: New Perspectives

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Over the past decade, a great amount of interest has been generated in the study of mass outflow in active galactic nuclei (AGN). X-ray spectra from *ASCA* confirmed the presence of a "warm absorber" (characterized by O VII and O VIII absorption edges) in least half of all Seyfert 1 galaxies. Ultraviolet spectra from the *Hubble Space Telescope* (*HST*) revealed that a similar fraction of Seyferts show absorption lines from moderately ionized species (C IV, N V); these lines are typically blueshifted with respect to the systemic velocity of the host galaxy, indicating outflow from the nucleus. Ground based observations revealed

the presence of high-velocity clouds (up to 0.1c) ejected from quasars, and spectropolarimetry helped to constrain the geometry of the broad absorption lines (BALs) found in about 10% of all quasars. Much of the progress in this field was summarized in the proceedings of a workshop (ASP Conference Series Volume 128) on "Mass Ejection From AGN", which was held at the Carnegie Observatories on 19 – 21 February, 1997.

Since the workshop in 1997, new and exciting results on mass outflow from AGN have become available through new space missions or instruments, including the Space Telescope Imaging Spectrograph (STIS) on *HST*, the *Far-Ultraviolet Spectroscopic Explorer* (*FUSE*), the *Chandra X-ray Observatory* (*CXO*), and the *X-ray Multi-Mirror Satellite* (*XMM-Newton*), principally due to their increased light gathering power and spectral resolution compared to previous missions. New ground-based facilities and projects, including the Keck Observatory and the Sloan Digital Sky Survey (SDSS), have helped to greatly expand the sample of quasars with intrinsic absorption. Finally, dynamical models, such as those that invoke accretion disk winds driven by radiative and/or magnetic forces, are reaching a level of sophistication that yields testable predictions.

The rapid pace of discoveries in this field suggested that the time was ripe for another conference on mass outflow in AGN. "Mass Outflow in Active Galactic Nuclei: New Perspectives" was held on 8 – 10 March, 2001 at The Catholic University of America, in Washington, DC. The stated purpose of the workshop was to review the new observations and their implications, investigate the correspondence between the observations and models, and stimulate new directions for future collaborative efforts. Scientific topics included intrinsic UV and X-ray absorption, broad absorption-line quasars, evidence for radial outflow in the emission line regions (narrow-line region and broad-line region), photoionization and shock models of the emission-line and absorption regions, new observations and models of jets, and dynamical outflow models. These proceedings provide a record of the presentations at the workshop.

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An ISO–SWS survey of molecular hydrogen in Starburst and Seyfert Galaxies

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We present results from a survey of molecular hydrogen emission from a sample of Starburst and Seyfert galaxies carried out with the Infrared Space Observatory (ISO). Pure rotational H_2 emission has been detected in a number of extragalactic objects and a variety of environments. A number of transitions from S(7) to S(0) are detected in both Starbursts and Seyferts. Using excitation diagrams we derive temperatures and masses of the "warm" molecular hydrogen. We find that the temperature of the "warm" gas is similar in Starbursts and Seyferts (those Seyferts for which we have firm detections of the S(0) line) with a value of around T$\sim$150 K. This "warm" gas accounts for as much as 10% of the total galactic mass (as probed by CO molecular observations) in Starbursts. The fraction of "warm" gas is overall higher in Seyferts, ranging between 2–35%. We then investigate the origin of the warm H_2 emission. Comparison with published theoretical models and Galactic templates implies that although emission from photodissociation regions (PDR) alone could explain the emission from Starbursts and Seyferts, most likely a combination of PDR, shock emission and gas heated by X-rays (mostly for the Seyferts) is responsible for H_2 excitation in extragalactic environments. Finally, we find that although PAH and H_2 line emission correlate well in Starbursts and the large scale emission in AGN, H_2 emission is much stronger compared to PAH emission in cases where a "pure" AGN dominates the energy output.

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Detection of Iron Emission in the $z = 5.74$ QSO SDSSp J104433.04-012502.2

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We obtained near-infrared spectroscopy of the z=5.74 QSO, SDSSp J104433.04-012 502.2 with the Infrared Camera and Spectrograph of the Subaru telescope. The redshift of 5.74 corresponds to a cosmological age of 1.0 Gyr for the current Λ-dominated cosmology. We found a similar strength of the Fe II (3000-3500 Å) emission lines in SDSSp J104433.04-012502.2 as in low

redshift QSOs. This is the highest redshift detection of iron. We subtracted a power-law continuum from the spectrum and fitted model Fe II emission and Balmer continuum. The rest equivalent width of Fe II (3000-3500 Å) is ~ 30 Å which is similar to those of low redshift QSOs measured by the same manner. The chemical enrichment models that assume the life time of the progenitor of SNe Ia is longer than 1 Gyr predict that weaker Fe II emission than low red shift. However, none of the observed high redshift ($z > 3$) QSOs show a systematic dec rease of Fe II emission compared with low redshift QSOs. This may due to a shorter lifetime of SNe Ia in QSO nuclei than in the solar neighborhood. Another reason of strong Fe II emission at $z = 5.74$ may be longer cosmological age due to smaller $\Omega_{\rm M}$.

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preprint available at http://www.ioa.s.u-tokyo.ac.jp/Users/kaoki/qso5.74.ps.gz

Thesis Abstracts

Dust and gas in extra-galactic radio sources

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Ph.D degree awarded: May 2002

For my thesis I have studied radio-loud active galaxies, in specific their infrared emission from dust, and optical emission from the narrow-line regions. Tests have been performed for the unification scheme, comparing the far-infrared emission of radio galaxies and radio quasars. Furthermore, the broad-line radio galaxies are studied in detail, and the contribution from non-thermal emission to the infrared is assessed. New models are constructed for obscuring tori around an active nucleus. Finally, Cygnus A has been studied in detail, using optical spectropolarimetry.

The most important conclusion is, that the thermal infrared emission in radio-loud active galaxies arises from two components. The near- and mid-infrared is dominated by small scale, hot dust emission, presumably some sort of obscuring medium. However, the far-infrared emission (longward of $\sim 40\mu$m) is dominated by thermal dust emission in star-forming regions in the host galaxy.

The case study of Cygnus A reveals new facts about the kinematics of the narrow-line regions, and yields the deepest linelist currently available for a radio galaxy. At least three separate kinematical components are found. To explain the observations of coronal lines, a new model for coronal line emission in active galaxies has been developed.