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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

The Ionization Fraction in the Obscuring 'Torus' of an Active Galactic Nucleus

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The LINER galaxy NGC 2639 contains a water vapor megamaser, suggesting the presence of an edge-on nuclear accretion disk or torus. This galaxy is thus a good candidate for revealing absorption by the torus of any compact nuclear continuum emission. In this paper, we report VLBA radio maps at three frequencies and an ASCA X-ray spectrum obtained to search for free-free and photoelectric absorptions, respectively. The radio observations reveal a compact (< 0.2 pc) nuclear source with a spectrum that turns over sharply near 5 GHz. This turnover may reflect either synchrotron self-absorption or free-free absorption. The galaxy is detected by ASCA with an observed luminosity of 1.4×10^{41} erg s^{-1} in the 0.6 – 10 keV band. The X-ray spectrum shows emission in excess of a power-law model at energies greater than 4 keV; we interpret this excess as compact, nuclear, hard X-ray emission with the lower energies photoelectrically absorbed by an equivalent hydrogen column of $\simeq 5 \times 10^{23}$ cm^{-2}.

If we assume that the turnover in the radio spectrum is caused by free-free absorption and that both the free-free and photoelectric absorptions are produced by the same gaseous component, the ratio $\int n_e^2 dl / \int n_H dl$ may be determined. If the masing molecular gas is responsible for both absorptions, the required ionization fraction is $\gtrsim 1.3 \times 10^{-5}$, which is comparable to the theoretical *upper* limit derived by Neufeld, Maloney & Conger (1994) for X-ray heated molecular gas. The two values may be reconciled if the molecular gas is very dense – $n_{H_2} \gtrsim 10^9$ cm^{-3}. The measured ionization fraction is also consistent with the idea that both absorptions occur in a hot ($\sim$ 6,000K), weakly ionized (ionization fraction a few times 10^{-2}) atomic region that may co-exist with the warm molecular gas. If this is the case, the absorbing gas is ~ 1 pc from the nucleus. If our line of sight

passes through more than one phase, the atomic gas probably dominates the free-free absorption while the molecular gas may dominate the photoelectric absorption.

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Ultraviolet-Optical observations of the Seyfert 2 Galaxies NGC 7130, NGC 5135 and IC 3639: Implications for the Starburst-AGN Connection

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We present and discuss HST (WFPC2 and FOC) images and ultraviolet (GHRS) spectra plus ground-based optical spectra of three Seyfert 2 nuclei (NGC 7130, NGC 5135 and IC 3639). These galaxies together with Mrk 477 (Heckman et al 1997) were selected on the basis of ultraviolet-brightness from a bigger sample that comprises the 20 brightest Seyfert 2 nuclei, with the goal of studying the Starburst-AGN connection and the origin of the so-called 'featureless continuum' in Seyfert 2 nuclei.

The data provide direct evidence of the existence of nuclear starbursts that dominate the ultraviolet light, and that are responsible for the featureless continuum in these type 2 Seyfert nuclei. The GHRS spectra show absorption features formed in the photospheres (SV λ1501, CIII λ1426,1428, SiIII λ1417, and SiIII+PIII λ1341-1344) and in the stellar winds (CIV λ1550, SiIV λ1400, and NV λ1240) of massive stars. Signatures of massive stars are also clearly detected in their optical and near-UV spectra where the high order Balmer series and HeI lines are observed in absorption. These lines are formed in the photospheres of O and B stars, and thus they also provide strong independent evidence of the presence of massive stars in the nuclei of these Seyfert 2 nuclei. Interstellar absorption lines similar to those formed in the interstellar medium of starbursts are also observed. They are blueshifted by a few hundred km s^{-1} with respect to the systemic velocity, indicating that the interstellar gas is outflowing. These outflows are most likely driven by the nuclear starburst.

These starbursts are dusty, compact, and powerful. They have sizes ranging from less than 100 pc to a few hundred pc (much smaller than that seen in the prototype Seyfert 2 galaxy NGC 1068). Their UV colors imply that they are heavily reddened (by 2 to 3 magnitudes in the UV), and the implied bolometric luminosities are of-order 10^{10} L$_\odot$. The bolometric luminosities of these starbursts are similar to the estimated bolometric luminosities of their obscured Seyfert 1 nuclei. The data on this small sample suggest that more powerful AGN may be related to more powerful central starbursts. Comparing the HST spectra to IUE spectra obtained through apertures with projected sizes of 3 to 11 kpc (and to IRAS far-IR data) we estimate the nuclear starbursts account for 6 to 25% of the total intrinsic UV luminosity of the entire galaxy.

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Radiatively Driven Mass Accretion onto Galactic Nuclei by Circumnuclear Starbursts

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We examine the physical processes regarding the radiatively driven mass accretion onto galactic nuclei due to the intensive radiation from circumnuclear starbursts. The radiation from a starburst not only contracts an inner gas disk by the radiation flux force, but also extracts angular momenta due to the relativistic radiation drag, thereby inducing an avalanche of the surface layer of disk. To analyze such a mechanism, the radiation-hydrodynamical equations are solved with including the effects of radiation drag force as well as radiation flux force. As a result, it is found that the mass accretion rate due to the radiative avalanche is given by $\dot{M}(r) = \eta(L_*/c^2)(r/R)^2(\Delta R/R)(1-\mathrm{e}^{-\tau})$ at radius r, where the efficiency η ranges from 0.2 up to 1, L_* and R are respectively the bolometric luminosity and the radius of a starburst ring, ΔR is the extension of the emission regions, and τ is the face-on optical depth of a disk. In an optically thick regime, the rate depends upon neither the optical depth nor the surface mass density distribution of the disk. The present radiatively driven mass accretion may provide a physical mechanism which enables mass accretion from 100 pc scales down to ~pc, and it can eventually link to an advection-dominated viscous accretion onto a massive black hole. The radiation-hydrodynamical and self-gravitational instabilities of the disk are

briefly discussed. In particular, the radiative acceleration possibly builds up a dusty wall, which shades the nucleus in edge-on views. It provides another version for the formation of an obscuring torus.

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The Difference Between the Narrow Line Region of Seyfert 1 and Seyfert 2 Galaxies

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This paper presents a comparative study of emission line ratios of the Narrow Line Region (NLR) of Seyfert 1 and Seyfert 2 galaxies. It includes a literature compilation of the emission line fluxes [OII]λ3727Å, [NeIII]λ3869Å, [OIII]λ5007Å and [NeV]λ3426Å, as well as 60μm continuum flux, for a sample of 52 Seyfert 1's and 68 Seyfert 2's. The distribution of the emission line ratios [OII]/[NeIII] and [OII]/[NeV] shows that Seyfert 1's and Seyfert 2's are statistically different, in the sense that Seyfert 1's have values smaller than those of Seyfert 2's, indicating a higher excitation spectrum. These and other emission line ratios are compared with sequences of models which combine different proportions of matter and ionization bounded clouds and also sequences of models which vary only the ionization parameter. This comparison shows that the former models reproduce better the overall distribution of emission line ratios, indicating that Seyfert 1's have a smaller number of ionization bounded clouds than Seyfert 2's. This difference, together with other results available in the literature, are interpreted from the point of view of four different scenarios. The most likely scenario assumes that Seyfert 1's have NLR's smaller than those of Seyfert 2's, possibly due to a preferential alignment of the torus axis close to the host galaxy plane axis in Seyfert 1's.

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On the Evidence for Extreme Gravity Effects in MCG−6-30-15

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We examine the unusual Fe-Kα line profile in MCG−6-30-15 observed by *ASCA* during a deep minimum in the source intensity. The intense red wing and depressed blue wing of the line have been interpreted as evidence for extreme gravitational redshifts in terms of emission from within six gravitational radii of a black hole. We find that the data do not uniquely support this interpretation and can be equally well explained by occultation of the continuum source and the putative line-emitting accretion disk, which we offer as an alternative hypothesis. Two problems with previous modeling were that the equivalent width of the line during the deep minimum was required to be unusually large ($>$ 1 keV) and the line intensity was thought to increase as the source became dim. The occultation model does not suffer from these problems. Our results serve to highlight the hazards of over-interpreting observational results which have low statistical significance, to the extent that theoretical implications can become generally accepted when the data do not provide a strong case for them.

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2.5–11.6 μ spectrophotometry and imaging of the CfA sample

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We report on low resolution (3000 $\mathrm{km\,s^{-1}}$) spectrophotometric and imaging observations of a sample of 54 AGN's drawn from the CfA list over the 2.5–11.6 μ range with the ISO satellite. The sample is about equally divided into type I ($\leq$ 1.5; 26 sources) and type II ($>$ 1.5; 28 sources) objects. The mid-IR spectra of type I (SfI) and type II (SfII) objects are statistically *different*: SfI spectra are characterized by a strong and smooth continuum well approximated by a power-law of average ($\pm$

r.m.s.) index $\langle\alpha\rangle = -0.93 \pm 0.26$ with only weak emission features from Polycyclic Aromatic Hydrocarbon (PAH) bands at 3.3, 6.2, 7.7 and 8.6 μ. In sharp contrast to SfI's, SfII's display a very weak or no continuum but PAH emission bands of very large equivalent widths. However, the *luminosity* of the PAH bands is not statistically different in the two populations. These results are broadly consistent with the unification scheme in that the mid-IR nuclear continuum is extinguished in SfII's up to at least 11 μ, presumably by the molecular torus, whereas it is directly visible in SfI's. The fact that the torus is opaque to its own mid-IR emission suggests an average visual extinction 100 ± 50 magnitudes in the radial direction and an absorbing column $N_H = 2.3 \pm 1.0\ 10^{23}\ cm^{-2}$ in good agreement with X-ray observations of SfII's. Furthermore, since their luminosity does not depend on the viewing angle, the PAH bands must originate from outside the torus, either in the NLR or the interstellar medium (ISM). Observations of non active galactic nuclei show that SfII's are indistinguishable from normal galaxies in the mid-IR. It is therefore concluded that the PAH bands are unrelated to the active nucleus and probably arise in the ISM of the bulge. Beside the usual "big blue-bump" the Spectral Energy Distribution (SED) of at least some SfI's clearly shows an excess of emission from ~ 1.5 to 15 μ. The width and spectral shape of this mid-IR "bump" is strikingly similar to the theoretical emission spectrum of the molecular torus when seen at small inclination (Pier and Krolik 1992). The silicate 9.7 μ feature appears weakly in *emission* in SfI's which constrains the *vertical* optical column of the torus to be in the range $10^{-23} \leq N_H \leq 10^{24}\ cm^{-2}$ (Pier and Krolik 1992).

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Free-free absorption in the Seyfert nucleus of NGC4151

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We present subarcsecond MERLIN 0.4 GHz (73 cm) and 1.6 GHz (18 cm) radio measurements of the nuclear region of the Seyfert galaxy NGC4151. By comparison with higher frequency observations we deduce that one component (C4) shows a low frequency turnover which we interpret as evidence for free-free absorption by ionised gas with an emission measure between 3×10^5 and 10^6pc cm^{-6} . The free-free absorption appears to be localised to a region $\sim$ 50pc in extent and we consider models in which the ionised gas may be closely associated with a neutral molecular torus.

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