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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

X-ray study of the NGC 383 group of galaxies and the source 1E 0104+3153

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We present results from an analysis of the X-ray properties of the NGC 383 galaxy group based on *ROSAT* PSPC and HRI data. X-ray emission can be traced out to $\sim 1 h_{50}^{-1}$ Mpc, the estimated virial radius of the system. We determine a total mass of $6\,10^{13} h_{50}^{-1}$ $M_\odot$ for the group inside this radius with a gas mass fraction of 21%. The intragroup gas temperature of 1.5 keV is both consistent with the galaxy velocity dispersion and the X-ray luminosity - temperature relation of groups and clusters suggesting that the group is fairly relaxed. This is also indicated by the almost spherically symmetric appearance of the group's X-ray halo.

The X-ray properties of the radio galaxy NGC 383 (3C 31) which is located near the center of the group are discussed. Its spectrum is best described by a two-component model, consisting of emission from a low-temperature Raymond-Smith plasma, and a hard tail. The emission from NGC 383 is not resolved by the *ROSAT* HRI. The possible interaction of the radio jets of 3C 31 with the IGM is studied.

A spatial, spectral and temporal analysis of the *Einstein* source 1E0104+3153 located within the field of view is performed, one goal being the identification of the optical counterpart (with both, a high-redshift BAL quasar and a nearby elliptical galaxy, member of a small group, located within the *Einstein* X-ray error circle). We find evidence that the IGM of the small group contributes significantly to the X-ray emission of 1E0104, which can be described by a Raymond-Smith model of $kT \simeq 2$ keV and a soft X-ray luminosity of $L_x \simeq 3\,10^{43}$ erg/s.

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Magnetically Driven Outflows in a Starburst Environment

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We here investigate the possibility that the observed collimated outflows in luminous infrared galaxies (LIGs) and some Seyfert galaxies can be produced in a starburst (SB) environment. In the former source class, in particular, there seems to be some observational evidence for the presence of nuclear SBs in some objects (e.g. Scoville, Lonsdale, & Lonsdale 1998).

A nuclear disk can be quickly produced by gas infall during star formation in a *rotating*, stellar cluster. We find that massive nuclear SBs with core disk masses $M_d \sim 10^8 - 10^9 M_\odot$, and supernova rates $\nu_{SN} \simeq 5\times10^{-3} - 2$ yr^{-1} (which are consistent with the ν_{SN} values inferred from the observed non-thermal radio power in source candidates) may inject kinetic energies which are high enough to blow out directed flows from the accreting disk surface, within the SB lifetimes. In our models, the acceleration and collimation of the nuclear outflow are provided by magnetic fields anchored into the rotating SB-disk. The emerging outflow carries a kinetic power that is only a small fraction (a few percent) of the supernovae energy rate produced in the SB. Based on conditions determined from observed outflows and disks, we find that moderate disk magnetic fields ($\gtrsim 8\times10^{-4}$ G) are able to accelerate the outflows up to the observed terminal velocities ($\lesssim$ few 100 km s^{-1} in the case of the Seyfert galaxies, and $\sim$ 400 - 950 km s^{-1} in the case of the LIGs). The outflow is produced within a wind zone in the disk of radius $\lesssim$ 100 pc in the the LIGs, and $\lesssim$ 10 pc in the Seyferts, with wind mass loss to disk accretion rate ratios $\dot{M}_w/\dot{M}_d \gtrsim 0.1$ (where $\dot{M}_d \sim 100\, M_\odot$ yr^{-1}). The observation of rotating nuclear disks of gas within $\sim$ few 100 pc scales, like that in the prototype LIG, Arp 220 (for which $\dot{M}_d \sim 100\, M_\odot$ yr^{-1}), and magnetized outflows in Sey galaxies and LIGs (with terminal $B \sim 10^{-5}$ G at the kpc-scales), provide some observational support for the magneto-centrifugal disk picture drawn here.

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Parsec-scale radio structures in the nuclei of four Seyfert galaxies

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We present 18-cm radio maps of four Seyfert nuclei, Mrk 1, Mrk 3, Mrk 231 and Mrk 463E, made with the European VLBI Network (EVN). Linear radio structures are present in three out of four sources on scales of ~100 pc to ~1 kpc, and the 20-mas beam of the EVN enables us to resolve details within the radio structures on scales of < 10 pc. Mrk 3 was also imaged using MERLIN and the data combined with the EVN data to improve the sensitivity to extended emission. We find an unresolved flat-spectrum core in Mrk 3, which we identify with the hidden Seyfert 1 nucleus in this object, and we also see marked differences between the two highly-collimated radio jets emanating from the core. The western jet terminates in a bright hotspot and resembles an FRII radio structure, whilst the eastern jet has more in common with an FRI source. In Mrk 463E, we use the radio and optical structure of the source to argue that the true nucleus lies approximately 1 arcsec south of the position of the radio and optical brightness peaks, which probably represent a hotspot at the working surface of a radio jet. The EVN data also provide new evidence for a 100-pc radio jet powering the radio source in the Type 1 nucleus of Mrk 231. However, the Seyfert 2 galaxy Mrk 1 shows no evidence for radio jets down to the limits of resolution (~ 10 pc). We discuss the range of radio source size and morphology which can occur in the nuclei of Seyfert galaxies and the implications for Seyfert unification schemes and for radio surveys of large samples of objects.

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Do Jet-Driven Shocks ionize the Narrow Line Regions of Seyfert Galaxies?

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We consider a model in which the narrow line regions (NLRs) of Seyfert galaxies are photoionized “in situ” by fast (300 – 1,000 km s^{-1}), radiative shock waves driven into the interstellar medium of the galaxy by radio jets from the active nucleus. Such shocks are powerful sources of soft X-rays. We compute the expected ratio of the count rates in the ROSAT PSPC and Einstein

IPC detectors to the [OIII]λ5007 flux as a function of shock velocity, and compare these ratios with observations of type 2 Seyferts. *If* most of the observed soft X-ray emission from these galaxies originates in the NLR and the absorbing hydrogen column is similar to that inferred from the reddening of the NLR, a photoionizing shock model with shock velocity $\simeq 400-500$ km s^{-1} is compatible with the observed ratios. High angular resolution observations with AXAF are needed to isolate the X-ray emission of the NLR and measure its absorbing column, thus providing a more conclusive test. We also calculate the expected coronal iron line emission from the shocks. For most Seyfert 2s, the [Fe X]λ6374/Hβ ratio is a factor of $2-14$ lower than the predictions of $300-500$ km s^{-1} shock models, suggesting that less hot gas is present than required by these models.

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The nature of the luminous X-ray emission of NGC 6240

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We briefly review and extend our discussion of the *ROSAT* detection of the extraordinarily luminous ($>10^{42}$ erg/s) partly *extended* ($>$30 kpc diameter) X-ray emission from the ultraluminous infrared galaxy NGC 6240. The 'standard'-model of starburst outflow is contrasted with alternatives and a comparison with the X-ray properties of ellipticals is performed.

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Long-term optical variability properties of the Palomar-Green quasars

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We present results from a monitoring program of 42 quasars from the Palomar-Green sample. The objects were observed for seven years at the Wise Observatory, as part of a long term effort to monitor AGN of various types. This is the most extensive program of its kind carried out to date on a well-defined optically-selected quasar sample. The typical sampling interval is ~ 40 days. One third of the quasars were observed at ~ 60 epochs and the rest at ~ 30 epochs in two bands (B and R) with photometric accuracy of ~ 0.01 mag. We present lightcurves for all of the sources and discuss the sample variability properties. All of the quasars in the sample varied during the campaign with intrinsic rms amplitudes of $5\% < \sigma_B < 34\%$ and $4\% < \sigma_R < 26\%$. The rms amplitude and colour for the entire sample are $\sigma_B = 14\%$, $\sigma_R = 12\%$, and $\sigma_{B-R} = 5\%$. On time scales of 100 to 1000 days the power spectra of the sources have a power-law shape, $P_\nu \propto \nu^{-\gamma}$, with $\gamma \approx 2.0$ and a spread $\lesssim 0.6$. At least half of the quasars, particularly those that are most variable, become bluer when they brighten, and the rest do not show this behaviour. We quantify this phenomenon, which has been observed previously only in Seyfert galaxies. The quasars which are most variable tend also to exhibit asymmetry in their variations, in the sense that the brightening phases last longer than the fading phases. We have searched for correlations between the measured variability properties and other parameters of the quasars, such as luminosity, redshift, radio loudness, and X-ray slope. We find several new correlations, and reproduce some of the correlations reported by previous studies. Among them are an anticorrelation of variability amplitude with luminosity, a trend of the autocorrelation time scale with luminosity, and an increase in variability amplitude with Hβ equivalent width. However, all of these trends have a large scatter despite the low observational uncertainties.

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Nuclear activity in nearby galaxies

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I discuss some recent observational results in the research of nearby active galactic nuclei (AGN). These results cover three main topics: (i) evidences for the current paradigm for AGN's, which include a nuclear supermassive blackhole (SMBH) fed via an accretion disk; (ii) evidence that this paradigm may also apply to LINER's, the lowest luminous AGN's and to normal galaxies; (iii) evidences of how the fueling of the SMBH occurs and its relation to recent and intermediate age (10^6 to 10^8 yrs old) episodes of star formation.

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The Location of the Nucleus of NGC 1068 and the Three-dimensional Structure of Its Nuclear Region

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The HST archival UV imaging polarimetry data of NGC 1068 is re-examined. Through an extensive estimation of the observational errors, we discuss whether the distribution of the position angles (PAs) of polarization is simply centrosymmetric or not. Taking into account the effect of a bad focus at the time of the observation, we conclude that, within the accuracy of HST/FOC polarimetry, the PA distribution is completely centrosymmetric. This means that the UV polarization originates only from scattering of the radiation from a central point-like source.

However, our analysis shows that the most probable location of the nucleus is only $\sim 0.''08$ ($\sim$ 6 pc) south from the brightest cloud called "cloud B". The error circle of 99% confidence level extends to cloud B and to "cloud A" which is about $0.''2$ south of cloud B. By this FOC observation, Cloud B is only marginally rejected as the nucleus.

Assuming that the UV flux is dominated by electron-scattered light, we have also derived a three-dimensional structure of the nuclear region. The inferred distribution suggests a linear structure which could be related to the radio jet.

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X-ray Emission from the Prototypical LINER Galaxy NGC 1052

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We examine the 0.1 to 10.0 keV X-ray spectrum of the bright nuclear LINER galaxy NGC 1052, one of two elliptical galaxies known to contain a luminous H_2O maser. The observed $2.0 - 10.0$ keV spectrum is unusually flat (photon index $\Gamma \sim 0.2$) and best described as intrinsically power-law shaped nuclear flux that is either (1) attenuated by a complex absorber with $\sim 70\%$ of the nuclear flux absorbed by a column density of $N_{\rm H} \sim 3 \times 10^{23}$ cm^{-2} and $\sim 30\%$ absorbed by a column density of $N_{\rm H} \sim 3 - 5 \times 10^{22}$ cm^{-2}, or (2) reprocessed, with the nuclear source blocked and the X-rays Compton reflected in our direction by high column density ($\geq 10^{24}$ cm^{-2}) gas. The moderate equivalent width of the Fe Kα line favors the dual absorption model as the most likely scenario. The $0.1 - 2.0$ keV spectrum does not resemble the few times 10^6 to 10^7 K thermal emission typically found in other elliptical galaxies, but instead is best described as nuclear X-rays leaking through a patchy absorber or scattered in our direction by low-density, ionized gas plus a $15\% - 20\%$ contribution from a thermal component, which is most likely due to the galaxy. The absorption-corrected $2 - 10$ keV luminosity of the nuclear source is $L_X \sim 8 \times 10^{41}$ ergs s^{-1} or $L_X \sim 2 \times 10^{43}$ ergs s^{-1} for the dual-absorption and Compton-reflection models, respectively. The absorbing and H_2O masing gases appear to

be spatially separate in this galaxy.

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Exploratory ASCA Observations of Broad Absorption Line Quasi-Stellar Objects

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We present the analysis and interpretation of a sample of eight ASCA observations of Broad Absorption Line Quasi-Stellar Objects (BALQSOs). This is the first moderate-sized sample of sensitive BALQSO observations above 2 keV, and the BALQSOs in our sample are among the optically brightest known ($B = 14.5$–18.5). Despite the ability of 2–10 keV X-rays to penetrate large column densities, we find BALQSOs to be extremely weak sources above 2 keV, and we are only able to add two new 2–10 keV detections (0226–104 and IRAS 07598+6508) to those previously reported. By comparison with non-BALQSOs of similar optical continuum magnitudes, we derive the column densities needed to suppress the expected X-ray fluxes of our BALQSOs. In several cases we derive column densities $> 5 \times 10^{23}$ cm^{-2} for a neutral absorber with solar abundances. These are the largest X-ray column densities yet inferred for BALQSOs, and they exceed ROSAT lower limits by about an order of magnitude.

Optical brightness does not appear to be a good predictor of 2–10 keV brightness for BALQSOs, but our data do suggest that the BALQSOs with high optical continuum polarizations *may* be the X-ray brighter members of the class. For example, the highly polarized object PHL 5200 appears to be unusually X-ray bright for a BALQSO given its optical magnitude.

We discuss the implications of our results for future observations with AXAF and XMM. If the objects in our sample are representative of the BALQSO population, precision X-ray spectroscopy of most BALQSOs will unfortunately prove difficult in the near future.

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Chimneys in the starburst galaxy M82

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A new radio image of the core of the starburst galaxy M82 is presented. A pair of probable galactic chimneys are evident. Such structures have been conjectured to result when a giant shell of ionized gas breaks out of the dense plane of a galaxy and ejects hot gas into the halo. In M82, the starburst activity drives a galactic superwind and theoretical models of this process require a knowledge of the kinematics of the hot gas in the core of the galaxy. The results presented here imply that the ejection of material into the base of the superwind does not occur smoothly over the starburst region; instead, very localised venting of the hot gas appears to be taking place.

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ROSAT HRI monitoring of extreme X-ray variability in the narrow-line quasar PHL 1092

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We report results from an 18-day ROSAT HRI monitoring campaign on the ultrasoft Narrow-Line Seyfert 1 (NLS1) class quasar PHL 1092. This luminous, radio-quiet quasar showed strong X-ray variability in a short ROSAT PSPC observation, and ROSAT

HRI monitoring of the similar object IRAS 13224–3809 revealed extreme variability on intermediate timescales. We wanted to determine whether remarkable X-ray variability persistently occurs in PHL 1092, and we also wanted to search for outstanding variability events that constrain emission processes. Given the large luminosity of PHL 1092 ($\sim 5 \times 10^{45}$ erg s^{-1} in the HRI band), we detect extremely rapid and large-amplitude X-ray variability throughout our monitoring. The maximum observed variability amplitude is a factor of ≈ 14, and in the most rapid variability event the HRI count rate increases by a factor of ≈ 3.8 in a rest-frame time interval of < 3580 s. The most rapid event has a rate change of luminosity of $> 1.3 \times 10^{42}$ erg s^{-2}, making it the most extreme such event we are aware of from a radio-quiet quasar. Standard 'radiative efficiency limit' arguments imply a radiative efficiency larger than can be achieved by accretion onto a Kerr black hole rotating at the maximum plausible rate, although we point out that such arguments depend upon the geometry of initial radiation release. Relativistic motions of the X-ray source are probably causing the radiative efficiency limit to break down; such relativistic motions have also been inferred in the similar NLS1-class quasar PKS 0558–504.

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PKS2250-41 and the rôle of jet-cloud interactions in powerful radio galaxies.

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We present high resolution, long-slit spectra of the jet-cloud interaction in the powerful southern radio galaxy PKS2250-41. We have resolved the emission lines into two main kinematic components: a broad component (FWHM$\geq$900 km s^{-1}) and a narrow component (FWHM$\leq$150 km s^{-1}). While the broad component is characterized by a low ionization level (with particularly weak HeIIλ4686 emission) and is spatially associated with the radio lobe, the narrow component is characterized by a higher ionization level and extends well beyond the radio lobe. Crucially, we measure a higher electron temperature for the broad component ($T \sim$30,000 K) than for the narrow component ($T \sim$15,000 K). The general line ratios and physical conditions of the two components are consistent with a model in which the broad component represents gas cooling behind the shock front driven by the radio jets, while the narrow component represents the AGN- or shock-photoionized precursor gas. However, uncertainties remain about the gas acceleration mechanism behind the shock front: unless the radio components are expanding unusually fast in this source, it is likely that entrainment of the warm clouds in the hot post-shock wind or radio plasma is required in addition to the initial acceleration across the shock front, in order to explain the large line widths of the broad component.

The similarities between the kinematic properties of PKS2250-41 and some high redshift radio galaxies suggest that the ambient and the shocked gas have also been resolved in the more distant objects. Given the evidence that the emission line processes are affected by the interactions between the radio and the optical structures, care must be taken when interpreting the UV spectra of high redshift radio galaxies.

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Probing the hard X–ray properties of high-redshift Radio-Quiet Quasars with ASCA

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This paper reports the X-ray spectral analysis of 5 high-redshift (z$\geq$2) radio-quiet quasars observed by ASCA. A simple power law continuum plus cold Galactic absorption model well fits all the spectra (tipically between $\sim$ 2–30 keV in the sources frame). Neither the X–ray spectral hardening, attributed to a reflection component and observed in Seyfert galaxies, nor the excess absorption previously detected in high-redshift radio-loud quasars, have been revealed. Only a marginal evidence of a neutral

or mildly ionized FeKα line is found in one of the quasars. The average spectral slope in the observed 0.7–10 keV energy range, $<\Gamma> = 1.67\pm0.11$ (dispersion $\sigma \sim 0.07$), appears to be flatter than that of low-z radio-quiet quasars ($\Gamma \simeq 1.9$–2) and slightly steeper, but consistent with $\Gamma = 1.61\pm0.04$ ($\sigma \sim 0.10$) of high-z radio-loud quasars.

Astrophysical Journal, in press

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The Close Environment of Seyfert Galaxies and Its Implication for Unification Models

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This paper presents a statistical analysis of the circumgalactic environment of nearby Seyfert galaxies based on a computer-aided search of companion galaxies on the Digitized Sky Survey (DSS). We defined a sample of 72 nearby Seyfert 1 (redshift $0.007 \leq z \leq 0.034$) and a sample of 60 Seyfert 2 galaxies ($0.007 \leq z \leq 0.020$), which include only high galactic latitude objects. In addition, we built two control samples of non-active galaxies matching the number of sample members, the redshift, morphological type, and diameter distribution of the Seyfert 1 and Seyfert 2 samples separately. We stress how our sample selection introduces important methodological improvements that avoid several sources of strong bias. An intrinsic difference between the environment of Seyfert 1 and Seyfert 2 galaxies, suggested by previous work, is confirmed as statistically significant. For Seyfert 2 galaxies we find a significant excess of large companions ($D_C \gtrsim 10$ Kpc) within a search radius $\lesssim$ 100 Kpc of projected linear distance, as well as within a search radius equal to three times the diameter D_S of each Seyfert galaxy. For Seyfert 1 galaxies there is no clear evidence of any excess of companion galaxies neither within 100 Kpc, nor within $3D_S$. For all samples the number of companions actually counted within a search radius of 3 D_S is a factor ≈ 2 above the expectation values derived from the number density of galaxies over one square degree fields centered on the sample galaxies, suggesting a markedly non-Poissonian distribution for galaxies on scales $\lesssim 100$ Kpc. This difference in environment is not compatible with the simplest formulation of the Unification Model (UM) for Seyferts: both types 1 and 2 should be intrinsicaly alike, the *only* difference being due to orientation of an obscuring torus. We propose an alternative formulation.

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UGC 3995: A Close Pair of Spiral Galaxies

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UGC 3995 is a close pair of spiral galaxies whose eastern component hosts a Seyfert 2 nucleus. The object was selected because a bright filamentary structure that apparently connects the nuclei of the two galaxies made it a good candidate to investigate a possible interaction–AGN connection. We present a detailed analysis of this system using long slit spectroscopy and narrow (Hα + [NII]$\lambda\lambda$6548,6583) as well as broad band (B, R) imaging and an archive WFPC2 image. The component galaxies reveal surprisingly small signs of interaction considering their spatial proximity and almost identical recession velocities, as the bright filament is probably an optical illusion due to the superposition of the bar of the Seyfert galaxy and of the spiral arms of the companion.

The broad band morphology, a B–R color map, and a continuum-subtracted Hα + [NII]$\lambda\lambda$6548,6583 image demonstrate that the western component UGC 3995B is in front of the Seyfert-hosting component UGC3995A, partly obscuring its western side. The small radial velocity difference leaves the relative motion of the two galaxies largely unconstrained. The observed lack of major tidal deformations, along with some morphological peculiarities, suggests that the galaxies are proximate in space but may have recently approached each other on the plane of the sky. The geometry of the system and the radial velocity curve at P. A. $\approx 106^\circ$ suggest that the encounter may be retrograde or, alternatively, prograde before perigalacticon.

The partial overlap of the two galaxies allows us to estimate the optical thickness of the disk of component B. We derive an extinction ≈ 0.18 visual magnitudes in the infra-arms parts of the foreground galaxy disk, and $\gtrsim 1 - 1.5$ visual magnitudes in correspondence of the spiral arms.

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The Effects of Intrinsic UV Absorption on the Ionizing Continuum and Narrow Emission Line Ratios in Seyfert Galaxies

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We explore the effects of UV absorbing material on the shape of the EUV continuum radiation emitted by the active galactic nucleus, and on the relative strengths of emission lines, formed in the narrow line regions of Seyfert galaxies, excited by this continuum. Within a sample of Seyfert 1.5 galaxies, objects with flatter soft X-ray slopes tend to have lower values of He II λ4686/Hβ, which implies a correlation between the observed spectral energy distribution of the ionizing continuum and the narrow emission line strengths. Objects with the flattest soft X-ray continua tend to possess high column density UV absorption and it is plausible that the differences in narrow emission line ratios among these galaxies are an indication of the effects of absorbing material internal to the narrow line region, rather than intrinsic differences in continuum shape. We have generated a set of photoionization models to examine the effect of a range of UV absorbers on the ionizing continuum and, hence, the resulting conditions in a typical narrow line cloud. Our results indicate that a low ionization UV absorber with large covering factor will indeed produce the combination of narrow line ratios and soft X-ray spectral characteristics observed in several Seyfert 1.5 galaxies. Our results also suggest that low ionization UV absorption may be more common than currently believed.

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Intrinsic Absorption Lines in Seyfert 1 Galaxies. I. Ultraviolet Spectra from the Hubble Space Telescope

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We present a study of the intrinsic absorption lines in the ultraviolet spectra of Seyfert 1 galaxies. The study is based on spectra from the *Hubble Space Telescope*, and includes the Seyfert 1 galaxies observed with the Faint Object Spectrograph and Goddard High Resolution Spectrograph at spectral resolutions of $\lambda/\Delta\lambda \approx 1000 - 20{,}000$ with good signal-to-noise ratios. We find that the fraction of Seyfert 1 galaxies that show intrinsic absorption associated with their active nuclei is more than one-half (10/17), which is much higher than previous estimates (3 – 10%) based on *IUE* data. There is a one-to-one correspondence between Seyferts that show intrinsic UV absorption and X-ray "warm absorbers", indicating that these two phenomena are related. Although our sample is not complete, we conclude that intrinsic absorption represents an important component that needs to be integrated into our overall physical picture of active galaxies.

The intrinsic UV absorption is generally characterized by high-ionization: C IV and N V are seen in all 10 Seyferts with detected absorption (in addition to Lα), whereas Si IV is present in only four of these Seyferts, and Mg II absorption is only detected in NGC 4151. The absorption lines are blueshifted (or in a few cases at rest) with respect to the narrow emission lines, indicating that the absorbing gas is undergoing net radial outflow. At high resolution, the absorption often splits into distinct kinematic components that show a wide range in widths (20 – 400 km s^{-1} FWHM), indicating macroscopic motions (e.g., radial velocity subcomponents or turbulence) within a component. The strong absorption components have cores that are much deeper than the continuum flux levels, indicating that the regions responsible for these components lie completely outside of the broad

emission-line regions.

Additional information on the covering factors and column densities can be derived from the absorption profiles in the high resolution spectra. The covering factor of the absorbing gas in the line of sight, relative to the total underlying emission, is $C_{los} \geq 0.86$, on average. The global covering factor, which is the fraction of emission intercepted by the absorber averaged over all lines of sight, is $C_{global} \geq 0.5$. Thus, structures covering large solid angles as seen by the central continuum source (e.g., spherical shells, sheets, or cones with large opening angles) are required. The individual absorption components show a wide range in C IV column densities (0.1 – 14 x 10^{14} cm^{-2}), and the ratio of N V to C IV column density varies significantly from one absorption component to the next, even in the same Seyfert galaxy. Thus, the intrinsic absorption in a Seyfert 1 galaxy is typically comprised of distinct kinematic components that are characterized by a range in physical conditions (e.g., ionization parameter and hydrogen column density).

Finally, we show evidence for extreme variability in the intrinsic absorption lines of NGC 3783. In addition to our earlier report of the appearance of a C IV absorption doublet at -560 km s^{-1} (relative to the emission lines) over 11 months, we have detected the appearance of another C IV doublet at -1420 km s^{-1} over 15 months. On the other hand, the C IV absorption lines of NGC 3516 and NGC 4151 were very stable over periods of 6 months and 4 years, respectively. Monitoring observations of individual Seyferts at higher time resolution are needed to distinguish between different sources of variability (variable ionization, motion of gas across the line of sight) and to determine the densities and radial locations of the absorption components.

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Physical Conditions in the Emission-Line Gas in the Extremely Low-Luminosity Seyfert Nucleus of NGC 4395

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We have combined *Hubble Space Telescope*/Faint Object Spectrograph, ground-based, and *Infrared Space Observatory* spectra of the nucleus of NGC 4395, the least luminous and nearest known type 1 Seyfert galaxy. The spectra show emission lines from a wide range of ionization states and critical densities. We have generated multicomponent photoionization models of both the broad and narrow emission-line regions (BLR and NLR) to investigate the physical conditions in the emission-line gas and test the proposition that the source of ionization is the non-stellar continuum radiation emitted by the central source. We show that, with a minimum of free parameters, the model predictions match the observed emission-line intensity ratios quite well. The elemental abundances appear to be be subsolar, with even greater underabundance of nitrogen. From the size of the BLR predicted by the models, we estimate a central mass of a few x 10^5 $M_\odot$, in reasonable agreement with estimates from the stellar kinematics. Finally, our results suggest that the covering factor of the emission-line gas is close to unity, and that the observed UV to X-ray continuum is absorbed by intervening NLR gas. We argue that a high covering factor is responsible for the apparent flattening of the Baldwin relation relation in low-luminosity active galactic nuclei.

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Origin of MeV gamma ray emissions from blazars

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We have developed a model for MeV emission from blazars that involves the production of MeV γ -rays through Inverse Compton (IC) scattering of electrons in the blob of a jet, with the UV photons of the accretion disk. The OSSE and the COMPTEL spectra of PKS 0528 + 134 have been fitted with the computed MeV γ -ray fluxes of the above model. A good fit was obtained with electrons of Lorentz factor of $10^{1.5}$ to 10^3 and a jet the viewing angle of $\leq 15^o$ and an accretion disk temperature in the range of 2.0 to 6.0 x 10^5K.

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The HST Survey of BL Lac Objects: Gravitational Lens Candidates and Other Unusual Sources

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We present HST observations of seven unusual objects from the HST "snapshot survey" of BL Lac objects, of which four are gravitational lens candidates. In three cases a double point sources is observed: 0033+595, with 1.58 arcsec separation, and 0502+675 and 1440+122, each with ~ 0.3 arcsec separation. The last two also show one or more galaxies, which could be either host or lensing galaxies. If any are confirmed as lenses, these BL Lac objects are excellent candidates for measuring H_0 via gravitational time delay because of their characteristic rapid, high amplitude variability. An additional advantage is that, like other blazars, they are likely superluminal radio sources, in which case the source plane is mapped out over a period of years, providing strong additional constraints on the lensing mass distribution. The fourth gravitational lens candidate is 1517+656, which is surrounded by three arclets forming an almost perfect ring of radius 2.4 arcsec. If this is indeed an Einstein ring, it is most likely a background source gravitationally lensed by the BL Lac object host galaxy and possibly a surrounding group or cluster. In the extreme case that all four candidates are true lenses, the derived frequency of gravitational lensing in this BL Lac sample would be an order of magnitude higher than in comparable quasar samples.

We also report on three other remarkable BL Lac objects: 0138–097, which is surrounded by a large number of close companion galaxies; 0806+524, whose host galaxy contains an uncommon arc-like structure; and 1959+650, which is hosted by a gas rich elliptical galaxy with a prominent dust lane of $\sim 5 \times 10^5$ $M_\odot$.

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Strong optical line variability in Mkn 110

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We present results of a long-term variability campaign on the Seyfert 1 galaxy Markarian 110. Mkn 110 is a narrow-line Seyfert 1 object hosted in a morphological peculiar galaxy. We monitored the optical continuum and the line intensities as well as their profiles over a time interval of nearly ten years. The continuum and the Balmer lines varied by a factor of 2 to 5 within two years. The HeII4686 line showed exceptional intensity variations of a factor of eight. We detected an additional independent very broad-line region in high intensity stages of the Balmer and HeII lines. The CCF analysis of the HeII line indicates that this very broad-line region originates at a distance of 9 light days only from the central ionizing source.

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Broad band X-ray observations of the narrow line X-ray galaxy NGC 5506

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We present a detailed analysis of broad band X-ray data of the Seyfert 2 galaxy NGC5506, obtained with the ASCA and ROSAT, to address the nature of Fe Kα line profile and the soft X-ray excess in this AGN. Variations up to 60% in the 2-10 keV

band are detected during a 1-day ASCA observation performed in January 1997, while no significant change in the 2-10 keV continuum shape is found. The ASCA spectrum consists of an absorbed power-law, a 'soft excess' below 2 keV, and an Fe Kα emission line at 6.4 keV. The 'soft excess' can be well described by either thermal emission from very low abundance material at a temperature kT$\simeq$0.8 keV, or scattered/leaking flux from the primary power-law plus a small amount of thermal emission. The luminosity of the thermal emission in the former case is 1.2×10^{40} erg s^{-1} over the 0.5-2 keV band, while the excess is $\sim$ 1% of the intrinsic hard X-ray continuum in the latter case. Analysis of ROSAT HRI data reveals that the soft X-ray emission is extended on kpc scales in this object, and the extended component may account for most of the soft X-ray excess observed by the ASCA. The result suggests that in this type 2 AGN, the 'soft excess' at least partly comes from an extended region, imposing serious problem for the model in which the source is partially covered. We argue that the generally low abundances are a drawback for the thermal model, favoring a scattering dominated model. The scatterer is likely to be relatively cold (kT $\ll$ 1 keV) in this object.

Fe Kα profile is complex and can not be satisfactorily modeled by a single gaussian. Models of either double gaussians, or a narrow gaussian plus a line from a relativistic accretion disk viewed at an inclination of about $40\pm10^{\circ}$ provide good fits to the data. However, the inclination of the disk can be substantially larger if there is a small amount of excessive Fe K edge absorption. The intermediate inclinations for NLXGs are consistent with the ideas that the inner accretion disk is aligned with the outer obscuring torus.

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