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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.

As always as editor of the newsletter I am very interested to hear any suggestions or feedback regarding the newsletter. So do not hesitate in emailing me your suggestions.

Many thanks for your continued subscription.

Janine van Eymeren

Abstracts of recently accepted papers

The Lick AGN Monitoring Project: Velocity-Delay Maps from the Maximum-Entropy Method for Arp 151

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We present velocity-delay maps for optical HI, HeI, and HeII recombination lines in Arp 151, recovered by fitting a reverberation model to spectrophotometric monitoring data using the maximum-entropy method. HI response is detected over the range 0–15 days, with the response confined within the virial envelope. The Balmer-line maps have similar morphologies but exhibit radial stratification, with progressively longer delays for Hγ to Hβ to Hα. The HeI and HeII response is confined within 1–2 days. There is a deficit of prompt response in the Balmer-line cores but strong prompt response in the red wings. Comparison with simple models identifies two classes that reproduce these features: freefalling gas, and a half-illuminated disk with a hotspot at small radius on the receding lune. Symmetrically illuminated models with gas orbiting in an inclined disk or an isotropic distribution of randomly inclined circular orbits can reproduce the virial structure but not the observed asymmetry. Radial outflows are also largely ruled out by the observed asymmetry. A warped-disk geometry provides a physically plausible mechanism for the asymmetric illumination and hotspot features. Simple estimates show that a disk in the broad-line region of Arp 151 could be unstable to warping induced by radiation pressure. Our results demonstrate the potential power of detailed modeling combined with monitoring campaigns at higher cadence to characterize the gas kinematics and physical processes that give rise to the broad emission lines in active galactic nuclei.

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preprint available at arXiv:1007.0781

Color-Magnitude Relations of Active and Non-Active Galaxies in the *Chandra* Deep Fields: High-Redshift Constraints and Stellar-Mass Selection Effects

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We extend color-magnitude relations for moderate-luminosity X-ray AGN hosts and non-AGN galaxies through the galaxy formation epoch ($z \approx 1$–4) in the *Chandra* Deep Field-North and *Chandra* Deep Field-South (CDF-N and CDF-S, respectively; jointly CDFs) surveys. This study was enabled by the deepest available X-ray data from the 2 Ms CDF surveys as well as complementary ultradeep multiwavelength data in these regions. We utilized analyses of color-magnitude diagrams (CMDs) to assess the role of moderate-luminosity AGNs in galaxy evolution. First, we confirm some previous results and extend them to higher redshifts, finding, for example, that (1) there is no apparent color bimodality (i.e., the lack of an obvious red sequence and blue cloud) for AGN hosts from $z \approx 0 - 2$, but non-AGN galaxy color bimodality exists up to $z \approx 3$ and the relative fraction of red-sequence galaxies generally increases as the redshift decreases (consistent with a blue-to-red migration of galaxies); (2) most AGNs reside in massive hosts and the AGN fraction rises strongly toward higher stellar mass, up to $z \approx 2$–3; and (3) the colors of both AGN hosts and non-AGN galaxies become redder as the stellar mass increases, up to $z \approx 2$–3. Second, we point out that, in order to obtain a complete and reliable picture, it is critical to use mass-matched samples to examine color-magnitude relations of AGN hosts and non-AGN galaxies. We show that for mass-matched samples up to $z \approx 2$–3, AGN hosts lie in the same region of the CMD as non-AGN galaxies; i.e., there is no specific clustering of AGN hosts in the CMD around the red sequence, the top of the blue cloud, or the green valley in between. The AGN fraction ($\approx 10\%$) is mostly independent of host-galaxy color, providing an indication of the duty cycle of supermassive black hole growth in typical massive galaxies. These results are in contrast to those obtained with non-mass-matched samples where there is apparent AGN clustering in the CMD and the AGN fraction generally increases as the color becomes redder. We also find, for mass-matched samples, that the star-formation rates of AGN hosts are typically a factor of ≈ 2–3 larger than those of non-AGN galaxies at $z \approx 0$–1, whereas this difference diminishes at $z \approx 1$–3. With mass-selection effects taken into account, we find that almost all the results obtained in this work can be reasonably explained by two main ingredients, color-mass correlation (i.e., X-ray AGNs preferentially reside in massive galaxies that generally tend to be redder than less-massive galaxies) and passive or secular evolution of galaxies. Our results show that the presence of moderate-luminosity AGN activity does not have a significant effect on the colors of galaxies and thus tightly constrain any effects from moderate-luminosity AGN feedback upon color-magnitude properties over the $\approx 80\%$ of cosmic time during which most of galaxy formation occurred.

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E-mail contact: xuey@astro.psu.edu,
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The broad-band X-ray spectrum of the Seyfert 1 galaxy, MCG+8-11-11

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Mounting evidence is showing that the main ingredients of the Unification Models of Active Galactic Nuclei may behave differently from what expected, and they could be intimately related to fundamental physical parameters. The availability of high signal-to-noise broad-band X-ray spectra gives us the opportunity to study in detail all the contributions from the materials invoked in these models, and infer their general properties, including if their presence/absence is related to other quantities.

We present a long (100 ks) *Suzaku* observation of one of the X-ray brightest AGN, MCG+8-11-11. These data were complemented with the 54-month *Swift* BAT spectrum, allowing us to perform a broad-band fit in the 0.6-150 keV range.

The fits performed in the 0.6-10 keV band give consistent results with respect to a previous XMM-*Newton* observation, i.e. the lack of a soft excess, warm absorption along the line of sight, a large Compton reflection component ($R \simeq 1$) and the absence of a relativistic component of the neutral iron Kα emission line. However, when the PIN and *Swift* BAT data are included, the reflection amount drops significantly ($R \simeq 0.2 - 0.3$), and a relativistic iron line is required, the latter confirmed by a phenomenological analysis in a restricted energy band (3-10 keV). When a self-consistent model is applied to the whole broadband data, the observed reflection component appears to be all associated to the relativistic component of the iron Kα line.

The resulting scenario, though strongly model-dependent, requires that all the reprocessing spectral components from Compton-thick material must be associated to the accretion disc, and no evidence for the classical pc-scale torus is found. The narrow core of the neutral iron Kα line is therefore produced in a Compton-thin material, like the BLR, similarly to what found in another Seyfert galaxy, NGC 7213, but with the notable difference that MCG+8-11-11 presents spectral signatures from an accretion disc. The very low accretion rate of NGC 7213 could explain the lack of relativistic signatures in its spectrum, but the absence of the torus in both sources is more difficult to explain, since their luminosities are comparable, and their accretion rates are completely different.

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Quasar Mass Functions Across Cosmic Time

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I present mass functions of actively accreting black holes detected in different quasar surveys which in concert cover a wide range of cosmic history. I briefly address what we learn from these mass functions. I summarize the motivation for such a study and the methods by which we determine black hole masses.

Invited contribution to IAU Symposium, Vol. 267, "Co-Evolution of Central Black Holes and Galaxies", Proceedings of the International Astronomical Union, p. 239-247

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preprint available at arxiv/1007.2600

Line profile and continuum variability in the very broad-line Seyfert galaxy Mrk 926

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We present results of an intensive spectroscopic variability campaign of the very broad-line Seyfert 1 galaxy Mrk 926. Our aim is to investigate the broad-line region (BLR) by studying the intensity and line profile variations of this galaxy on short timescales. High signal-to-noise ratio(S/N) spectra were taken with the 9.2m Hobby-Eberly Telescope (HET)in identical conditions during two observing campaigns in 2004 and 2005. After the spectral reduction and internal calibration we achieved a relative flux accuracy of better than 1%. The rms profiles of the very broad Balmer lines have shapes that differ from their mean line profiles, consisting of two inner (v $\lesssim \pm$ 6 000 km s^{-1}) and two outer (v $\gtrsim \pm$ 6 000 km s^{-1}) line components in addition to a central component (v $\lesssim \pm$ 600 km s^{-1}). These outer and inner line segments varied with different amplitudes during our campaign. The radius of the BLR is very small with an upper limit of 2 light-days for the Hβ BLR size. We derived an upper limit to the central black hole mass of $M = 11.2 \times 10^7 M_\odot$. The 2-D cross-correlation functions CCF(τ,v) of Hβ and Hα are flat within the error limits. The response of the Balmer line segments with respect to continuum variations is different in the outer and inner wings of Hα and Hβ. This double structure in the response curves - of two separate inner and outer components - has also been seen in the rms line profiles. We conclude that the outer and inner line segments originate in different regions and/or under different physical conditions.

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An expanded $M_{\rm bh}$-σ diagram, and a new calibration of active galactic nuclei masses

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We present an updated and improved $M_{\rm bh}$-σ diagram containing 64 galaxies for which $M_{\rm bh}$ measurements (not just upper limits) are available. Due to new and increased black hole masses at the high-mass end, and a better representation of barred galaxies at the low-mass end, the "classical" (all morphological type) $M_{\rm bh}$-σ relation for predicting black hole masses is $\log(M_{\rm bh}/M_\odot) = (8.13 \pm 0.05) + (5.13 \pm 0.34) \log[\sigma/200\,{\rm km\,s^{-1}}]$, with an r.m.s. scatter of 0.43 dex. Modifying the regression analysis to correct for a hitherto over-looked sample bias in which black holes with masses $< 10^6 M_\odot$ are not (yet) detectable, the relation steepens further to give $\log(M_{\rm bh}/M_\odot) = (8.15 \pm 0.06) + (5.95 \pm 0.44) \log[\sigma/200\,{\rm km\,s^{-1}}]$. We have also updated the "barless" and "elliptical-only" $M_{\rm bh}$-σ relations introduced by Graham and Hu in 2008 due to the offset nature of barred galaxies. These relations have a total scatter as low as 0.34 dex and currently define the upper left envelope of points in the $M_{\rm bh}$-σ diagram. These relations also have a slope consistent with the value 5, in agreement with the prediction by Silk & Rees based on feedback from massive black holes in bulges built by monolithic-collapse.

Using updated virial products and velocity dispersions from 28 active galactic nuclei, we determine that the optimal scaling factor f — which brings their virial products in line with the 64 directly measured black hole masses — is $2.8^{+0.7}_{-0.5}$. This is roughly half the value reported by Onken et al. and Woo et al., and consequently halves the mass estimates of most high-redshift quasars. Given that barred galaxies are, on average, located $\sim$0.5 dex below the "barless" and "elliptical-only" $M_{\rm bh}$-σ relations, we have explored the results after separating the samples into barred and non-barred galaxies, and developed a preliminary corrective term to the velocity dispersion based on bar dynamics. In addition, given the recently recognised coexistence of massive black holes and nuclear star clusters, we present the first ever $(M_{\rm bh} + M_{\rm nc})$-$\sigma$ diagram and begin to explore how galaxies shift from their former location in the $M_{\rm bh}$-σ diagram.

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DRAFT is available at Preprints.html

Relativistic plasma as the dominant source of the optical continuum emision in the broad-line radio galaxy 3C 120

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We report a relation between radio emission in the inner jet of the Seyfert galaxy $3C$ 120 and optical continuum emission in this galaxy. Combining the optical variability data with multi-epoch high-resolution very long baseline interferometry observations reveals that an optical flare rises when a superluminal component emerges into the jet and its maxima is related to the passage of such component through the location a stationary feature at a distance of $\approx$1.3 parsecs from the jet origin. This indicates that a significant fraction of the optical continuum produced in 3C 120 is non-thermal and it can ionize material in a sub-relativistic wind or outflow. We discuss implications of this finding for the ionization and structure of the broad emission line region, as well as for the use of broad emission lines for determining black hole masses in radio-loud AGN.

2010, ApJ, 715, 355

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preprint available at http://arxiv.org/abs/0910.1320

Radiation pressure force emission line profiles and black hole mass in active galactic nuclei

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We present a new analysis of the motion of broad line region (BLR) clouds in active galactic nuclei (AGNs) taking into account the combined influence of gravity and radiation pressure force. We calculate orbits for pressure confined clouds under a large range of conditions and include the effect of a changing column density as a function of location. The dependence of radiation pressure force on the level of ionization and the column density are accurately computed. The main results are: a. The mean cloud location (r_{BLR}) and the line widths (FWHMs) are combined in such a way that the simple virial mass estimate, $r_{BLR}FWHM^2/G$, gives a reasonable approximation to $M_{\rm BH}$ even when radiation pressure force is important. The reason is that L/M rather than L is the main parameter affecting the planar cloud motion. b. Reproducing the observed mean radius, FWHM and intensity of H_β and C IV λ1549 requires at least two different populations of clouds. c. The cloud location is a function of both $L^{1/2}$ and L/M. Given this we suggest a new approximation for r_{BLR} which, when inserted into the BH mass equation, results in a new approximation for $M_{\rm BH}$. The new expression involves $L^{1/2}$, FWHM and two constants that are obtained from a comparison with available $M-\sigma*$ mass estimates. It deviates only slightly from the old mass estimate at all luminosities. d. The quality of present black hole mass estimators depends, critically, on the way the present $M-\sigma*$ AGN sample (16 objects) represents the AGN population, in particular the distribution of $L/L_{\rm Edd}$.

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Thesis Abstracts

Weighing Supermassive Black Holes

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Ph.D degree awarded: April 2010

We calculate the black hole masses for a sample of 27728 quasars selected from the Sloan Digital Sky Survey (SDSS) Data Release 3 (DR3). To ensure a high signal-to-noise ratio, we reconstruct quasar spectra for this large sample of quasars using the eigenspectra method (Yip et al., 2004). This method reduces the uncertainty of the measurements for even noisy original spectra, making almost all the SDSS quasar spectra usable for our study.

A few applications for black hole mass estimates are presented here. Wang et al. (2006) estimated an average radiative efficiency of 30%–35% for quasars at moderate redshift, which implies that most supermassive black holes are rotating very rapidly. Using our black hole mass estimates, we have found that their method is not independent of quasar lifetimes and thus that quasars do not necessarily have such high efficiencies.

As a second application, we have investigated a claim by Steinhardt and Elvis (2009) that there exists a sub-Eddington boundary in the quasar mass-luminosity plane using the Shen et al. (2008) mass estimates. We re-calibrate the mass-scaling relations following Wang et al. (2009) with the most up-to-date reverberation estimates of black hole masses. We compare results from the original data sets with the new re-calibrated estimates of the mass-luminosity plane. We conclude that the presence of the sub-Eddington boundary in the original data of Shen et al. (2008) is likely due to biases in the mass-scaling relation and not to any physical process.

Special Announcements

Beta release of a Compton-thick reprocessor spectral-fitting model

July 2010

We announce the beta release of "MYTorus", a new spectral-fitting tool for Compton-thick X-ray reprocessors with a toroidal geometry, based on the model described in Murphy & Yaqoob 2009 (MNRAS, 397, 1549). The model self-consistently calculates the Fe $K\alpha$ and Fe $K\beta$ line emission in addition to the reprocessed continuum. The statistical accuracy and energy resolution is good enough for current X-ray data as well as data expected from *NuSTAR* and *Astro-H*. Although primarily designed as a spectral-fitting tool for AGN X-ray spectra, MYTorus can be used for simulations, as well as theoretical evaluation and/or investigation of spectra, observed to intrinsic luminosity ratios, and other properties. The tool comes with an instruction manual that can be obtained from `http://www.mytorus.com/`. The manual also has a detailed description of the files that are available and how to download them.

E-mail contact: model@mytorus.com