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Accepted Abstracts - Submitted Abstracts - Thesis Abstracts
Jobs Adverts - Meetings Adverts - Special Announcements

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.

Melanie Gendre

Abstracts of recently accepted papers

Clear detection of dusty torus signatures in a Weak-Line Radio Galaxy: the case of PKS 0043-42

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We report the clearest detection to date of dusty torus signatures in a Weak-Line Radio Galaxy (WLRG). The deep Spitzer InfraRed Spectrograph (IRS) rest-frame mid-infrared (MIR) spectrum of the WLRG PKS 0043-42 (z=0.116) shows a clear spectral turnover at $\lambda \geq 20$ μm suggestive of warm dust, as well as a 9.7 μm silicate absorption feature. In addition, the hard X-ray results, based on Chandra data, strongly support a picture in which PKS 0043−42 has a torus and accretion disc more typical of Strong-Line Radio Galaxies (SLRGs). The MIR and X-ray spectra are markedly different from those of other WLRGs at similar redshifts, and here we show that the former can be successfully fitted with clumpy torus models with parameters characteristic of Type-2 AGN tori: close to edge-on (i=74^o) and relatively broad (σ=60^o), with an outer radius of 2 pc, N_H=$1.6\pm^{0.2}_{0.1}\times10^{23}$ cm^{-2}, and AGN bolometric luminosity L_{bol}^{AGN} = $1.6\pm^{0.2}_{0.1}\times10^{44}$ $erg\ s^{-1}$. The presence of a compact torus in PKS 0043-42 provides evidence that this WLRG is fuelled by cold, rather than hot, gas accretion. We suggest that WLRGs are a diverse population, and PKS 0043-42 may represent a type of radio galaxy in which the AGN activity has been recently re-triggered as a consequence of intermittent gas supply, or in which the covering factor of the Narrow-Line Region (NLR) clouds is relatively low.

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E-mail contact: C.Ramos@sheffield.ac.uk,
preprint available at http://arxiv.org/abs/1101.1868

Dusty Tori of Luminous Type 1 Quasars at $z \sim 2$

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We present *Spitzer* infrared spectra and ultra-violet to mid-infrared spectral energy distributions (SEDs) of 25 luminous type 1 quasars at z $\sim$ 2. In general, the spectra show a bump peaking around 3 μm, and the 10 μm silicate emission feature. The 3 μm emission is identified with hot dust emission at its sublimation temperature. We explore two approaches to modeling the SED: (i) using the Clumpy model SED from Nenkova et al. (2008a), and (ii) the Clumpy model SED, and an additional blackbody component to represent the 3 μm emission. In the first case, a parameter search of $\sim$ 1.25 million Clumpy models shows: (i) if we ignore the UV-to-near-IR SED, models fit the 2–8 μm region well, but not the 10 μm feature; (ii) if we include the UV-to-near-IR SED in the fit, models do not fit the 2–8 μm region. The observed 10 μm features are broader and shallower than those in the best-fit models in the first approach. In the second case, the shape of the 10 μm feature is better reproduced by the Clumpy models. The additional blackbody contribution in the 2–8 μm range allows Clumpy models dominated by cooler temperatures ($T < 800$K) to better fit the 8–12μm SED. A centrally concentrated distribution of a small number of torus clouds is required in the first case, while in the second case the clouds are more spread out radially. The temperature of the blackbody component is $\sim$ 1200K as expected for graphite grains.

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He-like ions as practical astrophysical plasma diagnostics: From stellar coronae to active galactic nuclei

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We review X-ray plasma diagnostics based on the line ratios of He-like ions. Triplet/singlet line intensities can be used to determine electronic temperature and density, and were first developed for the study of the solar corona. Since the launches of the X-ray satellites Chandra and XMM-Newton, these diagnostics have been extended and used (from C V to Si XIII) for a wide variety of astrophysical plasmas such as stellar coronae, supernova remnants, solar system objects, active galactic nuclei, and X-ray binaries. Moreover, the intensities of He-like ions can be used to determine the ionization process(es) at work, as well as the distance between the X-ray plasma and the UV emission source for example in hot stars. In the near future thanks to the next generation of X-ray satellites (e.g., Astro-H and IXO), higher-Z He-like lines (e.g., iron) will be resolved, allowing plasmas with higher temperatures and densities to be probed. Moreover, the so-called satellite lines that are formed closed to parent He-like lines, will provide additional valuable diagnostics to determine electronic temperature, ionic fraction, departure from ionization equilibrium and/or from Maxwellian electron distribution.

Space Science Reviews in press (ArXiv/1101.3184)

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The final publication is available at http://www.springerlink.com

HST WFC3/IR Observations of Active Galactic Nucleus Host Galaxies at z∼2: Supermassive Black Holes Grow in Disk Galaxies[1]

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[1] Based on observations made with the NASA/ESA Hubble Space Telescope, obtained from the data archive at the Space Telescope Institute. STScI is operated by the association of Universities for Research in Astronomy, Inc. under the NASA contract NAS 5-26555.
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We present the rest-frame optical morphologies of active galactic nucleus (AGN) host galaxies at $1.5 < z < 3$, using near-infrared imaging from the *Hubble Space Telescope* Wide Field Camera 3, the first such study of AGN host galaxies at these redshifts. The AGN are X-ray selected from the *Chandra* Deep Field South and have typical luminosities of $10^{42} < L_{\rm X} < 10^{44}$ erg s^{-1}. Accreting black holes in this luminosity and redshift range account for a substantial fraction of the total space density and black hole mass growth over cosmic time; they thus represent an important mode of black hole growth in the universe. We find that the majority ($\sim 80\%$) of the host galaxies of these AGN have lowSersic indices indicative of disk-dominated light profiles, suggesting that secular processes govern a significant fraction of the cosmic growth of black holes. That is, many black holes in the present-day universe grew much of their mass in disk-dominated galaxies and not in early-type galaxies or major mergers. The properties of the AGN host galaxies are furthermore indistinguishable from their parent galaxy population and we find no strong evolution in either effective radii or morphological mix between $z \sim 2$ and $z \sim 0.05$.

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Testing the Unification Model for AGN in the Infrared: are the obscuring tori of Type 1 and 2 Seyferts different?

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We present new mid-infrared (MIR) imaging data for three Type-1 Seyfert galaxies obtained with T-ReCS on the Gemini-South Telescope at subarcsecond resolution. Our aim is to enlarge the sample studied in a previous work to compare the properties of Type-1 and Type-2 Seyfert tori using clumpy torus models and a Bayesian approach to fit the infrared nuclear spectral energy distributions (SEDs). Thus, the sample considered here comprises 7 Type-1, 11 Type-2, and 3 intermediate-type Seyferts. The unresolved IR emission of the Seyfert 1 galaxies can be reproduced by a combination of dust heated by the central engine and direct AGN emission, while for the Seyfert 2 nuclei only dust emission is considered. These dusty tori have physical sizes smaller than 6 pc radius, as derived from our fits. Unification schemes of AGN account for a variety of observational differences in terms of viewing geometry. However, we find evidence that strong unification may not hold, and that the immediate dusty surroundings of Type-1 and Type-2 Seyfert nuclei are intrinsically different. The Type-2 tori studied here are broader, have more clumps, and these clumps have lower optical depths than those of Type-1 tori. The larger the covering factor of the torus, the smaller the probability of having direct view of the AGN, and vice-versa. In our sample, Seyfert 2 tori have larger covering factors (C_T=0.95±0.02) and smaller escape probabilities ($P_{esc}=0.05\pm^{0.08}_{0.03}$ %) than those of Seyfert 1 (C_T=0.5±0.1; P_{esc}=18±3 %). All the previous differences are significant according to the Kullback-Leibler divergence. Thus, on the basis of the results presented here, the classification of a Seyfert galaxy as a Type-1 or Type-2 depends more on the intrinsic properties of the torus rather than on its mere inclination towards us, in contradiction with the simplest unification model.

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Off-axis Energy Generation in Active Galactic Nuclei: Explaining Broad-Line Profiles, Spectropolarimetric Observations, and Velocity-Resolved Reverberation Mapping

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It is shown that broad-line region (BLR) line profiles ranging from the classic "logarithmic" profile to double-peaked, disk-like profiles are readily explained by the distribution of BLR gas proposed by Gaskell, Klimek, & Nazarova (GKN) without any need to invoke fundamental differences in the AGNs other than differing viewing angles. It is argued that the highly-variable thermal energy generation in AGNs originates off axis in regions that cannot be axially symmetric. This off-axis model readily explains the varying degrees of temporal correlation found in multi-wavelength variability studies, the strong, variable asymmetry of BLR line profiles, the varying time delays in the response of the BLR to different continuum events, how narrow velocity ranges of line profiles will often appear to respond differently or not at all to continuum variability, complex changes in the Balmer decrement with velocity, inconsistent and variable inflow/outflow signatures found in velocity-resolved reverberation mapping, the diversity of velocity-dependent polarizations observed, and polarization variability. The fundamentally non-axisymmetric nature of AGN continuum variability severely limits what can be learned from reverberation mapping. In particular, high-fidelity reverberation mapping is not possible. There will be systematic orientation-dependent errors in black hole mass determinations. The effects of off-axis emission will mask subtle signatures of possible close supermassive black hole binaries. Some tests of the off-axis-variability model are proposed.

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Thesis Abstracts

Flares in Blazars

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Blazars are active galactic nuclei characterized by strong, nearly pure non-thermal radiations; these extend across the electromagnetic spectrum, from radio frequencies to the most energetics γ rays observed, in some cases up to TeV energies. They represent an ideal benchmark to test several fields of high energy astrophysics, like particle acceleration and emission processes. To this aim, a multi-λ approach is essential to disentangle the various processes taking place in these objects.

Even more enticing to understand Blazars physics is their variability, and in particular their "flares"; they are apparently random, substantial flux increases, taking place on timescales of days or less, in some cases down to hours. Flares may occur in different energy bands, and in this work I will in particular study how flux variations at different wavelength can be interpreted in terms of the underlying physical processes taking places in different type of Blazars.

Blazars are in fact divided in two major classes: BL Lacs and FSRQs. Both are widely held to radiate from a narrow relativistic jets closely aligned with observer's line of sight, and originating from a central engine constituted by a supermassive black hole coupled with a surrounding accretion disk. On the other hand, the differences between Blazars spectra point toward different environments surrounding the central black hole.

In fact, BL Lacs show no or just weak and intermittent emission lines, and yield no observational evidence of thermal emission from the accretion disk; these features can be interpreted in terms of scarce surrounding gas and small ongoing accretion. BL Lacs spectra are effectively interpreted in terms of pure synchrotron-self Compton (SSC) radiation, that is, synchrotron emission (in the bands from infrared to soft X-rays) from highly relativistic electrons inside the jet, and inverse Compton upscattering (radiating in the MeV - TeV energy range) by the same electrons on seed photons of the very synchrotron radiation.

FSRQs, on the other hand, with their broad emission lines and strong Big Blue Bump (BBB) yield evidence of plenty surrounding gas, associated to high current accretion rates onto the disk. Both emission lines and BBB provide seed photons that can be Compton scattered by the electrons inside the jets (the so called external Compton scenario), yielding the high γ-ray outputs often dominating their spectra.

Making use of refined and updated SSC models involving both analytical relations and numerical simulations I have performed detailed studies of flaring episodes of a number of BL Lacs, pushing the homogeneous single-zone SSC model to its limits to test whether it can explain observed multi wavelength variabilities, or more complex, structured sources are required.

Moreover, I investigated two saturation effects that can limit flux increase and so affect flaring behavior, either due to the particle acceleration processes or to the total available power. The latter, in particular, relates to the limited available power extractable from the central rotating hole via the Blandford-Znajek electrodynamical mechanism, involving the interplay between the accretion disk and the hole, governed by strong gravity effects of General Relativity; this mechanism is relevant for BL Lacs with very small current accretion rates. FSRQs, on the other hand, show evidences of high ongoing accretion and so easily overcome this limit.

My results show that the different physical properties of Blazars reflect into different flaring behaviors. While in BL Lacs the main driver of flaring episodes is provided by particle *acceleration* processes taking place *inside* the jets to energies $\gamma \simeq 10^6$, in FSRQs we understand flares in terms of increased *accretion* rates providing more and harder *external* photons to be inverse Compton scattered. In addition, the saturation effects taking place in BL Lacs reinforce these differences, yielding *divergent* flaring patterns for the two subclasses on the luminosity vs. electron energy plane.

Finally, to investigate the acceleration processes taking place in BL Lacs jets, I performed an extensive X-ray analysis of high-frequency peaked sources not (yet) detected at TeV energies, in order to compare these with those detected at such energies, to outline a simple electrostatic acceleration model to interpret their peak frequencies distribution and to single out some good TeV candidates.

This thesis is available in pdf format upon request.