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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

Rapidly variable Fe Kα line in NGC 4051

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We present a detailed analysis on the variability of the Fe K emission line in NGC 4051 using ASCA data. Through simple Gaussian line fits, we find not only obvious Fe K line variability with no significant difference in the X-ray continuum flux between two ASCA observations which were separated by $\sim$ 440 days, but also rapid variability of Fe K line on time scales $\sim 10^4$ s within the second observation. During the second observation, the line is strong (EW = 733^{+206}_{-219} eV) and broad ($\sigma = 0.96^{+0.49}_{-0.35}$ keV) when the source is brightest, and become weaker (EW = 165^{+87}_{-86} eV) and narrower ($\sigma < 0.09$ keV) whilst the source is weakest. The equivalent width of Fe K line correlatespositively with the continuum flux, which shows an opposite trend with another Seyfert 1 galaxy MCG –6-30-15.

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An Application of Kerr Blackhole Fly-Wheel Model to Statistical Properties of QSOs/AGNs

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The aim of this work is to demonstrate the properties of the magnetospheric model around Kerr blackholes (BHs), so-called the fly-wheel (rotation driven) model. The fly-wheel engine of the BH-accretion disk system is applied to the statistics of QSOs/AGNs. In the model, the central BH is assumed to be formed at $z \sim 10^2$ and obtains nearly maximum but finite rotation energy ($\sim$ extreme Kerr BH) at the formation stage. The inherently obtained rotation energy of the Kerr BH is released through an magnetohydrodynamic process. This model naturally leads finite lifetime of AGN activity.

Nitta et al. (1991) clarified individual evolution of Kerr BH fly-wheel engine which is parametrized by BH mass, initial Kerr parameter, magnetic field near the horizon and a dimension-less small parameter. We impose a statistical model for the initial mass function (IMF) of ensemble of BHs by the Press-Schechter formalism. By the help of additional assumptions, we can discuss the evolution of the luminosity function and the spatial number density of QSOs/AGNs.

Comparing with observations, somewhat flat IMF and weak dependence of the magnetic field on BH mass are preferred. The result well explains decrease of very bright QSOs and decrease of population after $z \sim 2$.

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X-ray spectral complexity in narrow-line Seyfert 1 galaxies

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We present a systematic analysis of the X-ray spectral properties of a sample of 22 "narrow-line" Seyfert 1 galaxies for which data are available from the ASCA public archive. Many of these sources, which were selected on the basis of their relatively narrow Hβ line width (FWHM $\leq$2000 km/s), show significant spectral complexity in the X-ray band. Their measured hard power-law continua have photon indices spanning the range $1.6 - 2.5$ with a mean of 2.1, which is only slightly steeper than the norm for "broad-line" Seyfert 1s. All but four of the sources exhibit a soft excess, which can be modelled as blackbody emission ($T_{bb} \approx 100 - 300$ eV) superposed on the underlying power-law. This soft component is often so strong that, even in the relatively hard bandpass of ASCA, it contains a significant fraction, if not the bulk, of the X-ray luminosity, apparently ruling out models in which the soft excess is produced entirely through reprocessing of the hard continuum.

Most notably, 6 of the 22 objects show evidence for a broad absorption feature centred in the energy range 1.1–1.4 keV , which could be the signature of resonance absorption in highly ionized material. A further 3 sources exhibit "warm absorption" edges in the 0.7–0.9 keV bandpass. Remarkably, all 9 "absorbed" sources have Hβ line widths below 1000 km/s, which is less than the median value for the sample taken as a whole. This tendency for very narrow line widths to correlate with the presence of ionized absorption features in the soft X-ray spectra of NLS1s, if confirmed in larger samples, may provide a further clue in the puzzle of active galactic nuclei.

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Mid-Infrared and Optical Spectroscopy of Ultraluminous Infrared Galaxies: A Comparison

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New tools from Infrared Space Observatory (ISO) mid-infrared spectroscopy have recently become available to determine the power sources of dust-obscured ultraluminous infrared galaxies (ULIRGs). We compare ISO classifications - starburst or active galactic nucleus (AGN) - with classification from optical spectroscopy, and with optical/near-infrared searches for hidden broad-line regions. The agreement between mid-infrared and optical classification is excellent if optical LINER spectra are assigned to the starburst group. The starburst nature of ULIRG LINERs strongly supports the suggestion that LINER spectra in infrared-selected galaxies, rather than being an expression of the AGN phenomenon, are due to shocks that are probably related to galactic superwinds. Differences between ISO and optical classification provide clues on the evolution of ULIRGs and on the configuration of obscuring dust. We find few ISO AGN with optical HII or LINER identification, suggesting that highly obscured AGN exist but are not typical for the ULIRG phenomenon in general. Rather, our results indicate that strong AGN activity, once triggered, quickly breaks the obscuring screen at least in certain directions, thus becoming detectable over a wide wavelength range.

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Galactic-Scale Outflow and Supersonic Ram-Pressure Stripping in the Virgo Cluster Galaxy NGC 4388

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The Hawaii Imaging Fabry-Perot Interferometer (HIFI) on the University of Hawaii 2.2m telescope was used to map the Hα and [O III] λ5007 emission-line profiles across the entire disk of the edge-on Sb galaxy NGC 4388. We confirm a rich complex of highly ionized gas that extends $\sim$ 4 kpc above the disk of this galaxy. Low-ionization gas associated with star formation is also present in the disk. Evidence for bar streaming is detected in the disk component and is discussed in a companion paper (Veilleux, Bland-Hawthorn, & Cecil 1999; hereafter VBC). Non-rotational blueshifted velocities of $50 - 250$ km s^{-1} are measured in the extraplanar gas north-east of the nucleus. The brighter features in this complex tend to have more blueshifted velocities. A redshifted cloud is also detected 2 kpc south-west of the nucleus. The velocity field of the extraplanar gas of NGC 4388 appears to be unaffected by the inferred supersonic (Mach number $M \approx 3$) motion of this galaxy through the ICM of the Virgo cluster. We argue that this is because the galaxy and the high-|z| gas lie behind a Mach cone with opening angle $\sim 80°$. The shocked ICM that flows near the galaxy has a velocity of $\sim$ 500 km s^{-1} and exerts insufficient ram pressure on the extraplanar gas to perturb its kinematics. We consider several explanations of the velocity field of the extraplanar gas. Velocities, especially blueshifted velocities on the N side of the galaxy, are best explained as a bipolar outflow which is tilted by >12° from the normal to the disk. The observed offset between the extraplanar gas and the radio structure may be due to buoyancy or refractive bending by density gradients in the halo gas. Velocity substructure in the outflowing gas also suggests an interaction with ambient halo gas.

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Optical Spectroscopy of the *IRAS* 1-Jy Sample of Ultraluminous Infrared Galaxies

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This paper discusses the optical spectroscopic properties of the *IRAS* 1-Jy sample ($f_{60} > 1$ Jy) of ultraluminous infrared galaxies (ULIGs: $L_{\rm ir} > 10^{12}$ $L_\odot$; $H_{\rm o} = 75$ km s^{-1} Mpc^{-1} and $q_{\rm o} = 0$). One hundred and eight of the 118 1-Jy ULIGs have been observed at $\Delta\lambda = 8.3$ Å resolution over the wavelength range $\sim$ 4500 Å – 8900 Å. These data are combined with large, previously published sets of optical spectroscopic data of lower luminosity infrared galaxies to look for systematic trends with infrared luminosity over the luminosity range $L_{\rm ir} \approx 10^{10.5} - 10^{13}$ $L_\odot$. As found in previous studies, the fraction of Seyfert galaxies among luminous infrared galaxies increases abruptly above $L_{\rm ir} \approx 10^{12.3}$ $L_\odot$ — about 50 % of the galaxies with $L_{\rm ir} > 10^{12.3}$ $L_\odot$ present Seyfert characteristics. Many of the optical and infrared spectroscopic properties of the Seyfert galaxies are consistent with the presence of a genuine active galactic nucleus (AGN). About 30 % of these galaxies are Seyfert 1s with broad-line regions similar to those of optical quasars. Published near-infrared spectroscopy also suggests that many of the Seyfert 2 galaxies (especially those with warm *IRAS* 25-to-60 μm colors) are in fact obscured Seyfert 1 galaxies with broad (> 2,000 km s^{-1}) recombination lines at 2 μm, where dust obscuration is less important. The percentage of Seyfert 1 ULIGs increases with infrared luminosity, contrary to the predictions of the standard unification model for Seyfert galaxies. Comparisons of the broad-line luminosities of optical and obscured Seyfert 1 ULIGs with those of optically selected quasars of comparable bolometric luminosity suggest that the dominant energy source in most of these ULIGs is the same as in optical quasars, namely mass accretion onto a supermassive black hole, rather than a starburst. These results are consistent with recently published *ISO*, *ASCA*, and VLBI data.

On the other hand, there is no unambiguous optical or near-infrared spectroscopic evidence for an AGN in ULIGs optically classified as H II-region galaxies ($\sim$ 30 % of the whole sample) or as LINERs ($\sim$ 40 %). The apparent lack of an energetically important AGN in these objects supports the results from recent mid-infrared spectroscopy with ISO. Photoionization by hot stars from a recent starburst appears to be the dominant source of ionization in the objects with H II region-like spectra, while both hot stars and shocks may contribute to the ionization in ULIGs with LINER-like spectra. The weaker Hβ and Mg Ib stellar absorption features, larger Hα emission equivalent widths and bluer optical continuum colors in objects of higher infrared luminosities suggests that the starburst took place more recently ($<$ few $\times$ 10^7 yrs) and/or is more important ($\sim$ 10 % of the galaxy mass) in ULIGs than in their lower luminosity counterparts.

As found in optically-selected starbursts, the emission-line gas in ULIGs is dustier than the stellar population which is producing the optical continuum. The color excess derived from the Balmer line ratio does not significantly depend on the infrared luminosity, optical spectral type, or *IRAS* 25-to-60 μm color of the luminous infrared galaxies. These results suggest that the optical method used to determine the color excess in infrared galaxies underestimates the amount of dust in the dustier objects.

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New Results from a Near-Infrared Search for Hidden Broad-Line Regions in Ultraluminous Infrared Galaxies.

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This paper reports the latest results from a near-infrared search for hidden broad-line regions (BLRs: $\Delta V_{\rm FWHM} > 2{,}000$ km s^{-1}) in ultraluminous infrared galaxies (ULIGs). The new sample contains thirty-nine ULIGs from the 1-Jy sample selected for their lack of BLRs at optical wavelengths. Broad Paα emission is detected for the first time in two sources—F05189–2524 and F13305–1739. Broad Paα emission may also be present in three other sources—F13443+0802 SW, F14394+5332, and F16156+0146—but new data are needed to make sure that H_2 $\lambda\lambda$1.8665, 1.8721 are not contributing to this excess emission. The [Si VI] feature, a strong indicator of AGN activity, appears to be present in one object—F13305–1739—and perhaps also in Mrk 273 and F13454–2956. In addition, the presence of a hidden BLR is confirmed in the lower luminosity source F11058–1131.

The results from this new study are combined with those from our previously published survey (Veilleux, Sanders, & Kim 1997b) to produce a large database on 64 (non-Seyfert 1) ULIGs from the 1-Jy sample. All of the galaxies with strong evidence for a hidden BLR at near-infrared wavelengths present an optical Seyfert 2 spectrum. Overall, at least 50% (and perhaps up to 70%) of the optical Seyfert 2 galaxies in the combined sample present either a BLR or strong [Si VI] emission. In contrast, none of the 41 optically classified LINERs and H II galaxies in the sample shows any obvious signs of an energetically important AGN. Galaxies with 'warm' *IRAS* colors ($f_{25}/f_{60} > 0.2$) show a tendency to harbor obscured BLRs in the near-infrared and to have large Paα-to-infrared luminosity ratios. These results support those of our earlier survey and suggest that the screen of dust in most 'warm' Seyfert 2 galaxies is optically *thin* at 2 μm.

When the results from this near-infrared survey are combined with those from a recent optical spectroscopic study of the entire 1-Jy sample of 118 ULIGs (Veilleux, Kim, & Sanders 1999), we find that the fraction of all ULIGs with optical or near-infrared signs of genuine AGN activity (either a BLR or [Si VI] emission) is at least 20 – 25%, but reaches 35 – 50% for objects with $L_{\rm ir} > 10^{12.3}$ $L_\odot$. Comparisons of the dereddened emission-line luminosities of the optical or obscured BLRs detected in the ULIGs of the 1-Jy sample with those of optical quasars indicate that the obscured AGN/quasar in ULIGs is the main source of energy in at least 15 – 25% of all ULIGs in the 1-Jy sample. This fraction is closer to 30 – 50% among ULIGs with $L_{\rm ir} > 10^{12.3}$ $L_\odot$. These results are compatible with those from recent mid-infrared spectroscopic surveys carried out with *ISO*.

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Polarization of Broad Absorption Line QSOs I. A Spectropolarimetric Atlas

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We present a spectropolarimetric survey of 36 broad absorption line quasi-stellar objects (BAL QSOs). The continuum, absorption trough, and emission line polarization of BAL QSOs yield clues about their structure. We confirm that BAL QSOs are in general more highly polarized than non-BAL QSOs, consistent with a more equatorial viewing direction for the former than the latter. We have identified two new highly-polarized QSOs in our sample (1232+1325 and 1333+2840). The polarization rises weakly to the blue in most objects, perhaps due to scattering and absorption by dust particles. We find that a polarization increase in the BAL troughs is a general property of polarized BAL QSOs, indicating an excess of scattered light relative to direct light, and consistent with the unification of BAL QSOs and non-BAL QSOs. We have also discovered evidence of resonantly scattered photons in the red wing of the C IV broad emission lines of a few objects. In most cases, the broad emission lines have lower polarization and a different position angle than the continuum. The polarization characteristics of low-ionization BAL QSOs are similar to those of high-ionization BAL QSOs, suggesting a similar BAL wind geometry.

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Modeling Variable Emission Lines in AGNs: Method and Application to NGC 5548

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We present a new scheme for modeling the broad line region in active galactic nuclei (AGNs). It involves photoionization calculations of a large number of clouds, in several pre-determined geometries, and a comparison of the calculated line intensities with observed emission line light curves. Fitting several observed light curves simultaneously provides strong constraints on model parameters such as the run of density and column density across the nucleus, the shape of the ionizing continuum, and the radial distribution of the emission line clouds.

When applying the model to the Seyfert 1 galaxy NGC 5548, we were able to reconstruct the light curves of four ultraviolet emission-lines, in time and in absolute flux. This has not been achieved by any previous work. We argue that the Balmer lines light curves, and possibly also the Mg II $\lambda2798$ light curve, cannot be tested in this scheme because of the limitations of present-day photoionization codes. Our fit procedure can be used to rule out models where the particle density scales as r^{-2}, where r is the distance from the central source. The best models are those where the density scales as r^{-1} or $r^{-1.5}$. We can place a lower limit on the column density at a distance of 1 ld, of $N_{col}(r=1) \gtrsim 10^{23}$ cm^{-2} and limit the particle density to be in the range of $10^{12.5} > N(r=1) > 10^{11}$ cm^{-3}.

We have also tested the idea that the spectral energy distribution (SED) of the ionizing continuum is changing with continuum luminosity. None of the variable-shape SED tried resulted in real improvement over a constant SED case although models with harder continuum during phases of higher luminosity seem to fit better the observed spectrum. Reddening and/or different composition seem to play a minor role, at least to the extent tested in this work.

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The Spectral Energy Distributions of Active Galactic Nuclei.

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Key to our understanding of the workings of the most powerful energy sources in the universe, active galactic nuclei (AGN), are full, multi-wavelength observations of their emission. In this article the current observational status of AGN spectral energy distributions (SEDs) throughout the radio–γ-ray spectral regions is reviewed along with our intepretation of them and discussion of key areas which remain insufficiently explored.

The past decade has seen great strides in a number of spectral regions including: X-ray, γ-ray, infrared (IR), mm; and has resulted in observed SEDs for a larger and more representative fraction of the AGN population. This has led to a, sometimes reluctant, concensus on the important energy generation mechanisms in the various wavelength bands. However there are key spectral regions which remain beyond our observational capabilities, the EUV in particular, and regions where the full potential of current instrumentation has not yet been achieved, far-infrared and mm.

The inter-relation between the emission in the various spectral bands is discussed along with currently popular scenarios to explain both these relations and the SEDs in general. This is followed by a discussion of the role of dust and related emission line studies as well as the newly recognised class of NLSy1 galaxies. The article concludes with the suggestion, based on the results in a number of widely different studies discussed here, that orientation may play an important role in determing the observed properties of AGN and AGNs with the pole-on view being provided by NLSy1 galaxies.

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The Spectral Energy Distribution of Spiral Galaxies

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Spectral energy distributions (SEDs) are some of the most important sources of information for galaxies, especially for high redshift ones. Here we review recent work on the subject. We discuss the integrated spectra of galaxies of different morphological and activity type, their application to derive K-corrections and classification of high redshift objects. We also discuss the radio to X-rays SEDs of Seyfert 2's, Starbursts and normal galaxies, their behavior as a function of the waveband, their bolometric fluxes and the wavebands that contribute most to it.

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1ES 1741+196: a BL Lacertae object in a triplet of interacting galaxies?

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We present subarcsecond resolution imaging and spectroscopy of the BL Lac object 1ES 1741+196 and neighboring galaxies. Based on 2−dimensional modelling, the host galaxy of 1ES 1741+196 is a very bright and large elliptical galaxy ($M_R = -24.85$, $r_e = 51.2$ kpc) whose overall luminosity distribution deviates significantly from a de Vaucouleurs profile. It is one of the most luminous and largest BL Lac host galaxies known.

Closeby to 1ES 1741+196 we found two companion galaxies at the same redshift as the BL Lac itself. They are at projected distances of 7.2 and 25.2 kpc, respectively. The closer companion galaxy can be best modelled by a Sa-type galaxy, whereas the more distant companion galaxy is an elliptical. This is supported by their spectra. We detected a tidal tail emerging from the closer companion galaxy which is possibly connected with the more distant galaxy. Its surface brightness increases towards the closer companion galaxy, which suggests that material has been released from that galaxy due to tidal forces.

The flat luminosity profile ($\beta = 0.15$), high ellipticity ($\epsilon = 0.35$) of the host galaxy of 1ES 1741+196 as well as its position angle along the impact parameter to the neighboring galaxies can be the result of tidal interaction. 1ES 1741+196 may be a BL Lac object in a triplet of interacting galaxies.

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Announcement

First large Incremental Data Release from the Two Micron All Sky Survey

The Two Micron All Sky Survey (2MASS) announces the public availability of its first large Incremental Data Release. The release data products can be accessed from the IPAC/2MASS Web site at http://www.ipac.caltech.edu/2mass/ or directly from the NASA/Infrared Science Archive site at http://irsa.ipac.caltech.edu/.

The 2MASS 1999 Spring Incremental Data Release consists of a Point Source Catalog containing 20.2 million objects, an Extended Source Catalog containing 73,980 resolved sources, and 233,979 compressed 512x1024 pixel (1"/pixel) images, covering about 2,483 square degrees of the northern sky. Also provided are tools for a) obtaining full resolution (non-compressed) "postage-stamp" images for the Extended Source Catalog objects, and b) for determining whether a specified position is included in the release area.

The 2MASS webpage contains general information, including sky coverage, and documentation about this data release. A gallery of interesting example objects in the release can be found at the 2MASS website. Assistance with the release is available via the 2MASS Help Desk at 2mass@ipac.caltech.edu.

The Two Micron All Sky Survey is a joint project of the University of Massachusetts and the Infrared Processing and Analysis Center, funded by the National Aeronautics and Space Administration and the National Science Foundation.

The Active Galaxies Newsletter is available on the World Wide Web. You can access it via the University of Manchester home page :- http://www.ast.man.ac.uk/~mpr/agn/