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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.
Rob Beswick

Abstracts of recently accepted papers

A Survey of Merger Remnants II: The Emerging Kinematic and Photometric Correlations

B. Rothberg[1], **& R. D. Joseph**[2]

[1] Space Telescope Science Institute, 3700 San Martin Drive Baltimore, MD 21218
[2] Institute for Astronomy, 2680 Woodlawn Drive, Honolulu, HI 96822

This paper is the second in a series exploring the properties of 51 *optically* selected, single-nuclei merger remnants. Spectroscopic data have been obtained for a sub-sample of 38 mergers and combined with previously obtained infrared photometry to test whether mergers exhibit the same correlations as elliptical galaxies among parameters su ch as stellar luminosity and distribution, central stellar velocity dispersion ($\sigma_\circ$), and metallicity. Paramount to the study is to test whether mergers lie on the Fundamental Plane. Measurements of $\sigma_\circ$ have been made using the Ca triplet absorption line at 8500 Å for all 38 mergers in the sub-sample. Additional measurements of $\sigma_\circ$ were made for two of the mergers in the sub-sample using the CO absorption line at 2.29 μm. The results indicate tha t mergers show a strong correlation among the parameters of the Fundamental Plane but fail to show a strong correlation between $\sigma_\circ$ and metallicity (Mg_2). In contrast to earlier studies, the $\sigma_\circ$ of the mergers are consistent with objects which lie somewhere between intermedia te-mass and luminous giant elliptical galaxies. However, the discrepancies with earlier studies appears to correlate with whether the Ca triplet or CO absorption lines are used to derive $\sigma_\circ$, with the latter almost always producing smaller values. Finally, the photometric and kinematic data are used to demonstrate for the first time that the central phase-space density of mergers are equivalent to elliptical galaxies. This resolves a long standing criticism of the merger hypothesis.

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E-mail contact: rothberg@stsci.edu,
preprint available at http://xxx.lanl.gov/abs/astro-ph/0510019

The First INTEGRAL AGN Catalog

V. Beckmann[1,2], N. Gehrels[1], C. R. Shrader[1] and S. Soldi[3]

[1] NASA Goddard Space Flight Center, Exploration of the Universe Division, Code 661, Greenbelt, MD 20771, USA
[2] Joint Center for Astrophysics, Department of Physics, University of Maryland, Baltimore County, MD 21250, USA
[3] INTEGRAL Science Data Centre, Chemin d' Écogia 16, 1290 Versoix, Switzerland

We present the first *INTEGRAL* AGN catalog, based on observations performed from launch of the mission in October 2002 until January 2004. The catalog includes 42 AGN, of which 10 are Seyfert 1, 17 are Seyfert 2, and 9 are intermediate Seyfert 1.5. The fraction of blazars is rather small with 5 detected objects, and only one galaxy cluster and no star-burst galaxies have been detected so far. A complete subset consists of 32 AGN with a significance limit of 7σ in the *INTEGRAL*/ISGRI 20--40 keV data. Although the sample is not flux limited, the distribution of sources shows a ratio of obscured to unobscured AGN of $1.5 - 2.0$, consistent with luminosity dependent unified models for AGN. Only four Compton-thick AGN are found in the sample. Based on the *INTEGRAL* data presented here, the Seyfert 2 spectra are slightly harder ($\Gamma = 1.95 \pm 0.01$) than Seyfert 1.5 ($\Gamma = 2.10 \pm 0.02$) and Seyfert 1 ($\Gamma = 2.11 \pm 0.05$).

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E-mail contact: beckmann@milkyway.gsfc.nasa.gov
preprint available at http://arxiv.org/abs/astro-ph/0510530

A New Exact Method for Line Radiative Transfer

Moshe Elitzur[1] and Andrés Asensio Ramos[2]

[1] Department of Physics & Astronomy, University of Kentucky, Lexington, KY 40506, USA; moshe@pa.uky.edu
[2] INAF-Osservatorio Astrofisico di Arcetri, Largo E. Fermi 5, 50125, Firenze, Italy; aasensio@arcetri.astro.it

We present a new method, the Coupled Escape Probability (CEP), for exact calculation of line emission from multi-level systems, solving only algebraic equations for the level populations. The CEP formulation of the classical two-level problem is a set of *linear equations*, and we uncover an exact analytic expression for the emission from two-level optically thick sources that holds as long as they are in the "effectively thin" regime. In comparative study of a number of standard problems, the CEP method outperformed the leading line transfer methods by substantial margins.

The algebraic equations employed by our new method are already incorporated in numerous codes based on the escape probability approximation. All that is required for an exact solution with these existing codes is to augment the expression for the escape probability with simple zone-coupling terms. As an application, we find that standard escape probability calculations generally produce the correct cooling emission by the C II 158 μm line but not by the ^{3}P lines of O I .

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E-mail contact: moshe@pa.uky.edu,
preprint available at http://xxx.lanl.gov/abs/astro-ph/0510616

HI absorption in 3C 49 and 3C 268.3. Probing the environment of CSS and GPS sources

A. Labiano[1,2], R.C. Vermeulen[3], P.D. Barthel[1], C.P. O'Dea[4,2], J.Gallimore[5] S.A. Baum[6,2] and W.H. de Vries[7]

[1] Kapteyn Astronomical Institute, Groningen, 9700 AV, The Netherlands
[2] Space Telescope Science Institute, Baltimore, MD 21218, USA
[3] Netherlands Foundation for Research in Astronomy, Dwingeloo, The Netherlands
[4] Department of Physics, Rochester Institute of Technology, Rochester, NY, 14623, USA
[5] Department of Physics, Bucknell University, Lewisburg, PA 17837, USA
[6] Center for Imaging Science, Rochester Institute of Technology, Rochester, NY 14623. USA
[7] Lawrence Livermore National Lab., Livermore CA, 94550, USA

We present and discuss European VLBI Network UHF band spectral line observations, made to localise the redshifted 21cm HI absorption known to occur in the subgalactic sized compact steep spectrum galaxies 3C 49 and 3C 268.3. We have detected HI absorptio n towards the western radio lobe of 3C 49 and the northern lobe of 3C 268.3. However, we cannot rule out the presence of similar amounts of HI towards the opposite and much fainter lobes. The radio lobes with detected HI absorption (1) are brighter and cl oser to the core than the opposite lobes; (2) are depolarized; and (3) are associated with optical emission line gas. The association between the HI absorption and the emission line gas, supports the hypothesis that the HI absorption is produced in the at omic cores of the emission line clouds. Our results are consistent with a picture in which compact steep spectrum sources interact with clouds of dense gas as they propagate through their host galaxy. We suggest that the asymmetries

in the radio and optic al emission can be due to interaction of a two sided radio source with an asymmetric distribution of dense clouds in their environment.

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E-mail contact: labiano@astro.rug.nl ,
preprint available at http://xxx.lanl.gov/abs/astro-ph/0510563

Atomic hydrogen in the one-sided "compact double" radio galaxy 2050+364

R.C. Vermeulen[1], A. Labiano[2,3], P.D. Barthel[3], S.A. Baum[4,3], W.H. de Vries[5] and C. P. O'Dea[6,3]

[1] Netherlands Foundation for Research in Astronomy, Dwingeloo, The Netherlands
[2] Kapteyn Astronomical Institute, Groningen, 9700 AV, The Netherlands
[3] Space Telescope Science Institute, Baltimore, MD 21218, USA
[4] Center for Imaging Science, Rochester Institute of Technology, Rochester, NY 14623. USA
[5] Lawrence Livermore National Lab., Livermore CA, 94550, USA
[6] Department of Physics, Rochester Institute of Technology, Rochester, NY, 14623, USA

European VLBI Network spectral imaging of the "compact double" radio source 2050+364 in the UHF band at 1049 MHz has resolved the HI absorbing region, and has shown a faint continuum component to the North (N), in addition to the well-known East-West d ouble (E, W). Re-examination of VLBI continuum images at multiple frequencies suggests that 2050+364 may well be a one-sided core-jet source, which appears as a double over a limited frequency range. One of the dominant features, W, would then be the inne rmost visible portion of the jet, and could be at or adjacent to the canonical radio core. The other, E, is probably related to shocks at a sudden bend of the jet, towards extended steep-spectrum region N. A remarkably deep and narrow HI absorption line c omponent extends over the entire projected extent of 2050+364. It coincides in velocity with the [OIII] optical doublet lines to within 10 km/s. This HI absorption could arise in the atomic cores of NLR clouds, and the motion in the NLR is then remarkabl y coherent both along the line-of-sight and across a projected distance of > 300 pc on the plane of the sky. Broader, shallower HI absorption at lower velocities covers only the plausible core area W. This absorption could be due to gas which is eit her being entrained by the inner jet or is flowing out from the accretion region; it could be related to the BLR.

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E-mail contact: rvermeulen@astron.nl ,
preprint available at http://xxx.lanl.gov/abs/astro-ph/0510440

XMM–Newton discovery of soft X–ray absorption in the high-z superluminous Blazar RBS 315

Enrico Piconcelli[1] and Matteo Guainazzi[1]

[1] European Space Astronomy Center (ESA), Apartado 50727, E–28080 Madrid, Spain

We present the analysis and the results of a 20 ks XMM–Newton observation of the extremely X-ray loud ($L_X \approx 5 \times 10^{47}$ erg s^{-1}) flat–spectrum radio quasar RBS 315 at a redshift of 2.69. This *EPIC* observation has allowed us to strongly constrain the slope of the continuum ($\Gamma = 1.23 \pm 0.01$) as well as to discover the presence of a sharp drop below ≈ 2 keV in its spectrum. Such a flat photon index and the huge luminosity suggest that the X-ray emission is due to the low energy tail of the Comptonized spectrum, produced from plasma in a relativistic jet oriented close to our line of sight. Even though the hypothesis of a break in the continuum cannot be completely discarded as an explanation of the soft X-ray cutoff, the presence of intrinsic absorption appears more plausible. Spectral fits with cold ($N_H^z = 1.62^{+0.09}_{-0.09} \times 10^{22}$ cm^{-2}) and lukewarm ($N_H^z = 2.2^{+0.9}_{-0.3} \times 10^{22}$ cm^{-2}; $\xi = 15^{+38}_{-12}$ erg cm^{-2} s^{-1}) absorbers are statistically indistinguishable. Remarkably, our results are very similar to those reported so far for other absorbed high-z Blazars observed by XMM–Newton. The existence of this "homogeneous" class of jet-dominated superluminous obscured QSOs at high z therefore could be important in the context of the formation and cosmological evolution of radio-loud objects.

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E-mail contact: Enrico.Piconcelli@sciops.esa.int,
preprint available at http://es.arxiv.org/abs/astro-ph/0509488

Optical Photometric and Spectroscopic Study of the Seyfert Galaxy SBS 0748+499

J. Torrealba[1], E. Benítez[1], A. Franco-Balderas[1], and V. Chavushyan[1,2]

[1] Instituto de Astronomía, UNAM, Apdo. Postal 70-264, México, DF, México
[2] Instituto Nacional de Astrofísica, Óptica y Electrónica, Apdo. Postal 51 y 216, 72000, Puebla, México

We present the first optical photometric study of the **active galaxy** SBS 0748+499. First, we present B, V, R and I photometric data: total magnitudes and $B-V$, $B-R$, $B-I$ colors; surface brightness, color and geometric profiles, with emphasis on the morphology and its relation to the global photometric properties of this galaxy. Then, from our surface photometry study we derived the **bulge–to–disk luminosity ratio** B/D in the four bands. We found that the host galaxy shows a bar ($a \sim 8$ kpc) and a low–brightness spiral structure. The morphological classification for the host galaxy of this AGN is **SBab**. Additionally, we present new optical spectrophotometric observations that clearly show that the object can be classified as Sy 1.9 galaxy. Finally, an estimation of the black hole mass (M_{BH}) associated with the nucleus of SBS 0748+499 was done using the absolute R–band bulge magnitude–M_{BH} relation, and also using the FWHM [OIII]$_{5007}$ – $\sigma_\star$ relation. We found that $M_{BH} = 2.6 \times 10^7\, M_\odot$ and $M_{BH} = 8.8 \times 10^7\, M_\odot$, respectively.

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E-mail contact: erika@astroscu.unam.mx,
preprint available at http://arxiv.org/abs/astro-ph/0509572

Gas and stellar dynamics in NGC 1068. Probing the galactic gravitational potential

Eric Emsellem[1], Kambiz Fathi[2,3], Hervé Wozniak[1], Pierre Ferruit[1], Carole G. Mundell[4], Eva Schinnerer[5]

[1] CRAL-Observatoire, 9 avenue Charles André, 69231 Saint Genis Laval, France
[2] RIT Dept. of Physics, 84 Lomb Memorial Dr., Rochester, NY 14623-5603, USA
[3] Kapteyn Astronomical Institute, P.O. Box 800, 9700 AV Groningen, The Netherlands
[4] Astrophysics Research Institute, Liverpool John Moores University, 12 Quays House, Egerton Wharf, Birkenhead CH41 1LD, UK
[5] Max-Planck-Institut für Astronomie, Königstuhl 17, 69117 Heidelberg, Germany

We present `SAURON` integral field spectrography of the central 1.5 kpc of the nearby Seyfert 2 galaxy NGC 1068, encompassing the well-known near-infrared inner bar observed in the K band. We have successively disentangled the respective contributions of the ionized gas and stars, thus deriving their two-dimensional distribution and kinematics. The [O III] and Hβ emission lines exhibit very different spatial distribution and kinematics, the latter following inner spiral arms with clumps associated with star formation. Strong inwards streaming motions are observed in both the Hβ and [O III] kinematics. The stellar kinematics also exhibit clear signatures of a non-axisymmetric tumbling potential, with a twist in both the velocity and Gauss-Hermite h_3 fields. We re-examined the long-slit data of Shapiro et al. (2003) using a penalized pixel fitting routine: a strong decoupling of the Gauss-Hermite term h_3 is revealed, and the central decrease of Gauss-Hermite term h_4 hinted in the `SAURON` data is confirmed. These data also suggest that NGC 1068 is a good candidate for a so-called σ-drop. We confirm the possible presence of two separate pattern speeds applying the Tremaine-Weinberg method to the Fabry-Perot Hα map (Bland-Hawthorn et al. , 1991). We also examine the stellar kinematics of bars formed in N-body + SPH simulations built from axisymmetric initial conditions approximating the luminosity distribution of NGC 1068. The resulting velocity, dispersion, and higher order Gauss-Hermite moments successfully reproduce a number of properties observed in the two-dimensional kinematics of NGC 1068, and the long-slit data, showing that the kinematic signature of the NIR bar is imprinted in the stellar kinematics. The remaining differences between the models and the observed properties are likely mostly due to the exclusion of star formation and the lack of the primary large-scale oval/bar in the simulations. These models nevertheless suggest that the inner bar could drive a significant amount of gas down to a scale of ~ 300 pc. This would be consistent with the interpretation of the σ-drop in NGC 1068 being the result of central gas accretion followed by an episode of star formation.

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E-mail contact: emsellem@obs.univ-lyon1.fr,
preprint available at http://www-obs.univ-lyon1.fr/eric.emsellem/Preprints.html

Low-luminosity Active Galaxies and their Central Black Holes

X.Y. Dong[1], M.M. De Robertis[1]

[1] Department of Physics and Astronomy, York University, 4700 Keele St., Toronto, ON, M3J 1P3, Canada

Central black hole masses for 118 spiral galaxies representing morphological stages S0/a through Sc and taken from the large spectroscopic survey of Ho, Filippenko, & Sargent (1997) are derived using K_s-band data from 2MASS. Black hole masses are found using a calibrated black-hole – K_s bulge luminosity relation, while bulge luminosities are measured by means of a two-dimensional bulge/disk decomposition routine.

The black hole masses are correlated against a variety of parameters representing properties of the nucleus and host galaxy. Nuclear properties such as line width (FWHM([N II])), as well as emission-line ratios (e.g., [O III]/Hβ, [O I]/Hα, [N II]/Hα, and [S II]/Hα), show a very high degree of correlation with black-hole mass. The excellent correlation with line-width supports the view that the emission-line gas is in virial equilibrium with either the black hole or bulge potential. The very good emission-line ratio correlations may indicate a change in ionizing continuum shape with black hole mass in the sense that more massive black holes generate harder spectra.

Apart from the inclination-corrected rotational velocity, no excellent correlations are found between black-hole mass and host-galaxy properties.

Significant differences are found between the distributions of black hole masses in early-, mid- and later-type spiral galaxies (subsamples A, B and C) in the sense that early-type galaxies have preferentially larger central black holes, consistent with observations that Seyfert galaxies are found preferentially in early-type systems. The line-width distributions show a marked difference among subsamples A, B and C, in the sense that earlier-type galaxies have larger line widths. There are also clear differences in line ratios between subsamples A+B and C that likely are related to the level of ionization in the gas. Finally, a K_s-band Simien & de Vaucouleurs diagram shows excellent agreement with the original B-band relation, though there is a large dispersion at a given morphological stage.

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E-mail contact: xydong@yorku.ca; mmdr@yorku.ca
preprint available at http://arxiv.org/abs/astroph-0510694

A Snapshot Survey for Gravitational Lenses Among $z \geq 4.0$ Quasars: II. Constraints on the $4.0 < z < 5.4$ Quasar Population

Gordon T. Richards[1], Zoltán Haiman[2], Bartosz Pindor[3], Michael A. Strauss[1], Xiaohui Fan[4], Daniel Eisenstein[4], Donald P. Schneider[5], Neta A. Bahcall[1], J. Brinkmann[6] and Masataka Fukugita[7]

[1] Princeton University Observatory, Peyton Hall, Princeton, NJ 08544.
[2] Department of Astronomy, Columbia University, 550 West 120th Street, New York, NY 10027.
[3] Department of Astronomy, University of Toronto, 60 St. George Street, Toronto M5S 3H8, Canada.
[4] Steward Observatory, University of Arizona, 933 North Cherry Avenue, Tucson, AZ 85721.
[5] Dept. of Astronomy & Astrophysics, The Pennsylvania State University, 525 Davey Lab, University Park, PA 16802.
[6] Apache Point Observatory, P.O. Box 59, Sunspot, NM 88349.
[7] ICRR/Institute for Cosmic Ray Research, University of Tokyo, 5-1-5 Kashiwa, Kashiwa City, Chiba 277-8582, Japan.

We report on i-band snapshot observations of 157 Sloan Digital Sky Survey (SDSS) quasars at $4 < z < 5.4$ using the Advanced Camera for Surveys on the *Hubble Space Telescope (HST)* to search for evidence of gravitational lensing of these sources. None of the quasars appear to be strongly lensed and multiply imaged at the angular resolution (~ 0.1 arcsec) and sensitivity of *HST*. The non-detection of strong lensing in these systems constrains the $z = 4$–5 luminosity function to an intrinsic slope of $\beta > -3.8$ (3σ), assuming a break in the quasar luminosity function at $M^{\star}_{1450} \sim -24.5$. This constraint is considerably stronger than the limit of $\beta > -4.63$ obtained from the absence of lensing in four $z > 5.7$ quasars. Such constraints are important for our understanding of the true space density of high-redshift quasars and the ionization state of the early universe.

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E-mail contact: gtr@pha.jhu.edu,
preprint available at http://xxx.lanl.gov/abs/astro-ph/0509135

Signatures of restarted activity in core-dominated, triple radio sources selected from the FIRST survey

A. Marecki[1], P. Thomasson[2], K.-H. Mack[3] and M. Kunert-Bajraszewska[4]

[1] Toruń Centre for Astronomy, N. Copernicus University, PL-87-100 Toruń, Poland
[2] Jodrell Bank Observatory, The University of Manchester, Macclesfield, Cheshire, SK11 9DL, UK
[3] INAF – Istituto di Radioastronomia, Via Gobetti 101, I-40129 Bologna, Italy

Signatures of re-occurrence of activity in radio-loud AGNs, indicated either by the so-called double–double or X-shaped structures, have been observed in a number of radio sources. All such objects known to date have linear sizes of the order of a megaparsec. A number of sources which are appreciably more compact than this, but which exhibit hints of a past phase of activity, have been found in the VLA FIRST survey. Their structures show symmetric relic lobes straddling relatively bright, unresolved cores. The cores of 15 of these have been observed with MERLIN at 5 GHz, which has shown that four of them are doubles or core-jets on the subarcsecond scale. Misalignments $\Delta PA \gtrsim 30^\circ$ between the axis of the inner structure and the line connecting the fitted maxima of the arcminute-scale relic lobes are clearly visible in three of the four sources. It can be readily inferred from these results that a rapid repositioning of the central engine in each of these three radio sources is the most plausible interpretation of the observed morphology and that a merger is the most likely the original cause of such a repositioning. In the case of TXS 1033+026, the optical image extracted from the SDSS archives clearly suggests that two objects separated by only 2.7 kpc (projected onto the sky plane) are indeed merging. The inner parts of TXS 0818+214 and TXS 1312+563 could be interpreted as double-lobed and consequently, these sources could be of the double–double type, but further multifrequency observations are necessary to provide support for such an interpretation.

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E-mail contact: amr@astro.uni.torun.pl,
preprint available at http://arxiv.org/abs/astro-ph/0510773

Gas Metallicity in the Narrow-Line Regions of High-redshift Active Galactic Nuclei

Tohru Nagao[1,2], Roberto Maiolino[1] and Alessandro Marconi[1]

[1] INAF – Osservatorio Astrofisico di Arcetri, Largo Enrico Fermi 5, 50125 Firenze, Italy
[2] National Astronomical Observatory of Japan, 2-21-1 Osawa, Mitaka, Tokyo 151-8588, Japan

We analyze optical (UV rest-frame) spectra of X-ray selected narrow-line QSOs at redshift $1.5 < z < 3.7$ found in the Chandra Deep Field South and of narrow-line radio galaxies at redshift $1.2 < z < 3.8$ to investigate the gas metallicity of the narrow-line regions and their evolution in this redshift range. Such spectra are also compared with UV spectra of local Seyfert 2 galaxies. The observational data are inconsistent with the predictions of shock models, suggesting that the narrow-line regions are mainly photoionized. The photoionization models with dust grains predict line flux ratios which are also in disagreement with most of the observed values, suggesting that the high-ionization part of the narrow-line regions (which is sampled by the available spectra) is dust-free. The photoionization dust-free models provide two possible scenarios which are consistent with the observed data: low-density gas clouds ($n < 10^3$ cm^{-3}) with a sub-solar metallicity ($0.2 < Z/Z_\odot < 1.0$), or high-density gas clouds ($n \sim 10^5$ cm^{-3}) with a wide range of gas metallicity ($0.2 < Z/Z_\odot < 5.0$). Regardless of the specific interpretation, the observational data do not show any evidence for a significant evolution of the gas metallicity in the narrow-line regions within the redshift range $1.2 < z < 3.8$. Instead, we find a trend for more luminous active galactic nuclei to have more metal-rich gas clouds (luminosity-metallicity relation), which is in agreement with the same finding in the studies of the broad-line regions. The lack of evolution for the gas metallicity of the narrow-line regions implies that the major epoch of star formation in the host galaxies of these active galactic nuclei is at $z > 4$.

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E-mail contact: tohru@arcetri.astro.it,
preprint available at http://arxiv.org/abs/astro-ph/0508652

The Evolution of the Broad-Line Region among SDSS Quasars

Tohru Nagao[1,2], Alessandro Marconi[1] and Roberto Maiolino[1]

[1] INAF – Osservatorio Astrofisico di Arcetri, Largo Enrico Fermi 5, 50125 Firenze, Italy
[2] National Astronomical Observatory of Japan, 2-21-1 Osawa, Mitaka, Tokyo 151-8588, Japan

Based on 5344 quasar spectra taken from the SDSS Data Release 2, the dependences of various emission-line flux ratios on redshift and quasar luminosity are investigated in the ranges $2.0 < z < 4.5$ and $-24.5 > M_B > -29.5$. We show that the emission lines in the composite spectra are fitted better with power-law profiles than with double Gaussian or modified Lorentzian profiles, and in particular we show that the power-law profiles are more appropriate to measure broad emission-line fluxes than other methods. The composite spectra show that there are statistically significant correlations between quasar luminosity and various emission-line flux ratios, such as NV/CIV and NV/HeII, while there are only marginal correlations between quasar redshift and emission-line flux ratios. We obtain detailed photoionization models to interpret the observed line ratios. The correlation of line ratios with luminosity is interpreted in terms of higher gas metallicity in more luminous quasars. For a given quasar luminosity, there is no metallicity evolution for the redshift range $2.0 < z < 4.5$. The typical metallicity of BLR gas clouds is estimated to be $Z \sim 5Z_{\odot}$, although the inferred metallicity depends on the assumed BLR cloud properties, such as their density distribution function and their radial distribution. The absence of a metallicity evolution up to z 4.5 implies that the active star-formation epoch of quasar host galaxies occurred at $z > 7$.

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E-mail contact: tohru@arcetri.astro.it,
preprint available at http://arxiv.org/abs/astro-ph/0510385

The role of absorption and reflection in the soft X-ray excess of Active Galactic Nuclei: 1. Preliminary results

Loïc Chevallier[1], Suzy Collin[1], Anne-Marie Dumont[1], Bozena Czerny[2], Martine Mouchet[1,3], Anabela C. Gonçalves[1,4], René Goosmann[1]

[1] LUTH, Observatoire de Paris, Section de Meudon, F-92195 Meudon Cedex, France
[2] Copernicus Astronomical Center, Bartycka 18, 00-716 Warsaw, Poland
[3] APC, Université Denis Diderot, F-75005 Paris, France
[4] Centro de Astronomia e Astrofísica da Universidade de Lisboa, Observatório Astronómico de Lisboa, Tapada da Ajuda, 1349-018 Lisboa, Portugal

The 2-10 keV continuum of AGN is well represented by a single power law, generally attributed to a hot Comptonizing medium, such as a corona above the accretion disk. At lower energies the continuum displays an excess with respect to the extrapolation of this power law, called the “soft X-ray excess”. Until now it was attributed either to reflection of the hard X-ray source by the accretion disk or to the presence of an additional Comptonizing medium. An alternative solution is that a single power law correctly represents both the soft and the hard X-ray emission, and the soft X-ray excess is an artefact due to the absorption of the primary power law by a relativistic wind. We examine the advantages and drawbacks of the reflection versus absorption models. We argue that in the absorption hypothesis, the absorbing medium should be in total pressure equilibrium to constrain the spectral distribution which otherwise would be too strongly variable in time and from one object to the other, as compared to observations. We conclude that some X-ray spectra, in particular those with strong soft X-ray excesses, can be modelled by absorption in the 0.3-10 keV range. However, due to the lack of a complete grid of models and good data extending above 10 keV, we are not able to conclude that all objects can be accommodated by such models. These absorption models imply either strong relativistic outflowing winds with mass rates of the order of the Eddington value (or even larger), or quasi-spherical inhomogeneous accretion flows. Only weak excesses can be modelled by reflection, unless the primary continuum is not directly seen. A reflection model absorbed by a modest relativistic wind could be the best solution to the problem.

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E-mail contact: loic.chevallier@obspm.fr,
preprint available at http://arxiv.org/abs/astro-ph/0510700

VIMOS-VLT and Spitzer observations of a radio galaxy at z =2.5

M. Villar-Martín[1], S.F. Sánchez[2], C. De Breuck[3], R. Peletier[4], J. Vernet[3], A. Rettura[3,5], N. Seymour[6], A. Humphrey[7], D. Stern[8], S. di Serego Alighieri[9], R. Fosbury[10]

[1] Instituto de Astrofísica de Andalucía (CSIC), Aptdo. 3004, 18080 Granada, Spain
[2] Centro Astronómico Hispano Alemán de Calar Alto, E4004 Almería, Spain
[3] European Southern Observatory, Karl Schwarschild Str, 2, D-85748 Garching bei München, Germany
[4] Kapteyn Astronomical Institute, Univ. of Groningen, Postbus 800, 9700 AV Groningen, The Netherlands
[5] Université Paris-Sud 11, Rue Georges Clemenceau 15, Orsay, F-91405, France
[6] Spitzer Science Center, California Institute of Technology, Mail Code 220-6,1200 East California Boulevard Pasadena, CA 91125 USA
[7] Dept. of Physical Sciences, University of Hertfordshire, College Lane, Hatfield, Herts AL10 9AB, UK
[8] Jet Propulsion Laboratory,California Institute of Technology, MS 169-506, Pasadena, CA 91109, USA
[9] INAF-Osservatorio Astrofisico di Arcetri, Largo Enrico Fermi 5, I-50125 Firenze, Italy
[10] ST-ECF, Karl-Schwarzschild Str. 2, 85748 Garching bei München, Germany

We present: 1) a kinematic and morphological study of the giant Lyα nebula associated with the radio galaxy MRC 2104−242 ($z = 2.49$) based on integral field spectroscopic VIMOS data from VLT ; 2) a photometric study of the host (proto?) galaxy based on *Spitzer Space Telescope* data.

The galaxy appears to be embedded in a giant ($\geq$ 120 kpc) gas reservoir that surrounds it completely. The kinematic properties of the nebula suggest that it is a rotating structure, which would imply a lower limit to the dynamical mass of $\sim 3 \times 10^{11} M_{\odot}$. An alternate scenario is that the gas is infalling. Such a process would be able to initiate and sustain significant central starburst activity, although it is likely to contribute with less than 10% of the total stellar mass of the galaxy.

The near- to mid-IR spectral energy distribution of the radio galaxy suggests the existence of a reddened, $E(B-V) = 0.4 \pm 0.1$, evolved stellar population of age $\geq$ 1.8 Gyr and mass $(5 \pm 2) \times 10^{11} M_{\odot}$. The implied formation redshift is $z_f \geq 6$. This stellar mass is similar to the stellar masses found for massive early-type galaxies at z ∼2 in deep, near-infrared surveys.

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E-mail contact: montse@iaa.es,
preprint available at http://babbage.sissa.it/abs/astro-ph/0510733

The jet and circumnuclear environment of 3C 293

David J. E. Floyd[1], Eric Perlman[2], J. Patrick Leahy[3], R. J. Beswick[3], Neal J. Jackson[3], William B. Sparks[1], David J. Axon[4], and Christopher P. O'Dea[4]

[1] Space Telescope Science Institute, 3700 San Martin Drive, Baltimore, MD 21218, U.S.A
[2] Joint Center for Astrophysics, Physics Dept. University of Maryland, Baltimore County, 1000 Hilltop Circle, Baltimore, MD 21250
[3] The University of Manchester, Jodrell Bank Observatory, Macclesfield, Cheshire, England
[4] Department of Physics, Rochester Institute of Technology, 54 Lomb Memorial Drive, Rochester, NY 14623-5604

We present the new HST near-infrared polarimetry, broad and narrow-band imaging, and MERLIN 4.5 GHz Multi-Frequency Synthesis radio imaging of 3C 293, a unique radio galaxy whose host is an obvious merger remnant, in an exceptionally underdense region o f space. We have discovered near-infrared, optical, and ultra-violet synchrotron emission from the jet. In the optical, the jet is mostly obscured by a dust lane, but three knots are clear in our HST NICMOS images at 1.6 and 2.0 microns, clearly aligning with features in the radio. The outer jet knot is highly polarized (15%) at 2 microns, confirming the synchrotron emission mechanism. The radio-IR spectral index steepens significantly with distance from the nucleus, as in 3C 273 and in contrast to M 87 . The inner knot is visible (with hindsight) on the WFPC2 and STIS images obtained for the earlier 3CR HST snapshot surveys. There is no [Fe II] emission seen associated with the jet, constraining the role of shock-induced ionisation by the jet. Overall t here is a strong implication that the NIR jet emission is indeed synchrotron.

From our NIR images, the core of the galaxy is clearly identifiable with the main feature in the western extension of the radio "jet" image, although no unresolved AGN component is identifiable even at K-band, consistent with an FRII-like nucleus obscur ed by an optically thick torus. The galaxy appears to have a single nucleus, with any multiple nuclei falling within the central $\lesssim$ 100 pc.

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E-mail contact: floyd@stsci.edu,
preprint available at http://arxiv.org/abs/astro-ph/0510853

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