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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.

Janine van Eymeren

Abstracts of recently accepted papers

A Radio Census of Binary Supermassive Black Holes

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Using archival VLBI data for 3114 radio-luminous active galactic nuclei, we searched for binary supermassive black holes using a radio spectral index mapping technique which targets spatially resolved, double radio-emitting nuclei. Only one source was detected as a double nucleus. This result is compared with a cosmological merger rate model and interpreted in terms of (1) implications for post-merger timescales for centralisation of the two black holes, (2) implications for the possibility of "stalled" systems, and (3) the relationship of radio activity in nuclei to mergers. Our analysis suggests that the binary evolution of paired supermassive black holes (both of masses $\geq 10^8\,M_{\odot}$) spends less than 500 Myr in progression from the merging of galactic stellar cores to within the purported stalling radius for supermassive black hole pairs. The data show no evidence for an excess of stalled binary systems at small separations. We see circumstantial evidence that the relative state of radio emission between paired supermassive black holes is correlated within orbital separations of 2.5 kpc.

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STIS Spectroscopy of the Central 14 pc of NGC 3998: Evidence for an Inflow.

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Prior imaging of the lenticular galaxy, NGC 3998, with the *Hubble Space Telescope* (*HST*) revealed a small, highly inclined, nuclear ionized gas disk, the kinematics of which indicate the presence of a 270 million solar mass black hole. Plausible kinematic models are used to constrain the size of the broad line region (BLR) in NGC 3998 by modeling the shape of the broad Hα emission line profile. The analysis indicates that the emitting region is large with an outer radius $\sim$ 7 pc, regardless of whether the kinematic model is represented by an accretion disk or a spherically symmetric inflow. The AGN is able to sustain the ionization of the BLR, albeit with a high covering factor ranging between 20% and 100% depending on the spectral energy distribution adopted for the AGN. Furthermore, the electron temperature in the BLR is $\leq$ 28,800 K consistent with photoionization by the AGN. If the gas density in the BLR is $\geq 7 \times 10^3$ cm^{-3}, then interpreting the broad Hα emission line in terms of a steady state spherically symmetric inflow leads to a rate $\leq 6.5 \times 10^{-2}$ M$_\odot$/yr which exceeds the inflow requirement to explain the X-ray luminosity in terms of a radiatively inefficient inflow by a factor of $\leq$18.

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DRAFT is available at http://adsabs.harvard.edu/abs/2010arXiv1008.4775D

Magnetohydrodynamic Accretion Disk Winds as X-ray Absorbers in Active Galactic Nuclei

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We present the two-dimensional (2D) ionization structure of self-similar magnetohydrodynamic (MHD) winds off accretion disks around irradiated by a central X-ray point source. Based on earlier observational clues and theoretical arguments, we focus our attention on a subset of these winds, namely those with radial density dependence $n(r) \propto 1/r$ (r is the spherical radial coordinate). We employ the photoionization code `XSTAR` to compute the ionic abundances of a large number of ions of different elements and then compile their line-of-sight (LOS) absorption columns. We focus our attention on the distribution of the column density of the various ions as a function of the ionization parameter ξ (or equivalently r) and the angle θ. Particular attention is paid to the absorption measure distribution (AMD), namely their Hydrogen-equivalent column per logarithmic ξ interval, $dN_H/d\log\xi$, which provides a measure of the winds' radial density profiles. For the chosen density profile $n(r) \propto 1/r$ the AMD is found to be independent of ξ, in good agreement with its behavior inferred from the X-ray spectra of several active galactic nuclei (AGNs). For the specific wind structure and X-ray spectrum we also compute detailed absorption line profiles for a number of ions to obtain their LOS velocities, $v \sim 100-300$ km s^{-1} (at $\log\xi \sim 2-3$) for Fe XVII and $v \sim 1,000-4,000$ km s^{-1} (at $\log\xi \sim 4-5$) for Fe XXV, in good agreement with the observation. Our models describe the X-ray absorption properties of these winds with only *two parameters*, namely the mass-accretion rate $\dot{m}$ and LOS angle θ. The probability of obscuration of the X-ray ionizing source in these winds decreases with increasing $\dot{m}$ and increases steeply with the LOS inclination angle θ. As such, we concur with previous authors that these wind configurations, viewed globally, incorporate all the requisite properties of the parsec scale "torii" invoked in AGN unification schemes. We indicate that a combination of the AMD and absorption line profile observations can uniquely determine these model parameters and their bearing on AGN population demographics.

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Searching for Black Hole Egrospheres in the QPO Timing Data

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We propose a temporal means to search for the black hole (BH) ergospheres (the distinguishing characteristic of spinning BHs) in both galactic X-ray binaries and AGNs by studying QPOs at frequencies $\sim 1.4/M_1$ kHz (where M_1 being the BH mass in units of 10-solar masses); these QPOs, as an inevitable consequence of general relativistic photon propagation within the ergosphere of Kerr geometry, are predicted to occur in rapidly-rotating BHs of $a/M \gtrsim 0.94$ but have not yet been observed. Our model may explain the suggested presence of AGN QPO at $\sim 5-7$ mHz in NGC 4051, for example. Their discovery will present an independent confirmation of the high BH spin, as inferred from the observed broad Fe line and will provide a very accurate determination of the underlying BH mass. Constraining BH spin is important for the determination of the accretion efficiency, its size and the consistency of its spectra with those expected on theoretical grounds.

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preprint available at ttp://adsabs.harvard.edu/abs/2008ApJ...679.1413F, http://adsabs.harvard.edu/abs/2009astro2010S.152K, http://adsabs.harvard.edu/abs/2009ApJ...695.1199F

A correlation between the highest energy cosmic rays and nearby AGN detected by *Fermi*

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We analyze the correlation of the positions of γ-ray sources in the *Fermi* Large Area Telescope First Source Catalog (1FGL) and the First LAT Active Galactic Nuclei (AGN) Catalog (1LAC) with the arrival directions of ultra-high-energy cosmic rays (UHECRs) observed with the *Pierre Auger Observatory*, in order to investigate the origin of UHECRs. We find that Galactic sources and blazars identified in the 1FGL are not significantly correlated with UHECRs, while the 1LAC sources display a mild correlation (2.6σ level) on an $\approx 2.4^\circ$ angular scale. When selecting only the 1LAC AGNs closer than 200 Mpc, we find a strong association (5.4σ) between their positions and the directions of UHECRs on an $\approx 17^\circ$ angular scale; the probability of the observed configuration being due to an isotropic flux of cosmic rays is 5×10^{-8}. There is also a 5σ correlation with nearby 1LAC sources on an 6.5° scale. We identify 7 "γ-ray loud" AGNs which are associated with UHECRs within $\approx 17^\circ$ and are likely candidates for the production sites of UHECRs: Centaurus A, NGC 4945, ESO 323-G77, 4C+04.77, NGC 1218, RX J0008.0+1450 and NGC 253. We interpret these results as providing additional support to the hypothesis of the origin of UHECRs in nearby extragalactic objects. As the angular scales of the correlations are large, we discuss the possibility that intervening magnetic fields might be considerably deflecting the trajectories of the particles on their way to Earth.

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Weak-Line Quasars at High Redshift: Extremely High Accretion Rates or Anemic Broad-Line Regions?

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We present *Gemini-North* K-band spectra of two representative members of the class of high-redshift quasars with exceptionally

weak rest-frame ultraviolet emission lines (WLQs), SDSS J114153.34+021924.3 at $z = 3.55$ and SDSS J123743.08+630144.9 at $z = 3.49$. In both sources we detect an unusually weak broad Hβ line and we place tight upper limits on the strengths of their [O III] lines. Virial, Hβ-based black-hole mass determinations indicate normalized accretion rates of $L/L_{\rm Edd} = 0.4$ for these sources, which is well within the range observed for typical quasars with similar luminosities and redshifts. We also present high-quality *XMM-Newton* imaging spectroscopy of SDSS J114153.34+021924.3 and find a hard-X-ray photon index of $\Gamma = 1.91^{+0.24}_{-0.22}$ which supports the virial $L/L_{\rm Edd}$ determination in this source. Our results suggest that the weakness of the broad-emission lines in WLQs is not a consequence of an extreme continuum-emission source but instead due to abnormal broad-emission line region properties.

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Pc-scale Imaging of the Radio-bubble Seyfert galaxy NGC 6764

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We have observed the composite AGN-starburst galaxy NGC 6764 with the Very Large Baseline Array at 1.6 and 4.9 GHz. These observations have detected a "core-jet" structure and a *possible* weak counterjet component at 1.6 GHz. The upper limits to the core and jet (1.6−4.9 GHz) spectral index are 0.6 and 0.3, respectively. Taken together with the high brightness temperature of $\sim 10^7$ K for the core region, the radio emission appears to be coming from a synchrotron jet. At a position angle of $\sim 25^\circ$, the parsec-scale jet seems to be pointing closely towards the western edge of the southern kpc-scale bubble in NGC 6764. A real connection between the parsec and sub-kpc scale emission would not only suggest the presence of a curved jet, but also a close link between the AGN jet and the radio bubbles in NGC 6764. We demonstrate that a precessing jet model can explain the radio morphology from parsec- to sub-kpc scales, and the model best-fit parameters of jet speed and orientation are fully consistent with the observed jet-to-counterjet surface brightness ratio. The jet however appears to be disrupted on scales of 100s of parsecs, possibly due to interaction with, and entrainment of the interstellar medium gas, which subsequently leads to the formation of bubbles. The jet energetics in NGC 6764 suggest that it would take 12−21 Myr to inflate the (southern) bubble. This timescale corresponds roughly to the starburst episode that took place in NGC 6764 about 15−50 Myr ago, and could be indicative of a close connection between jet formation and the starburst activity in this galaxy.

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The dusty heart of nearby active galaxies. II. From clumpy torus models to physical properties of dust around AGN

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With the possibilities of high spatial resolution imaging and spectroscopy as well as infrared (IR) interferometry, the dusty environments (= "dusty torus") of active galactic nuclei (AGN) are now in reach of observations. Following our paper I on ground-based mid-IR spectro-photometry, we present an upgrade to our radiative transfer model of three-dimensional clumpy dust tori. The upgrade with respect to earlier work concerns an improved handling of the diffuse radiation field in the torus, which is approximated by a statistical approach. The models are presented as tools to translate classical and interferometric observations into characteristic properties of the dust distribution. We compare model spectral energy distributions (SEDs) for different chemical and grain-size compositions of the dust and find that clouds with standard interstellar matter (ISM) dust and optical depth $\tau_V \sim 50$ appear in overall agreement with observed IR SEDs. By studying parameter dependencies, it is shown that type 1 AGN SEDs, in particular the mid-IR spectral index, can be used to constrain the radial dust cloud

distribution power law index a, while other parameters are more difficult to assess using SEDs only. Interferometry adds important additional information for modeling when it is interpreted concurrently with the SED. Although type 2 AGN can in principle be used to constrain model parameters as well, obscuration effects make the analysis more ambiguous. We propose a simple, interferometry-based method to distinguish between "compact" and "extended" radial dust distributions without detailed modeling of the data and introduce a way to easily determine individual or sample average model parameters using the observed optical depth in the silicate feature and the mid-IR spectral index.

The clumpy torus model presented in this paper are made available at http://cat3d.sungrazer.org

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Heavily Obscured AGN in High Redshift Luminous Infrared Galaxies

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We take advantage of the rich multi-wavelength data available in the Chandra Deep Field South (CDF-S), including the 4 Msec Chandra observations (the deepest X-ray data to date), in order to search for heavily-obscured low-luminosity AGN among infrared-luminous galaxies. In particular, we obtained a stacked rest-frame X-ray spectrum for samples of galaxies binned in terms of their IR luminosity or stellar mass. We detect a significant signal at E$\sim$1 to 8 keV, which we interpret as originating from a combination of emission associated with star-formation processes at low energies combined with a heavily-obscured AGN at E>5 keV. We further find that the relative strength of this AGN signal decays with decreasing IR luminosity, indicating a higher AGN fraction for more luminous IR sources. Together, these results strongly suggest the presence of a large number of obscured AGN in IR-luminous galaxies. Using samples binned in terms of stellar mass in the host galaxy, we find a significant excess at E=6-7 keV for sources with M>10^{11}M$_\odot$, consistent with a large obscured AGN population in high mass galaxies. In contrast, no strong evidence of AGN activity was found for less-massive galaxies. The integrated intensity at high energies indicates that a significant fraction of the total black hole growth, $\sim$22%, occurs in heavily-obscured systems that are not individually detected in even the deepest X-ray observations. There are also indications that the number of low-luminosity, heavily-obscured AGN does not evolve significantly with redshift, in contrast to the strong evolution seen in higher luminosity sources.

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The X-Ray Properties of the Optically Brightest Mini-BAL Quasars from the Sloan Digital Sky Survey

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We have compiled a sample of 14 of the optically brightest radio-quiet quasars ($m_i \leq 17.5$ and $z \geq 1.9$) in the Sloan Digital Sky Survey Data Release 5 quasar catalog that have C IV mini-BALs present in their spectra. X-ray data for 12 of the objects were obtained via a *Chandra* snapshot survey using ACIS-S, while data for the other two quasars were obtained from archival *XMM-Newton* observations. Joint X-ray spectral analysis shows the mini-BAL quasars have a similar average power-law photon index ($\Gamma \approx 1.9$) and level of intrinsic absorption ($N_H \leq 8 \times 10^{21}$ cm^{-2}) as non-BMB (neither BAL nor mini-BAL) quasars. Mini-BAL quasars are more similar to non-BMB quasars than to BAL quasars in their distribution of relative X-ray brightness (assessed with $\Delta\alpha_{\rm ox}$). Relative colors indicate mild dust reddening in the optical spectra of mini-BAL quasars. Significant correlations

between $\Delta\alpha_{\rm ox}$ and UV absorption properties are confirmed for a sample of 56 sources combining mini-BAL and BAL quasars with high signal-to-noise ratio rest-frame UV spectra, which generally supports models in which X-ray absorption is important in enabling driving of the UV absorption-line wind. We also propose alternative parametrizations of the UV absorption properties of mini-BAL and BAL quasars, which may better describe the broad absorption troughs in some respects.

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Quasar feedback revealed by giant molecular outflows

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In the standard scenario for galaxy evolution young star-forming galaxies transform into red bulge-dominated spheroids, where star formation has been quenched. To explain this transformation, a strong negative feedback generated by accretion onto a central super-massive black hole is often invoked. The depletion of gas resulting from quasar-driven outflows should eventually stop star-formation across the host galaxy and lead the black hole to "suicide" by starvation. Direct observational evidence for a major quasar feedback onto the host galaxy is still missing, because outflows previously observed in quasars are generally associated with the ionized component of the gas, which only accounts for a minor fraction of the total gas content, and typically occurrs in the central regions. We used the IRAM PdB Interferometer to observe the CO(1–0) transition in Mrk 231, the closest quasar known. Thanks to the wide band we detected broad wings of the CO line, with velocities of up to 750 km s^{-1} and spatially resolved on the kpc scale. These broad CO wings trace a giant molecular outflow of about 700 M$_\odot$/year, far larger than the ongoing star-formation rate ($\sim$200 M$_\odot$/year) observed in the host galaxy. This wind will totally expel the cold gas reservoir in Mrk 231 in about 10^7 yrs, therefore halting the star-formation activity on the same timescale. The inferred kinetic energy in the molecular outflow is $\sim 1.2\times10^{44}$ erg/s, corresponding to a few percent of the AGN bolometric luminosity, which is very close to the fraction expected by models ascribing quasar feedback to highly supersonic shocks generated by radiatively accelerated nuclear winds. Instead, the contribution by the SNe associated with the starburst fall short by several orders of magnitude to account for the kinetic energy observed in the outflow. The direct observational evidence for quasar feedback reported here provides solid support to the scenarios ascribing the observed properties of local massive galaxies to quasar-induced large-scale winds.

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Multi-epoch X-ray observations of the Seyfert 1.2 galaxy Mrk 79: bulk motion of the illuminating X-ray source

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Multi-epoch X-ray spectroscopy (0.3-25 keV) of the Seyfert 1.2 galaxy Mrk 79 (UGC 3973) spanning nearly eight years and a factor of three in broadband flux are analysed. The data are obtained at seven epochs with either *XMM-Newton* or *Suzaku*. Comparison with contemporaneous *RXTE* monitoring indicate that all flux states of Mrk 79 are represented by the data. The spectra are fitted in a self-consistent manner adopting a power law and ionised reflection to describe the broadband continuum. Modification of the spectra by a distant photoionised medium, seen predominantly in emission, are also included.

Under the assumption that the inner disk is at the innermost stable circular orbit, our blurred reflection models give a spin of $a = 0.7 \pm 0.1$. The reflection component in each spectrum is weaker than predicted by simple reflection models. If the illuminating X-ray emission is produced by flares above the disk that move at mildly relativistic velocities, however, diminished reflection is expected. Light bending due to strong gravity near black holes can influence how the illuminating and reflected flux are observed; variations in Mrk 79 do not suggest that light bending is important in this source.

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Multiwavelength Observations of Radio-quiet Quasars with Weak Emission Lines

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We present radio and X-ray observations, as well as optical light curves, for a subset of 26 BL Lac candidates from the Sloan Digital Sky Survey (SDSS) lacking strong radio emission and with $z < 2.2$. Half of these 26 objects are shown to be stars, galaxies, or absorbed quasars. We conclude that the other 13 objects are active galactic nuclei (AGNs) with abnormally weak emission features; 10 of those 13 are definitively radio quiet, and, for those with available optical light curves, their level of optical flux variability is consistent with radio-quiet quasars. We cannot exclude the possibility that some of these 13 AGNs lie on the extremely radio-faint tail of the BL Lac distribution, but our study generally supports the notion that all BL Lac objects are radio-loud. These radio-quiet AGNs appear to have intrinsically weak or absent broad emission line regions (BELRs), and, based on their X-ray properties, we argue that some are low-redshift analogs to weak line quasars (WLQs). SDSS BL Lac searches are so far the only systematic surveys of the SDSS database capable of recovering such exotic low-redshift WLQs. There are 71 more $z < 2.2$ radio-quiet BL Lac candidates already identified in the SDSS, but not considered here, and many of those might be best unified with WLQs as well. Future studies combining low- and high-redshift WLQ samples will yield new insight on our understanding of the structure and formation of AGN BELRs.

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A survey of Low Luminosity Compact sources and its implication for evolution of radio-loud AGNs. I. Radio data

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We present a new sample of Compact Steep Spectrum (CSS) sources with radio luminosity below 10^{26} W Hz^{-1} at 1.4 GHz called the low luminosity compact (LLC) objects. The sources have been selected from FIRST survey and observed with MERLIN at L-band and C-band. The main criterion used for selection was luminosity of the objects and approximately one third of the CSS sources from the new sample have a value of radio luminosity comparable to FR Is. About 80% of the sources have been resolved and about 30% of them have weak extended emission and disturbed structures when compared with the observations of higher luminosity CSS sources. We studied correlation between radio power and linear size, and redshift with a larger sample that included also published samples of compact objects and large scale FR IIs and FR Is. The low luminosity compact objects occupy the space in radio power versus linear size diagram below the main evolutionary path of radio objects. We suggest that many of them might be short-lived objects, and their radio emission may be disrupted several times before becoming FR IIs. We conclude that there exists a large population of short-lived low luminosity compact objects unexplored so far and part of them can be precursors of large scale FR Is.

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A survey of Low Luminosity Compact sources and its implication for evolution of radio-loud AGNs. II. Optical analysis

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This is the second in a series of papers concerning a new sample of low luminosity compact (LLC) objects. Here we discuss the optical properties of the sample based on Sloan Digital Sky Survey (SDSS) images and spectra. We have generated different diagnostic diagrams and classified the sources as high and low excitation galaxies (HEG and LEG, respectively). We have studied the jet-host interactions, relation between radio and optical line emission and evolution of the radio source within a larger sample that included also the published samples of compact steep spectrum (CSS), gigahertz peaked spectrum (GPS) sources and FR II and FR I objects. The optical and radio properties of the LLC sample are in general consistent with brighter CSS and large-scale radio sources, although the LLC objects have lower values of [O III] luminosity than the more powerful CSS sources ($L_{1.4\,\mathrm{GHz}} > 10^{25}$ W Hz^{-1}). However, when LLC are added to the other samples, HEG and LEG seem to follow independent, parallel evolutionary tracks. Regarding ionization mechanisms, LLC and luminous CSS objects behave like FR II sources, while FR I seem to belong to a different group of objects. Based on our results, we propose the independent, parallel evolutionary tracks for HEG and LEG sources, evolving from GPS - CSS - FR.

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The Field X-ray AGN Fraction to z=0.7 from the Chandra Multiwavelength Project and the Sloan Digital Sky Survey

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We employ the *Chandra* Multiwavelength Project (ChaMP) and the Sloan Digital Sky Survey (SDSS) to study the fraction of X-ray-active galaxies in the field to $z = 0.7$. We utilize spectroscopic redshifts from SDSS and ChaMP, as well as photometric redshifts from several SDSS catalogs, to compile a parent sample of more than 100,000 SDSS galaxies and nearly 1,600 *Chandra* X-ray detections. Detailed ChaMP volume completeness maps allow us to investigate the local fraction of active galactic nuclei (AGN), defined as those objects having broad-band X-ray luminosities L_X(0.5-8 keV) $\geq 10^{42}$ erg s^{-1}, as a function of absolute optical magnitude, X-ray luminosity, redshift, mass, and host color/morphological type. In five independent samples complete in redshift and i-band absolute magnitude, we determine the field AGN fraction to be between $0.16 \pm 0.06\%$ (for $z \leq 0.125$ and $-18 > M_i > -20$) and $3.80 \pm 0.92\%$ (for $z \leq 0.7$ and $M_i < -23$). We find excellent agreement between our ChaMP/SDSS field AGN fraction and the *Chandra* cluster AGN fraction, for samples restricted to similar redshift and absolute magnitude ranges: $1.19 \pm 0.11\%$ of ChaMP/SDSS field galaxies with $0.05 < z < 0.31$ and absolute R-band magnitude more luminous than $M_R < -20$ are AGN. Our results are also broadly consistent with measures of the field AGN fraction in narrow, deep fields, though differences in the optical selection criteria, redshift coverage, and possible cosmic variance between fields introduce larger uncertainties in these comparisons.

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A possible jet precession in the periodic quasar B0605−085

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The quasar B0605−085 (OH 010) shows a hint for probable periodical variability in the radio total flux-density light curves. We study the possible periodicity of B0605−085 in the total flux-density, spectra, and opacity changes in order to compare it with jet kinematics on parsec scales. We have analyzed archival total flux-density variabilities at ten frequencies (408 MHz, 4.8 GHz, 6.7 GHz, 8 GHz, 10.7 GHz, 14.5 GHz, 22 GHz, 37 GHz, 90 GHz, and 230 GHz) together with the archival high-resolution very long baseline interferometry data at 15 GHz from the MOJAVE monitoring campaign. Using the Fourier transform and discrete autocorrelation methods we have searched for periods in the total flux-density light curves. In addition, spectral evolution and changes of the opacity have been analyzed. We found a period in multi-frequency total flux-density light curves of 7.9 ± 0.5 yrs. Moreover, a quasi-stationary jet component $C1$ follows a prominent helical path on a similar timescale of eight years. We have also found that the average instantaneous speeds of the jet components show a clear helical pattern along the jet with a characteristic scale of 3 mas. Taking into account average speeds of jet components, this scale corresponds to a timescale of about 7.7 years. Jet precession can explain the helical path of the quasi-stationary jet component $C1$ and the periodical modulation of the total flux-density light curves. We have fitted a precession model to the trajectory of the jet component $C1$, with a viewing angle $\phi_0 = 2.6^\circ \pm 2.2^\circ$, aperture angle of the precession cone $\Omega = 23.9^\circ \pm 1.9^\circ$ and fixed precession period (in the observers frame) $P = 7.9$ yrs.

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Broad Line Region Physical Conditions along the Quasar Eigenvector 1 Sequence

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We compare broad emission line profiles and estimate line ratios for all major emission lines between Lyα and Hβ in a sample of six quasars. The sources were chosen with two criteria in mind: the existence of high quality optical and UV spectra as well as the possibility to sample the spectroscopic diversity in the 4D Eigenvector 1 context (4DE1). In the latter sense each source occupies a region (bin) in the FWHM(Hβ) vs. Fe II$_{\rm opt}$ strength plane that is significantly different from the others. High S/N Hβ emission line profiles are used as templates for modeling the other lines (Lyα, CIVλ1549, HeIIλ1640, AlIIIλ1860, SiIII]λ1892, and MgIIλ2800). We can adequately model all broad lines assuming the existence of three components distinguished by blueshifted, unshifted and redshifted centroids (indicated as blue, broad and very broad component respectively). The broad component (electron density $n_{\rm e} \sim 10^{12}$ cm^{-3}; ionization parameter $U \sim 10^{-2}$; column density $N_{\rm c} \gtrsim 10^{23}$ cm^{-2}) is present in almost all type-1 quasars and therefore corresponds most closely to the classical broad line emitting region (the reverberating component). The bulk of MgIIλ2800 and FeII emission also arises in this region. The blue component emission ($\log n_{\rm e} \sim 10$; $\log U \sim -1$; $\log N_{\rm c} < 23$) arises in less optically thick gas; it is often thought to arise in an accretion disk wind. The least understood component involves the very broad component (high ionization and large column density) which is found in no more than half (but almost all radio-loud) type-1 quasars and luminous Seyfert nuclei. It is perhaps the most distinguishing characteristic of quasars with FWHM H$\beta \gtrsim 4000$ km s^{-1} that belong to the so-called Population B of our 4DE1 space. Population A quasars (FWHM H$\beta \lesssim 4000$ km s^{-1}) are dominated by broad component emission in Hβ and blue component emission in CIVλ1549 and other high ionization lines. 4DE1 appears to be the most useful current context for revealing and unifying spectral diversity in type-1 quasars.

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Compact molecular disc and ionized gas outflows within 350 pc of the active nucleus of Mrk 1066

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We present stellar and gaseous kinematics of the inner $\approx$350 pc radius of the Seyfert galaxy Mrk 1066 derived from J and K_l bands data obtained with the Gemini's Near-Infrared Integral Field Spectrograph (NIFS) at a spatial resolution of $\approx$35 pc. The stellar velocity field is dominated by rotation in the galaxy plane but shows an S-shape distortion along the galaxy minor axis which seems to be due to an oval structure seen in an optical continuum image. Along this oval, between 170 and 280 pc from the nucleus we find a partial ring of low σ_* ($\approx$50 km s^{-1}) attributed to an intermediate age stellar population. The velocity dispersion of the stellar bulge ($\sigma_* \approx 90$ km s^{-1}) implies a super-massive black hole mass of $\approx 5.4\times10^6$ M$_\odot$. From measurements of the emission-line fluxes and profiles ([P II]λ1.1886 μm, Fe IIλ1.2570 μm, Paβ and H$_2\lambda$2.1218 μm), we have constructed maps for the gas centroid velocity, velocity dispersion, as well as channel maps. The velocity fields for all emission lines are dominated by a similar rotation pattern to that observed for the stars, but are distorted by the presence of two structures: (i) a compact rotating disc with radius $r \approx 70$ pc; (ii) outflows along the radio jet which is oriented approximately along the galaxy major axis. The compact rotating disc is more conspicuous in the H$_2$ emitting gas, which presents the smallest σ values (≤ 70 km s^{-1}) and most clear rotation pattern, supporting a location in the galaxy plane. We estimate a gas mass for the disc of $\sim 10^7$ M$_\odot$. The H$_2$ kinematics further suggests that the nuclear disc is being fed by gas coming from the outer regions. The outflow is more conspicuous in the Fe II emitting gas, which presents the highest σ values (up to 150 km s^{-1}) and the highest blue and redshifts of up to 500 km s^{-1}, while the highest stellar rotation velocity is only $\approx$130 km s^{-1}. We estimate a mass-outflow rate in ionized gas of $\approx 6\times10^{-2}$M$_\odot$yr^{-1}. The derived kinematics for the emitting gas is similar to that observed in previous studies supporting that the H$_2$ is a tracer of the AGN feeding and the Fe II of its feedback.

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Modeling High-Velocity QSO Absorbers with Photoionized MHD Disk-Winds

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We extend our modeling of the ionization structure of magnetohydrodynamic (MHD) accretion-disk winds, previously applied to Seyfert galaxies, to a population of quasi-stellar-objects (QSOs) of much lower X-ray-to-UV flux ratios, i.e. smaller $\alpha_{\rm ox}$ index, motivated by UV/X-ray ionized absorbers with extremely high outflow velocities in UV-luminous QSOs. We demonstrate that magnetically-driven winds ionized by a spectrum with $\alpha_{\rm ox} \simeq -2$ can produce the charge states responsible for C IV and Fe XXV/Fe XXVI absorption in wind regions with corresponding maximum velocities of v(C IV) $\lesssim 0.1c$ and v(Fe XXV) $\lesssim 0.6c$ (where c is the speed of light) and column densities $N_H \sim 10^{23} - 10^{24}$ cm^{-2}, in general agreement with observations. In contrast to the conventional radiation-driven wind models, *high-velocity flows are always present in our MHD-driven winds* but manifest in the absorption spectra only for $\alpha_{\rm ox} \lesssim -2$, as larger $\alpha_{\rm ox}$ values ionize the wind completely out to radii too large to demonstrate the presence of these high velocities. We thus predict increasing velocities of these ionized absorbers with decreasing (steeper) $\alpha_{\rm ox}$, a quantity that emerges as the defining parameter in the kinematics of the AGN UV/X-ray absorbers.

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Asymmetries in Extragalactic Double Radio Sources: Clues from 3D Simulations of Jet – Disc Interaction

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Observational and theoretical studies of extragalactic radio sources have suggested that an inhomogeneous environment may be responsible for observed arm length asymmetries of jets and the properties of extended emission line regions in high redshift radio galaxies. We perform 3D hydrodynamic simulations of the interaction of a powerful extragalactic bipolar jet with a disc-shaped clumpy interstellar medium of log-normal density distribution and analyze the asymmetry. Furthermore, we compute the relation between jet asymmetry and the ISM properties by means of Monte Carlo simulations based on a 1D propagation model for the jet through the dense medium. We find that the properties of the ISM can be related to a probability distribution of jet arm length asymmetries: Disc density and height are found to have the largest effect on the asymmetry for realistic parameter ranges, while the Fourier energy spectrum of the ISM and turbulent Mach number only have a smaller effect. The hydrodynamic simulations show that asymmetries generally may be even larger than expected from the 1D model due to the complex interaction of the jet and its bow shock with gaseous clumps, which goes much beyond simple energy disposal. From our results, observed asymmetries of medium-sized local radio galaxies may be explained by gas masses of 10^9 to $10^{10}\,M_\odot$ in massive elliptical galaxies. Furthermore, the simulations provide a theoretical basis for the observed correlation that emission line nebulae are generally found to be brighter on the side of the shorter lobe in high redshift radio galaxies McCarthy et al. (1991). This interaction of jets with the cold gas phase suggests that star formation in evolving high redshift galaxies may be affected considerably by jet activity.

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The Effect of Active Galactic Nuclei on the Mid-Infrared Aromatic Features

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We present Spitzer measurements of the aromatic (also known as PAH) features for 35 Seyfert galaxies from the revised Shapley–Ames sample and find that the relative strengths of the features differ significantly from those observed in star-forming galaxies. Specifically, the features at 6.2, 7.7, and 8.6 μm are suppressed relative to the 11.3 μm feature in Seyferts. Furthermore, we find an anti-correlation between the L(7.7 μm)/L(11.3 μm) ratio and the strength of the rotational H_2 emission, which traces shocked gas. This suggests that shocks suppress the short-wavelength features by modifying the structure of the aromatic molecules or destroying the smallest grains. Most Seyfert nuclei fall on the relationship between aromatic emission and [Ne II] emission for star-forming galaxies, indicating that aromatic-based estimates of the star-formation rate in AGN host galaxies are generally reasonable. For the outliers from this relationship, which have small L(7.7 μm)/L(11.3 μm) ratios and strong H_2 emission, the 11.3 μm feature still provides a valid measure of the star-formation rate.

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Thesis Abstracts

Black Hole Growth and Star Formation in a Complete Sample of Seyfert Galaxies

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Ph.D degree awarded: September 2010

I investigate methods for determining black hole accretion rates and star-formation rates in galaxies hosting active galactic nuclei (AGNs) and use these results to identify biases in our census of black hole growth, to probe fundamental differences between obscured and unobscured AGNs, and to explore the connection between black hole growth and galaxy evolution. I show that the mid-infrared [O IV] emission line, which probes high-ionization gas and suffers little dust attenuation, is a useful diagnostic of AGN luminosity. Using [O IV] measurements for a complete sample of Seyfert galaxies, I show that the intrinsic luminosities of obscured and unobscured AGNs are quite similar. This is in contrast to the [O III] optical emission line and hard X-ray continuum luminosities, which are systematically smaller for obscured Seyferts, revealing strong biases in existing AGN surveys. I also explore the effect of AGNs on the mid-infrared aromatic features, which are useful probes of star-formation activity. I find that the 6.2, 7.7, and 8.6 μm features are suppressed relative to the 11.3 μm feature in Seyfert galaxies, and show that this behavior is correlated with the strength of the rotational H_2 emission, which traces shocked gas. This suggests that shocks associated with the AGN modify the structure of aromatic molecules, but I show that the 11.3 μm aromatic feature is robust to the effects of such shock processing, and use it to estimate nuclear star-formation rates for AGN host galaxies. I find an approximately linear relationship between black hole accretion rate and nuclear star-formation rate, and show that high-luminosity AGNs reside in galaxies with more centrally concentrated star formation. This suggests that the strength of AGN activity is driven by the amount of gas in the central few hundred parsecs, and is consistent with models where AGN activity is linked with elevated nuclear star formation.

Meetings

Narrow-Line Seyfert 1 Galaxies and their place in the Universe

Milano, Italy
April 4-6, 2011

Webpage: `http://nls1.brera.inaf.it/`
Email: `nls1@brera.inaf.it`

In 1978, Davidson and Kinman wrote about Markarian 359: "This unusual object merits further observations...". In 1985, Osterbrock and Pogge defined a new class of active galactic nuclei (AGN), named Narrow-Line Seyfert 1 (NLS1). Twenty-five years later, NLS1s still continue to intrigue and bewilder. NLS1s manifest extreme behaviour at all wavelengths. They exhibit the most extreme X-ray variability seen in radio-quiet AGN, the most intense optical FeII emission, and high rates of star formation. In general, their characteristics are consistent of AGNs with relatively low mass black holes accreting close to the Eddington rate. The 2009 *Fermi Gamma-ray Space Telescope* discovery of high-energy ($E > 100$ MeV) gamma rays in a handful of NLS1s has established the existence of relativistic jets in these systems – a fact previously hinted at by the flat radio spectrum and high brightness temperature seen in some objects. Since NLS1 are generally hosted by spirals, this poses some intriguing questions on the galaxy evolution and on how relativistic jets are generated.

It is therefore time for the broad community to come together and discuss what we have discovered in the last quarter century and lay the foundation for future work. We propose to meet in Milano on April 4-6 2011 for a workshop dedicated to NLS1 and focused on these topics:

- Central engine: BH mass, accretion disk, BLR/NLR, jet
- Host galaxy: morphology, star formation, merging history
- NLS1 in the Universe: comparison with other types of AGN, surveys/statistics, formation/merging, cosmological evolution

Invited speakers:

- Todd Boroson
- Andy Fabian (to be confirmed)
- Bradley Peterson
- Richard Pogge

Deadline for abstract submission and registration: 31 January 2011

Scientific Organizing Committee: **M. Colpi** (University Milano Bicocca, Italy); **L. Foschini** (INAF OA Brera, Italy, Chair); **L. Gallo** (St. Mary's University, Canada); **D. Grupe** (Penn State University, USA); **S. Komossa** (MPE, Germany); **K. Leighly** (University of Oklahoma, USA); **S. Mathur** (Ohio State University, USA).

Local Organizing Committee: C. Bernasconi; G. Bonnoli; G. Ghirlanda; G. Ghisellini; F. Taddei; F. Tavecchio.