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

From the Editor

Welcome to all the new subscribers, and thanks to everyone who contributed to this issue of the Active Galaxies Newsletter. This newsletter is intended to disseminate paper abstracts, meeting announcements, job adverts and other information which may be of interest to the active galaxies community. It is produced monthly and, whilst the deadline for contributions is the last day of the month, contributions may be submitted at any time. 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, any suggestions or feedback regarding the newsletter are welcome. Many thanks for your continued subscription.

Megan Argo

Abstracts of recently accepted papers

A large sample of Kohonen-selected SDSS quasars with weak emission lines: selection effects and statistical properties

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We performed a search for weak emission line quasars (WLQs) in the spectroscopic data from the Sloan Digital Sky Survey Data Release 7 based on Kohonen self-organising maps for nearly 10^5 quasar spectra. The final sample consists of 365 quasars and includes in particular a subsample of 46 WLQs with low equivalent widths $W(\mathrm{Mg\ II}) < 11$ Å and $W(\mathrm{C\ IV}) < 4.8$ Å. We compared various properties of the WLQs with those of control samples of ordinary quasars. Particular attention was paid to selection effects. The WLQs have, on average, significantly higher luminosities, Eddington ratios, and accretion rates. About half of the excess comes from a selection bias, but an intrinsic excess remains probably caused primarily by higher accretion rates. The spectral energy distribution shows a bluer continuum at rest-frame wavelengths longer than ~ 1500 Å. The variability in the optical and UV is relatively low, even taking the variability-luminosity anti-correlation into account. The percentage of radio detected quasars and of core-dominant radio sources is significantly higher than for the control sample, whereas the mean radio-loudness is lower. We argue that the properties of our WLQ sample can be consistently understood assuming that it consists of a mix of quasars at the beginning of a stage of increased accretion activity and of beamed radio-quiet quasars.

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Preprint available at http://arxiv.org/abs/1407.0193

The Dependence of C IV Broad Absorption Line Properties on Accompanying Si IV and Al III Absorption: Relating Quasar-Wind Ionization Levels, Kinematics, and Column Densities

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We consider how the profile and multi-year variability properties of a large sample of C IV Broad Absorption Line (BAL) troughs change when BALs from Si IV and/or Al III are present at corresponding velocities, indicating that the line-of-sight intercepts at least some lower ionization gas. We derive a number of observational results for C IV BALs separated according to the presence or absence of accompanying lower ionization transitions, including measurements of composite profile shapes, equivalent width (EW), characteristic velocities, composite variation profiles, and EW variability. We also measure the correlations between EW and fractional-EW variability for C IV, Si IV, and Al III. Our measurements reveal the basic correlated changes between ionization level, kinematics, and column density expected in accretion-disk wind models; e.g., lines-of-sight including lower ionization material generally show deeper and broader C IV troughs that have smaller minimum velocities and that are less variable. Many C IV BALs with no accompanying Si IV or Al III BALs may have only mild or no saturation.

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Spatially-Resolved Spectra of the "Teacup" AGN: Tracing the History of a Dying Quasar

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The Sloan Digital Sky Survey (SDSS) Galaxy Zoo project has revealed a number of spectacular galaxies possessing Extended Emission-Line Regions (EELRs), the most famous being Hanny's Voorwerp galaxy. We present another EELR object discovered in the SDSS endeavor: the Teacup Active Galactic Nucleus (AGN), nicknamed for its EELR, which has a "handle" like structure protruding 15 kpc into the northeast quadrant of the galaxy. We analyze physical conditions of this galaxy with long-slit ground based spectroscopy from Lowell, Lick, and KPNO observatories. With the Lowell 1.8-m Perkins telescope we took multiple observations at different offset positions, allowing us to recover spatially resolved spectra across the galaxy. Line diagnostics indicate the ionized gas is photoionized primarily by the AGN. Additionally we are able to derive the hydrogen density from the [S II] $\lambda6716/\lambda6731$ ratio. We generated two-component photoionization models for each spatially resolved Lowell spectrum. These models allow us to calculate the AGN bolometric luminosity seen by the gas at different radii from the nuclear center of the Teacup. Our results show a drop in bolometric luminosity by more than two orders of magnitude from the EELR to the nucleus, suggesting that the AGN has decreased in luminosity by this amount in a continuous fashion over 46,000 years, supporting the case for a dying AGN in this galaxy independent of any IR based evidence. We demonstrate that spatially resolved photoionization modeling could be applied to EELRs to investigate long time scale variability.

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TANAMI monitoring of Centaurus A: The complex dynamics within the inner parsec of an extragalactic jet

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Centaurus A (Cen A) is the closest radio-loud active galactic nucleus. Very Long Baseline Interferometry (VLBI) enables us to study the spectral and kinematic behavior of the radio jet–counterjet system on milliarcsecond scales, providing essential information for jet emission and propagation models. In the framework of the TANAMI monitoring, we investigated the kinematics and complex structure of Cen A on sub-parsec scales.

We study the evolution of the central parsec jet structure of Cen A over 3.5 years. The proper motion analysis of individual jet components allows us to constrain jet formation and propagation and to test the proposed correlation of increased high energy flux with jet ejection events. Cen A is an exceptional laboratory for such detailed study as its proximity translates to unrivaled linear resolution, where one milliarcsecond corresponds to 0.018 pc.

As a target of the Southern Hemisphere VLBI monitoring program TANAMI, observations of Cen A are made approximately every six months at 8.4 GHz with the Australian Long Baseline Array (LBA) and associated telescopes in Antarctica, Chile, New Zealand and South Africa, complemented by quasi-simultaneous 22.3 GHz observations.

The first seven epochs of high-resolution TANAMI VLBI observations at 8.4 GHz of Cen A are presented, resolving the jet on (sub-)milliarcsecond scales. They show a differential motion of the sub-parsec scale jet with significantly higher component speeds further downstream where the jet becomes optically thin. We determined apparent component speeds within a range of $0.1\,c$ to $0.3\,c$, as well as identified long-term stable features. In combination with the jet-to-counterjet ratio we can constrain the angle to the line of sight to $\theta \sim 12^\circ - 45^\circ$.

The high resolution kinematics are best explained by a spine-sheath structure supported by the downstream acceleration occurring where the jet becomes optically thin. On top of the underlying, continuous flow, TANAMI observations clearly resolve individual jet features. The flow appears to be interrupted by an obstacle causing a local decrease in surface brightness and a circumfluent jet behavior. We propose a jet-star interaction scenario to explain this appearance. The comparison of jet ejection times with high X-ray flux phases yields a partial overlap of the onset of the X-ray emission and increasing jet activity, but the limited data do not support a robust correlation.

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Are both BL Lacs and pulsar wind nebulae the astrophysical counterparts of IceCube neutrino events?

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IceCube has recently reported the discovery of high-energy neutrinos of astrophysical origin, opening up the PeV (10^{15} eV) sky. Because of their large positional uncertainties, these events have not yet been associated to any astrophysical source. We have found plausible astronomical counterparts in the GeV – TeV bands by looking for sources in the available large area high-energy γ-ray catalogues within the error circles of the IceCube events. We then built the spectral energy distribution of these sources and compared it with the energy and flux of the corresponding neutrino. Likely counterparts include mostly BL Lacs and two Galactic pulsar wind nebulae. On the one hand many objects, including the starburst galaxy NGC 253 and Centaurus A, despite being spatially coincident with neutrino events, are too weak to be reconciled with the neutrino flux. On the other hand, various GeV powerful objects cannot be assessed as possible counterparts due to their lack of TeV data. The definitive association between high-energy astrophysical neutrinos and our candidates will be significantly helped by new TeV observations but will be confirmed or disproved only by further IceCube data. Either way, this will have momentous implications for blazar jets, high-energy astrophysics, and cosmic-ray and neutrino astronomy.

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X-ray spectral variability of LINERs selected from the Palomar sample

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Variability is a general property of active galactic nuclei (AGN). The way in which these changes occur at X-rays is not yet clearly understood. In the particular case of low-ionization nuclear emission line region (LINER) nuclei, variations on the timescales from months to years have been found for some objects, but the main driver of these changes is still debated. The main purpose of this work is to investigate the X-ray variability in LINERs, including the main driver of these variations, and to search for possible differences between type 1 and 2 objects. We examined the 18 LINERs in the Palomar sample with data retrieved from the *Chandra* and/or *XMM*–Newton archives that correspond to observations gathered at different epochs. All the spectra for the same object were fitted simultaneously to study long-term variations. The nature of the variability patterns were studied by allowing different parameters to vary during the spectral fit. Whenever possible, short-term variations from the analysis of the light curves and long-term UV variability were studied. Short-term variations are not reported in X-rays. Three LINERs are classified as non-AGN candidates in X-rays, all of them are *Compton*-thick candidates; none of them show variations at these frequencies, and two of them vary in the UV. Long-term X-ray variations were analyzed in 12 out of 15 AGN candidates; about half of them showed variability (7 out of the 12). At UV frequencies, most of the AGN candidates with available data are variable (five out of six). Thus, 13 AGN candidates are analyzed at UV and/or X-rays, ten of which are variable at least in one energy band. None of the three objects that do not vary in X-rays have available UV data. This means that variability on long-timescales is very common in LINERs. These X-ray variations are mainly driven by changes in the nuclear power, while changes in absorptions are found only for NGC 1052. We do not find any difference between type 1 and 2 LINERs, neither in the number of variable cases (three out of five type 1 and four out of seven type 2 LINERs), nor in the nature of the variability pattern. We find indications of an anticorrelation between the slope of the power law, Γ, and the Eddington ratio.

LINERs are definitely variable sources irrespective of whether they are classified as optical type 1 or 2. Their BH masses, accretion rates, and variability timescales place them in the same plane as more powerful AGN at X-rays. However, our results suggest that the accretion mechanism in LINERs may be different. UV variations of some type 2 LINERs were found, this could support the hypothesis of a torus that disappears at low luminosities.

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Spectroscopy of 7 Radio-Loud QSOs at $2 < z < 6$: Giant Lyman-α Emission Nebulae Accreting onto Host Galaxies

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We performed long-slit optical spectroscopy (GTC-OSIRIS) of 6 radio-loud QSOs at redshifts $2 < z < 3$, known to have giant ($\sim$ 50–100 kpc) Lyman-α emitting nebulae, and detect extended Lyman-α emission for 4, with surface brightness $\sim 10^{-16}$ ergs cm^{-2}s^{-1}arcsec^{-2} and line width FWHM 400–1100 (mean 863) km s^{-1}. We also observed the $z \simeq 5.9$ radio-loud QSO, SDSS J2228+0110, and find evidence of a ≥ 10 kpc extended Lyman-α emission nebula, a new discovery for this high-redshift object.

Spatially-resolved kinematics of the 5 nebulae are examined by fitting the Lyman-α wavelength at a series of positions along the slit. We found the line-of-sight velocity $\Delta(v)$ profiles to be relatively flat. However, 3 of the nebulae appear systematically redshifted by 250–460 km s^{-1} relative to the Lyman-α line of the QSO (with no offset for the other two), which we argue is evidence for infall. One of these (Q0805+046) had a small ($\sim$ 100 km s^{-1}) velocity shift across its diameter and a steep gradient at the centre. Differences in line-of-sight kinematics between these 5 giant nebulae and similar nebulae associated with high-redshift radio galaxies (which can show steep velocity gradients) may be due to an orientation effect, which brings infall/outflow rather than rotation into greater prominence for the sources observed 'on-axis' as QSOs.

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Numerical modelling of the lobes of radio galaxies in cluster environments II: Magnetic field configuration and observability

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We describe three-dimensional magnetohydrodynamical modelling of powerful radio galaxies in realistic poor cluster environments. This modelling extends our earlier work on the hydrodynamics of radio galaxies as a function of their cluster environment to consider the magnetic field configuration in the lobes and its observational consequences, using a realistic model for the magnetic field in the intracluster medium, very high density contrast in the lobes and high numerical resolution. We confirm, now with a realistic magnetic field model, that lobes have characteristic trajectories in the radio power/linear size diagram which depend strongly on their environment. We investigate the detailed evolution of polarized emission, showing that the lobes evolve from the initially ordered field configuration imposed by our boundary conditions to one in which the longitudinal field comes to dominate. We obtain simulated observations of polarization whose properties are quantitatively consistent with observations. The highly spatially intermittent magnetic field also reproduces the observation that inverse-Compton emission from lobes is much smoother than synchrotron. Our simulations allow us to study the depolarizing effect of the external medium on the lobes, and so to demonstrate that Faraday depolarization from environments of the type we consider can reproduce the integrated fractional polarization properties of large samples and the observed preferential depolarization of the receding lobe.

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The Effects of the Local Environment on Active Galactic Nuclei

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There continues to be significant controversy regarding the mechanism(s) responsible for the initiation and maintenance of activity in galactic nuclei. In this paper we will investigate possible environmental triggers of nuclear activity through a statistical analysis of a large sample of galaxy groups. The focus of this paper is to identify active galactic nuclei (AGNs) and other emission-line galaxies in these groups and to compare their frequency with a sample of over 260,000 isolated galaxies from the same catalog. The galaxy groups are taken from the catalog of Yang *et al.* (2007), in which over 20,000 virialized groups of galaxies ($2 \leq N \leq 20$) with redshifts between 0.01 and 0.20 from the Sloan Digital Sky Survey.y. We first investigate the completeness of our data set and find, though biases are a concern particularly at higher redshift, that our data provide a fair representation of the local universe. After correcting emission-line equivalent widths for extinction and underlying Balmer stellar absorption, we classify galaxies in the sample using traditional emission-line ratios, while incorporating measurement uncertainties. We find a significantly higher fraction of AGNs in groups compared with the isolated sample. Likewise, a significantly higher fraction of absorption-line galaxies are found in groups, while a higher fraction of star-forming galaxies prefer isolated environments. Within grouped environments, AGNs and star-forming galaxies are found more frequently in small- to medium-richness groups, while absorption-line galaxies prefer groups with larger richnesses. Groups containing only emission-line galaxies have smaller virial radii, velocity dispersions, and masses compared with those containing only absorption-line galaxies. Furthermore, the AGN fraction increases with decreasing distance to the group centroid, independent of galaxy morphology. Using properties obtained from Galaxy Zoo, there is an increased fraction of AGNs within merging systems, unlike star-forming galaxies. These results provide some indication that the local environment does play a role in initiating activity in galactic nuclei, but it is by no means simple or straightforward.

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Multi-epoch VLBA observations of radio galaxy 0932+075: is this a compact symmetric object?

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A part of the radio structure of the galaxy 0932+075 emerged as a possible compact symmetric object (CSO) after the observation with the Very Long Baseline Array (VLBA) at 5 GHz in 1997. More than a decade later, we carried out observations at 5, 15.4, and 22.2 GHz using the VLBA to test this possibility. We report here that we have found a component whose spectrum is inverted in the whole range from 5 GHz to 22 GHz and we label it a high-frequency peaker (HFP). Using a set of 5 GHz images from two epochs separated by 11.8 years and a set of 15.4 GHz images separated by 8.2 years, we were able to examine the proper motions of the three components of the CSO candidate with respect to the HFP. We found that their displacements cannot be reconciled with the CSO paradigm. This has led to the rejection of the hypothesis that the western part of the arcsecond-scale radio structure of 0932+075 is a CSO anchored at the HFP. Consequently, the HFP cannot be labelled a core and its role in this system is unclear.

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Investigating the radio-loud phase of BAL quasars

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Context. Broad Absorption Lines (BALs) are present in the spectra of 20% of quasars (QSOs), indicating the presence of fast outflows (up to 0.2c) intercepting the observers line of sight. Radio-Loud (RL) BAL QSOs are even more rare, being four times less common than Radio-Quiet (RQ) BAL QSOs. The reason for that is still not clear, leaving open questions about the nature of the BAL-producing outflows and their connection with the radio jet.
Aims. We explored the spectroscopic characteristics of RL and RQ BAL QSOs, aiming at finding a possible explanation for the rarity of the former.
Methods. We identified two samples of genuine BAL QSOs from SDSS optical spectra, one RL and one RQ, in a suitable redshift interval ($2.5<z<3.5$) that allowed us to observe the Mg II and Hβ emission lines in the adjacent Near-Infrared (NIR) band. We collected NIR spectra of the two samples using the Telescopio Nazionale Galileo (TNG, Canary Islands). Using relations known in the literature, we could estimate black hole mass, broad line region radius and Eddington ratio of our objects, comparing the two samples.
Results. Comparing the distributions of the cited physical quantities, no statistically significant differences have been found. This suggest similar geometries, accretion rates, and central black hole mass, despite the radio-emitting jet is present or not.
Conclusions. Following these results, the central engine of BAL QSOs does not show different physical properties in presence of the radio jet. The reasons for the rarity of RL BAL QSOs must reside in different environmental or evolutionary variables.

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Special Announcements

Fizeau exchange visitors program - call for applications

2014-08-31

The Fizeau exchange visitors program in optical interferometry funds (travel and accommodation) visits of researchers to an institute of his/her choice (within the European Community) to perform collaborative work and training on one of the active topics of the European Interferometry Initiative. The visits will typically last for one month, and strengthen the network of astronomers engaged in technical, scientific and training work on optical/infrared interferometry. The program is open for all levels of astronomers (Ph.D. students to tenured staff). non-EU based missions will only be funded if considered essential by the Fizeau Committee. Applicants are strongly encouraged to seek also partial support from their home or host institutions.

The **deadline for applications is September 15**. Fellowships can be awarded for missions starting in November 2014.

Further informations and application forms can be found at http://www.european-interferometry.eu. The program is funded by OPTICON/FP7.

Please distribute this message also to potentially interested colleagues outside of the your community!

Looking forward to your applications,
Josef Hron & Laszlo Mosoni
(for the European Interferometry Initiative)

E-mail contact: fizeau@european-interferometry.eu

Thesis Abstract

Broad Absorption Line Variability on Multi-Year Timescales in a Large Quasar Sample

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Outflows launched near the central supermassive black holes (SMBHs) are a common and important component of active galactic nuclei (AGNs). Outflows in luminous AGNs (i.e., quasars) play a key role in mass accretion onto SMBH as well as in the feedback into host galaxies. The most prominent signature of such outflows appears as broad absorption lines (BALs) that are blueshifted from the emission line with a few thousands $\mathrm{km\,s^{-1}}$ velocities. In this dissertation, I place further constrains upon the size scale, internal structure, dynamics, and evolution of the outflows investigating profiles, properties, and variation characteristics of BAL troughs. I present observational results on BAL troughs in a large quasar sample utilizing spectroscopic observations from the Sloan Digital Sky Survey spanning on multi-year timescales. The results presented here, for the first time, provide a large and well-defined variability data base capable of discriminating between time-dependent hydrodynamic wind calculations in a statistically powerful manner.

In a study of 582 quasars, I present 21 examples of BAL trough disappearance. Approximately 3.3% of BAL quasars show disappearing C IV trough on rest-frame timescales of 1.1–3.9 yr. BAL disappearance appears to occur mainly for shallow and weak or moderate-strength absorption troughs but not the strongest ones. When one BAL trough in a quasar spectrum disappears, the other present troughs usually weaken. Possible causes of such coordinated variations could be disk-wind rotation or variations of shielding gas that lead to variations of ionizing-continuum radiation.

I present a detailed study on the variability of 428 C IV and 235 Si IV BAL troughs using a systematically observed sample of 291 BAL quasars. BAL variation distributions indicate that BAL disappearance is an extreme type of general BAL variability, rather than a qualitatively distinct phenomenon. The high observed frequency of BAL variability on multi-year timescales is generally supportive of models where most BAL absorption arises at radii of 10–1000 light days. Average lifetime for a BAL trough along our line-of-sight is a few thousand years which is long compared to the orbital time of the accretion disk at the wind-launching radius. We have examined if BAL variations on several timescales depend upon quasar properties, including quasar luminosity, Eddington luminosity ratio, black hole mass, redshift, and radio loudness. Within the ranges of these properties spanned by our sample, we do not find any strong dependences. The coordinated trough variability of BAL quasars with multiple troughs suggests that changes in "shielding gas" may play a significant role in driving general BAL variability.

I present a study investigating the dependence of C IV BAL properties and variation characteristics on accompanying Si IV and Al III absorption. Results of this study show that C IV BAL trough shapes, depths, velocity widths and strengths show a strong dependence on the presence of Si IV and Al III BAL troughs at corresponding velocities. Similarly, the variation characteristics and depth variation profiles of C IV BAL troughs also show a strong connection to BAL troughs in these transitions. Using these ions as a basic tracer of ionization level of the absorbing gas, systematic measurements of variability and profiles for a large sample of C IV, Si IV, and Al III BAL troughs present observational evidences of the relation between ionization level, column density and kinematics of outflows.

Utilizing observational investigations on a large BAL quasar sample, we show that ionization level, column density and kinematics of outflows show correlated object-to-object differences. We present a detailed comparison between the observational results of this study and the well studied disk-wind model of quasar outflows, which suggests that the wind is launched from the accretion disk at $\sim 10^{16}$–10^{17} cm and radiatively driven by UV line pressure. Results of this study show that lines-of-sight with different viewing inclinations successfully explain the characteristics and the differences between those three C IV trough groups with a good agreement to our observational findings.