The Blazar Times

A Research Newsletter Dedicated to the BL Lac and Blazar Phenomena

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Employment Opportunities

Three Postdoctoral Vacancies and one PhD Opening

ENIGMA Network[1], LSW Heidelberg[2], MPI Radioastronomie Bonn[3], and Tuorla Observatory[4]

[1] ENIGMA Network: Structure and Radiation Processes of AGN through multi-frequency analysis
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Within the newly established European Research Training Network ENIGMA on "Structure and Radiation Processes of AGN through multi-frequency analysis" we seek to fill three postdoctoral positions. They will be hosted by three of the eight European research institutions working within this project.

The network has been established to carry out research on Blazars in the following areas:

- Numerical simulations and analytical modeling of Blazar jets to study:
  particle acceleration and radiation mechanisms,
  magneto-hydrodynamic flows,
  jet physics in Blazars.
- Multi-frequency observations of radio-loud AGN to study:
  radio/optical Intra-Day variability,
  relationships between structural and flux density variability,
  relations in different high-energy bands (X-ray, γ-rays, and VHE radiation with Cerenkov telescopes).
- Advanced statistical methods for time-series and applications to astrophysical models.
- Developing high-precision photometric routines in different waveband regimes.
- Developing reliable robotic systems for automated ground-based monitoring of AGN.

Postdocs will work in their host team and within this active and interacting network of empirical and theoretical research. They are encouraged to spend part of their time at other institutes during their appointment. They will have access to unique observational facilities and will profit from a strong training program involving hardware-related aspects, observational strategies in all waveband regimes, and theoretical research.

Questions regarding the research program can be directed to the network coordinator, S. Wagner.

The three positions will become available between March 2003 and May 2003. The positions are available for up to three years. Competitive salaries will be paid, differing according to local regulations. Additional support will be

available for extended visits to other partner institutions within the network, network meetings and conferences. More detailed information is available at http://www.lsw.uni-heidelberg.de/~swagner/enigmavac1.html

The PhD position is at the Landessternwarte Heidelberg. It is a three year position on a specific topic within the research goals of the network. The candidate may be enrolled in the PhD program at the University of Heidelberg. All fees in its graduate course will be covered. Applications will be reviewed starting March 1, 2003 until the position is filled. The position should start preferably with the summer term (April 2003), but no later than with the beginning of the winter term (October 2003).

According to the rules of the EC, the positions are open to young researchers, holding a passport of a member or associate state of the European Union. German citizens may only apply to the position in Finland, Finnish citizens may only apply to the positions in Germany. Further details and exceptions are given by the regulations of the EC programme, e.g. on (http://www.cordis.lu/improving/networks/faq.htm# q5).

Applications should include a curriculum vitae, a publication list, a summary of current research interests, as well as a list of topics of interest or institutes which they would prefer to join. Two letters of reference should also be arranged for. The review of applications will start in the end of February 2003, and will continue until all positions are filled. Material should be sent to Landessternwarte Heidelberg, S. Wagner, Königstuhl 12, 69117 Heidelberg, Germany, swagner@lsw.uni-heidelberg.de.

Further positions will become available during the next months.

For further information contact: swagner@lsw.uni-heidelberg.de

For further information on WWW: http://www.lsw.uni-heidelberg.de/~swagner/enigma.html

Journal Abstracts

Optical Variability of the BL Lacertae Object GC 0109+224. Multiband Behaviour and Time Scales from a 7-years Monitoring Campaign.

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We present the most continuous data base of optical BVR_cI_c observations ever published on the BL Lacertae object GC 0109+224, collected mainly by the robotic telescope of the Perugia University Observatory in the period November 1994-February 2002. These observations have been complemented by data from the Torino Observatory, collected in the period July 1995-January 1999, and Mount Maidanak Observatory (December 2000). GC 0109+224 showed rapid optical variations and six major outbursts were observed at the beginning and end of 1996, in fall 1998, at the beginning and at the end of 2000, and at the beginning of 2002. Fast and large-amplitude drops characterized its flux behaviour. The R_c magnitude ranged from 13.3 (16.16 mJy) to 16.46 (0.8 mJy), with a mean value of 14.9 (3.38 mJy). In the periods where we collected multi-filter observations, we analyzed colour and spectral indexes, and the variability patterns during some flares. The long-term behaviour seems approximatively achromatic, but during some isolated outbursts we found evidence of the typical loop-like hysteresis behaviour, suggesting that rapid optical variability is dominated by non-thermal cooling of a single emitting particle population. We performed also a statistical analysis of the data, through the discrete correlation function (DCF), the structure function (SF), and the Lomb-Scargle periodogram, to identify characteristic times scales, from days to months, in the light curves, and to quantify the mode of variability. We also include a photometric calibration of comparison stars, to favour further extensive optical monitoring of this interesting blazar.

Accepted by A&A

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The Speed and Orientation of the Parsec-Scale Jet in 3C 279

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A high degree of relativistic beaming is inferred for the jets of blazars based on several lines of evidence, but the intrinsic speed and angle of the jet to the line-of-sight for individual sources are difficult to measure. We have calculated inverse-Compton Doppler factors for 3C 279 using the collection of VLBI data (including high-resolution space VLBI data at low frequencies) recently published by us (as Wehrle et al. and Piner et al.), and the collection of multiwavelength spectra recently published by Hartman et al. From the Doppler factor and superluminal apparent speed, we then calculate the Lorentz factor and angle to the line-of-sight of the parsec-scale relativistic jet. We follow the method previously used by Unwin et al. for 3C 345 to model the jet components as homogeneous spheres and the VLBI core as an unresolved inhomogeneous conical jet, using Königl's formalism.

The conical-jet model can be made to match both the observed X-ray emission and the VLBI properties of the core with a suitable choice of Doppler factor, implying the core makes a significant contribution to the X-ray emission, in contrast to the situation for 3C 345, where the jet components dominated the X-ray emission. The parameters of the Königl models indicate the jet is particle dominated at the radii that produce significant emission (from ~ 5 to 20 pc from the apex of the jet for most models), and is not in equipartition. At the inner radius of the Königl jet the magnetic field is of order 0.1 G and the relativistic-particle number density is of order 10 cm^{-3}. The kinetic energy flux in the jet is of order $10^{46}(1+k)$ ergs sec^{-1}, where k is the ratio of proton to electron energy, which implies a mass accretion rate of order $0.1(1+k)/\eta M_\odot$ yr^{-1}, where η is the efficiency of conversion of mass to kinetic energy.

When all components are included in the calculation, then on average the core produces about half of the X-rays, with the other half being split between the long-lived component C4 and the brightest inner-jet component. We calculate an average speed and angle to the line-of-sight for the region of the jet interior to 1 mas of $v = 0.992c$ ($\gamma = 8$) and $\theta = 4°$, and an average speed and angle to the line-of-sight for C4 (at $r \approx 3$ mas) of $v = 0.997c$ ($\gamma = 13$) and $\theta = 2°$. These values imply average Doppler factors of $\delta = 12$ for the inner jet, and $\delta = 21$ for C4.

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For preprints via ftp or WWW: http://xxx.lanl.gov/abs/astro-ph/0301333

What Types of Jets does Nature Make: A New Population of Radio Quasars

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We use statistical results from a large sample of about 500 blazars, based on two surveys, the Deep X-ray Radio Blazar Survey (DXRBS), nearly complete, and the RASS-Green Bank survey (RGB), to provide new constraints on the spectral energy distribution of blazars, particularly flat-spectrum radio quasars (FSRQ). This reassessment is

prompted by the discovery of a population of FSRQ with spectral energy distribution similar to that of high-energy peaked BL Lacs. The fraction of these sources is sample dependent, being $\sim 10\%$ in DXRBS and $\sim 30\%$ in RGB (and reaching $\sim 80\%$ for the *Einstein* Medium Sensitivity Survey). We show that these "X-ray strong" radio quasars, which had gone undetected or unnoticed in previous surveys, indeed are the strong-lined counterparts of high-energy peaked BL Lacs and have synchrotron peak frequencies, $\nu_{\rm peak}$, much higher than "classical" FSRQ, typically in the UV band for DXRBS. Some of these objects may be 100 GeV – TeV emitters, as are several known BL Lacs with similar broadband spectra. Our large, deep, and homogeneous DXRBS sample does not show anti-correlations between $\nu_{\rm peak}$ and radio, broad line region, or jet power, as expected in the so-called "blazar sequence" scenario. However, the fact that FSRQ do not reach X-ray-to-radio flux ratios and $\nu_{\rm peak}$ values as extreme as BL Lacs and the elusiveness of high $\nu_{\rm peak}$–high-power blazars suggest that there might be an intrinsic, physical limit to the synchrotron peak frequency that can be reached by strong-lined, powerful blazars. Our findings have important implications for the study of jet formation and physics and its relationship to other properties of active galactic nuclei.

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For preprints via ftp or WWW: http://xxx.lanl.gov/abs/astro-ph/0301227

Radio/X-ray Offsets of Large Scale Jets Caused by Synchrotron Time Lags

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In the internal shock scenario, we argue that electrons in most kpc (or even larger) scale jets can be accelerated to energies high enough to emit synchrotron X-rays, if shocks exist on these scales. These high energy electrons emit synchrotron radiation at high frequencies and cool as they propagate downstream along the jet, emitting at progressively lower frequencies and resulting in time lags and hence radio/X-ray (and optical/X-ray if the optical knot is detectable) offsets at bright knots, with the centroids of X-ray knots being closer to the core. Taking into account strong effects of jet expansion, the behaviour of radio/X-ray and optical/X-ray offsets at bright knots in M87, Cen A, 3C 66B, 3C 31, 3C 273, and PKS $1127-145$ is consistent with that of synchrotron time lags due to radiative losses. This suggests that the large scale X-ray and optical jets in these sources are due to synchrotron emission.

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For preprints via ftp or WWW: http://arXiv.org/abs/astro-ph/0301512

Neutral Beams from Blazar Jets

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We treat the production of neutrons, photons, and neutrinos through photomeson interactions of relativistic protons with ambient photons in the compact inner jets of blazars. We show that the presence of the external UV radiation field makes possible strong energy losses already for protons with energies $> 1\,$PeV, while without this component effective energy losses of protons begin only at $E \geq 10^{18}\,$eV. We develop a model describing the production and escape of neutrons from a comoving spherical blob, which continue to interact with the ambient external radiation field on the parsec-scale broad line region (BLR). Neutrons may carry 10% of the overall energy of the protons accelerated beyond $E \sim 1\,$PeV outside the BLR. Ultra-high energy (UHE) gamma rays produced in photomeson interactions of neutrons outside the blob can also escape the BLR. The escaping neutrons, gamma rays and neutrinos form a collimated

neutral beam with a characteristic opening angle $\sim 1/\Gamma$, where Γ is the bulk Lorentz factor of the inner jet. The energy and the momentum of such beam is then mostly deposited in the extended jet due to neutron decay at distances $\sim (E_n/10^{17}\mathrm{eV})\,\mathrm{kpc}$, and through pair-production attenuation of gamma rays with energies $E_\gamma \sim 10^{15} - 10^{18}\,\mathrm{eV}$ which can propagate to distances beyond (10-100) kpc. In this scenario, neutral beams of UHE gamma rays and neutrons can be the reason for straight extended jets such as in Pictor A. Fluxes of neutrinos detectable with km-scale neutrino telescopes are predicted from flat spectrum radio quasars such as 3C 279.

ApJ **586**, in press

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Preprints via WWW: http://xxx.lanl.gov/abs/astro-ph/0209231

A View through Faraday's Fog: Parsec scale rotation measures in AGN

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Rotation measure observations of 9 quasars, 4 BL Lacertae objects, and 3 radio galaxies are presented. The rest frame rotation measures in the cores of the quasars and the jets of the radio galaxy M87 are several thousand rad m^{-2}. The BL Lacertae objects and the jets of the quasars have rest frame rotation measures of a few hundred rad m^{-2}. A rotation measure of 500 rad m^{-2} in the rest frame is suggested as the dividing line between quasar and BL Lacertae objects. The substantial rotation measures of the BL Lacertae objects and quasars cast doubt on the previous polarization position angle investigations of these objects at frequencies of 15 GHz or less. BL Lacertae itself has a rotation measure that varies in time, similar to the behavior observed for the quasars 3C 273 and 3C 279. A simple model with magnetic fields of 40 μG or less can account for the observed rotation measures.

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Lobe Advance Velocities in the Extragalactic Compact Symmetric Object 4C 31.04

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We report on the results of a two epoch study of the low power Compact Symmetric Object 4C 31.04. Observations performed with the VLBA at 5 GHz in 1995 and 2000 have yielded images of this source at milliarcsecond angular resolution. A central core is detected, with bright compact hot spots and extended lobes on both sides. Model-fitting and other analysis of the data (brightness profile, difference map) clearly indicate that the source is expanding. We estimate the velocity of this expansion to be (0.085 ± 0.016) mas/yr, i.e. (0.33 ± 0.06) h_{65}^{-1} c in both hot spots. Assuming a constant expansion velocity, we estimate the kinematic age of the source at 550 yrs. We also study the spectral index using VLBA observations at 1.3 GHz and MERLIN at 22 GHz. The derived spectral age is 3000-5000 years in equipartition conditions. The two estimates are discussed and found to be in agreement, given present uncertainties.

Accepted by A&A

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Abstract Guidelines

Abstracts for "The Blazar Times" are solicited for papers that have been recently accepted for publication by a refereed journal, and for recent Ph.D. theses. Please do not submit an abstract before it has been accepted, nor after it is published. Abstracts from papers which are not refereed (e.g., conference proceedings) are not accepted.

The subject matter should pertain directly to the BL Lac and/or blazar phenomenon in general. Both observational and theoretical abstracts are appropriate. Abstracts from papers dealing with other classes of AGN will generally not be included unless they explicitly discuss their relevance to the blazar phenomenon; however exceptions to this rule will be considered.

A monthly call for abstracts will be issued and abstracts received by the last day of the month will usually appear in the following month's newsletter. Announcements of general interest to the BL Lac and blazar communities may also be submitted for posting in the newsletter. These might include (but are not restricted to) the following: (i) *Job Openings* directed toward blazar researchers, (ii) announcements of *Upcoming Meetings*, (iii) announcements of *Upcoming Observing Campaigns* for which participation is solicited from the community at large, (iv) reviews of *New Books*, and (v) *General Announcements* that provide or request research-related information.

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`http://www.aoc.nrao.edu/~trector/blazar/`

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