The Blazar Times

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Journal Abstracts

High-Energy Emission from BL Lac Objects: The Case of W Comae

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Spectral fitting of the radio through hard X-ray emission of BL Lac objects has previously been used to predict their level of high-energy (GeV – TeV) emission. In this paper, we point out that such spectral fitting can have very large uncertainties with respect to predictions of the VHE emission, in particular if no reliable, contemporaneous measurement of the GeV flux is available and the νF_ν peak (flux and frequency) of the synchrotron component is not very precisely known. This is demonstrated with the example of the radio-selected BL Lac object W Comae, which is currently on the source list of the STACEE and CELESTE experiments, based on extrapolations of the EGRET flux measured from this source, and on model predictions from hadronic blazar jet models. We show that the best currently available contemporaneous optical – X-ray spectrum of W Comae, which shows clear evidence for the onset of the high-energy emission component beyond ~ 4 keV and thus provides a very accurate guideline for the level of hard X-ray SSC emission in the framework of leptonic jet models, still allows for a large range of possible parameters, resulting in drastically different > 40 GeV fluxes. We find that all acceptable leptonic-model fits to the optical – X-ray emission of W Comae predict a cut-off of the high-energy emission around ~ 100 GeV. We suggest that detailed measurements and analysis of the soft X-ray variability of W Comae may be used to break the degeneracy in the choice of possible fit parameters, and thus allow a more reliable prediction of the VHE emission from this object. Using the available soft X-ray variability measured by *BeppoSAX*, we predict a > 40 GeV flux from W Comae of $\sim (0.4 - 1) \times 10^{-10}$ photons cm^{-2} s^{-1} with no significant emission at $E > 100$ GeV for a leptonic jet model. We compare our results concerning leptonic jet models with detailed predictions of the hadronic Synchrotron-Proton Blazar model. This hadronic model predicts > 40 GeV fluxes very similar to those found for the leptonic models, but results in > 100 GeV emission which should be clearly detectable with future high-sensitivity instruments like VERITAS. Thus, we suggest this object as a promising target for VHE γ-ray and co-ordinated broadband observations to distinguish between leptonic and hadronic jet models for blazars.

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X-Ray Spectral Variability Signatures of Flares in BL Lac Objects

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We are presenting a detailed parameter study of the time-dependent electron injection and kinematics and the self-consistent radiation transport in jets of intermediate and low-frequency peaked BL Lac objects. Using a time-dependent, combined synchrotron-self-Compton and external-Compton jet model, we study the influence of variations of several essential model parameters, such as the electron injection compactness, the relative contribution of synchrotron to external soft photons to the soft photon compactness, the electron-injection spectral index, and the details of the time profiles of the electron injection episodes giving rise to flaring activity. In the analysis of our results, we focus on the expected X-ray spectral variability signatures in a region of parameter space particularly well suited to reproduce the broadband spectral energy distributions of intermediate and low-frequency peaked BL Lac objects. We demonstrate that SSC- and external-Compton dominated models for the γ-ray emission from blazars are producing significantly different signatures in the X-ray variability, in particular in the soft X-ray light curves and the spectral hysteresis at soft X-ray energies, which can be used as a powerful diagnostic to unveil the nature of the high-energy emission from BL Lac objects.

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Detection of the BL Lac object 1ES 1426+428 in the Very High Energy gamma-ray band by the CAT Telescope from 1998-2000

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The BL Lac Object 1ES 1426+428, at a red-shift of z=0.129, has been monitored by the CAT telescope from February 1998 to June 2000. The accumulation of 26 hours of observations shows a γ-ray signal of 321 events above 250 GeV at 5.2 standard deviations, determined using data analysis cuts adapted to a weak, steep-spectrum source. The source emission has an average flux of $\Phi_{\rm diff}(400\,{\rm GeV}) = 6.73 \pm 1.27^{\rm stat} \pm 1.45^{\rm syst} \times 10^{-11}\,{\rm cm}^{-2}\,{\rm s}^{-1}{\rm TeV}^{-1}$, and a very steep spectrum, with a differential spectral index of γ=-3.60 ± 0.57 which can be refined to γ=-3.66 ± 0.41 using a higher flux data subset. If, as expected from its broad-band properties, the Very High Energy emission is hard at the source, these observations support a strong absorption effect of γ-rays by the Intergalactic Infrared field.

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The Apparent Host Galaxy of PKS 1413+135: *HST*, *ASCA* and VLBA Observations

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PKS 1413+135 ($z = 0.24671$) is one of very few radio-loud AGN with an apparent spiral host galaxy. Previous authors have attributed its nearly exponential infrared cutoff to heavy absorption but have been unable to place tight limits on the absorber or its location in the optical galaxy. In addition, doubts remain about the relationship of the AGN to the optical galaxy given the observed lack of re-emitted radiation. We present new *HST*, *ASCA* and *VLBA* observations which throw significant new light on these issues. The *HST* observations reveal that the active nucleus of PKS 1413+135 has an extremely red color: $V - H = 6.9$ mag, requiring both a spectral turnover at a few microns due to synchrotron aging and a giant molecular cloud-sized absorbing region. Combining constraints from the *HST* and *ASCA* data we derive an intrinsic column $N_H = 4.6^{+2.1}_{-1.6} \times 10^{22}$ cm^{-2} and covering fraction $f = 0.12^{+0.07}_{-0.05}$. The spin temperature of the molecular absorption lines found by previous authors suggests that the cloud is located in the disk of the optical galaxy, making our sightline rather unlikely ($P \sim 2 \times 10^{-4}$). The properties of this region appear typical of large giant molecular clouds in our own galaxy. The HI absorber appears centered 25 milliarcseconds away from the nucleus, while the X-ray and nearly all of the molecular absorbers must cover the nucleus, implying a rather complicated geometry and cloud structure, in particular requiring a molecular core along our line of sight to the nucleus. Interestingly, the *HST*/NICMOS data require the AGN to be decentered relative to the optical galaxy by 13 ± 4 milliarcseconds. This could be interpreted as suggestive of an AGN location far in the background compared to the optical galaxy, but it can also be explained by obscuration and/or nuclear structure, which is more consistent with the observed lack of multiple images.

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PKS 1510−089: A Head-On View of a Relativistic Jet

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The gamma-ray blazar PKS 1510−089 has a highly superluminal milli-arcsecond jet at a position angle (PA) of −28° and an arcsecond jet with an initial PA of 155°. With a ΔPA of 177° between the arcsecond and milli-arcsecond jets, PKS 1510−089 is perhaps the most highly misaligned radio jet ever observed and serves as a graphic example of projection effects in a highly beamed relativistic jet. Here we present the results of observations designed to bridge the gap between the milli-arcsecond and arcsecond scales. We find that a previously detected "counter-feature" to the arcsecond jet is directly fed by the milli-arcsecond jet. This feature is located 0.3 arcseconds from the core, corresponding to a de-projected distance of 30 kiloparsecs. The feature appears to be dominated by shocked emission and has an almost perfectly ordered magnetic field along its outside edge. We conclude that it is most likely a shocked bend, viewed end-on, where the jet crosses our line of sight to form the southern arcsecond jet. While the bend appears to be nearly 180° when viewed in projection, we estimate the intrinsic bending angle to be between 12° and 24°. The cause of the bend is uncertain; however, we favor a scenario where the jet is bent after it departs the galaxy, either by ram pressure due to winds in the intracluster medium or simply by the density gradient in the transition to the intergalactic medium.

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BeppoSAX Observations of Synchrotron X-ray Emission from Radio Quasars

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We present new *BeppoSAX* LECS, MECS, and PDS observations of four flat–spectrum radio quasars (FSRQ) having effective spectral indices $\alpha_{\rm ro}$ and $\alpha_{\rm ox}$ typical of high-energy peaked BL Lacs. Our sources have X–ray–to–radio flux ratios on average ~ 70 times larger than "classical" FSRQ and lie at the extreme end of the FSRQ X–ray–to–radio flux ratio distribution. The collected data cover the energy range $0.1-10$ keV (observer's frame), reaching ~ 100 keV for one object. The *BeppoSAX* band in one of our sources, RGB J1629+4008, is dominated by synchrotron emission peaking at $\sim 2\times10^{16}$ Hz, as also shown by its steep (energy index $\alpha_{\rm x}\sim 1.5$) spectrum. This makes this object the *first* known FSRQ whose X–ray emission is not due to inverse Compton radiation. Two other sources display a flat *BeppoSAX* spectrum ($\alpha_{\rm x}\sim 0.7$), with weak indications of steepening at low X–ray energies. The combination of *BeppoSAX* and ROSAT observations, (non-simultaneous) multifrequency data, and a synchrotron inverse Compton model suggest synchrotron peak frequencies $\approx 10^{15}$ Hz, although a better coverage of their spectral energy distributions is needed to provide firmer values. If confirmed, these values would be typical of "intermediate" BL Lacs for which the synchrotron and inverse Compton components overlap in the *BeppoSAX* band. Our sources, although firmly in the radio–loud regime, have powers more typical of high–energy peaked BL Lacs than of FSRQ, and indeed their radio powers put them near the low–luminosity end of the FSRQ luminosity function. We discuss this in terms of an anti-correlation between synchrotron peak frequency and total power, based on physical arguments, and also as possibly due to a selection effect.

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Log-Normal Distributions in Cygnus X-1: Possible Physical Link with Gamma-Ray Bursts and Blazars

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Prompted by recent discoveries of log-normal distributions in gamma-ray/X-ray temporal variabilities of gamma-ray bursts (GRBs) and blazars, we re-examine the X-ray variability of Cygnus X-1 in the hard/low state using Ginga data in 1990. It was previously reported that the distributions of the time intervals between X-ray shots (flares) deviated from the Poisson distributions at short time intervals: the occurrence of shots tended to be suppressed for several seconds before and/or after a shot event. Detailed analyses show that this deviation is larger for shots with larger peaks, and that the time-interval distributions for large shots approach log-normal distributions with a peak at the interval of 7–8 s. Furthermore, we also show that the peak-intensity distribution for the shots is consistent with the log-normal distribution, though no typical peak intensity can be seen. This might indicate the presence of a physical link connecting the physics of black hole accretion flow and that of jet/GRB formation.

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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.

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