**Investigating the Peculiar Spectral Energy Distributions of TeV Blazars**

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Gamma-ray astrophysics has been developing rapidly over the course of the past couple of decades. This has allowed astrophysicists to probe physics occurring in the most extreme environments and the most powerful objects in the universe. One class of these powerful objects is blazars: active galactic nuclei (AGN) whose jets are aligned with our line of sight. Due to this unique alignment we observe relativistically boosted GeV and TeV photons.

The dominant particle processes in blazar jets are generally accepted to be leptonic, although hadronic models have not been completely ruled out. Inverse Compton (IC) scattering and synchrotron self-Compton (SSC) mechanisms produce a characteristically double peaked spectral energy distribution (SED). A challenge to interpreting the very-high-energy (VHE) radiation from blazars is the extragalactic background light (EBL), which interacts with high energy photons via absorption as they travel towards Earth (Costamante, 2012). Based on a given EBL model, we can deabsorb the observed spectrum to obtain an intrinsic spectrum and eliminate models which produce physically impossible intrinsic spectra (Gilmore et al., 2012).

New data is revealing an ever more peculiar picture of blazars. The TeV blazars 3C 66A and PKS 1424+240 have been selected for this project due to their peculiar deabsorbed SEDs and newly obtained redshift data. Each blazar has been detected at GeV and TeV energy regimes by both the *Fermi*-LAT and VERITAS (Abdo et al., 2011 and Acciari et al., 2010). These objects' SEDs are interesting because at ~100 GeV the data do not follow the models for currently accepted particle processes; there is an uncharacteristic dip in the SED. In addition, the VERITAS data do not appear to be an extrapolation of the lower energy *Fermi* data at this energy. The effect is even more evident when considering the deabsorbed spectra based on new redshift data for 3C 66A: a solid lower limit $z > 0.3343$ and an upper limit of 0.41 (at 99% confidence) (Furniss et al., 2013).

Based on an IC+SSC model of the AGN jet we expect emission to drop off after the second peak. At the redshift quoted above for 3C 66A the discrepancy between the deabsorbed data and the particle emission models is even clearer. PKS 1424+240 also exhibits this peculiar mismatch based on deabsorption at multiple redshifts; higher redshifts produce a more evident SED feature. The reason for this peculiar feature is unknown. To understand and explain this anomaly, intensive data taking and careful spectral modeling are necessary.

We are proposing an intense multiwavelength study of the blazars 3C 66A and PKS 1424+240. The data will include observations from *Swift*, *Fermi* and VERITAS in order to fully characterize the SED of these two sources in the optical, UV, X-ray, high-energy gamma ray and VHE gamma ray energy regimes. We will aim for as much simultaneous data as feasible and will investigate the use of other observations from *Suzaku*, *NuSTAR,* and the Nickel 40-inch optical telescope if we find that they are needed for a better characterization of the SEDs. VERITAS and *Swift* already have programs in place to observe targets simultaneously.

The next step in this project will be to analyze the data from all three instruments. In order to solidify the claim that variability is not the reason for this SED feature, strictly simultaneous data will be prioritized. To analyze the *Swift* data, I will use the data analysis tools available online through NASA's HEASARC. Similarly, the Fermi tools available online will be used to analyze *Fermi*-LAT data. As an active member of the VERITAS collaboration, I am familiar with the data analysis process. UCSC is already configured to handle the analysis of data from all three of these instruments.

After the data is analyzed, I will use spectral modeling to understand the features of the SED. I will start with the simplest (SSC), time independent model, and add parameters in order to ascertain which model and combinations of parameters provides the best explanation of the data. There are three aspects I wish to study and incorporate into modeling the SED.

*Particle acceleration and emission mechanisms:* Current particle emission models are degenerate due to the non-simultaneous nature of the data and the time independent modeling. Strictly simultaneous data will break the degeneracy between these models. However, we may actually be looking at a combination of components or a new intrinsic component altogether.

*Jet environment:* The unique spectral feature seen in these two blazars could be due to any one of several external factors impacting the jet's emission. Such features include an absorption region close to the jet, the structure of the jet's magnetic fields, accretion mechanisms, or relations to the age and formation of the host galaxy.

*Cosmological factors:* The EBL plays an important role in observed blazar SEDs, and the SEDs from this study will be able to further constrain EBL models. A recent study of extragalactic TeV emitters indicates an anomaly in the amount of absorption observed and attributes it to a "pair-production anomaly" (Horns & Meyer, 2012). This scenario suggests a suppression of pair production during VHE photon propagation which is relevant when interpreting blazar SEDs.

If the peculiar feature is apparent in other blazar SEDs, this research will lay the foundation for future blazar population studies. Much work is being done to solidify the redshifts of other TeV blazars. Combining future redshift data with deabsorption from the EBL will spur new, similar observation and analysis campaigns if this peculiar feature is seen in other blazars. If a model is found which fits the SEDs of 3C 66A and/or PKS 1424+240, it will contribute to blazar unification. Blazar unification is the attempt to understand the observed and intrinsic qualities of blazars and how they relate to their variety, structure and evolution.

We expect this project to take one year with the option of extending the work to other blazars in a time frame beyond one year. The financial support required for this project will cover a stipend, tuition and fees, travel expenses, and publication charges. Based on a monthly stipend of $1,712 and a 50% assignment, this would be $20,544 for the stipend, $17,646 for three quarters of tuition and fees, $1,000 for travel expenses, and $1,000 for publication charges. This totals $41,902.

This project is interesting because it simultaneously probes particle processes in AGN, jet structure and environment, and cosmology. It is an exciting time to be a gamma ray astrophysicist! The current technology and the community's understanding have reached a point where blazar observing campaigns are no longer aimed solely at detections. Now, we are investigating the fundamental physics and processes governing the most powerful and extreme environments in the universe.


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