Bulletin of the AAS • Vol. 56, Issue 2 (AAS243 Abstracts)

Correlating Gamma-Ray Variations of Blazars with Optical Light Curves and Polarization

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Published on: Feb 07, 2024

URL: https://baas.aas.org/pub/2024n2i104p11

In previous observations of blazars, increased gamma-ray emission has been correlated with the production of bright, superluminally moving knots at radio wavelengths. This suggests that shock waves or other disturbances propagating down the jet increase the energies of electrons, which then radiate at gamma-ray, via Compton scattering, and radio to optical, through synchrotron radiation, wavelengths. This study analyzes a 15-year data set to check the robustness of this hypothesis by comparing gamma-ray flux variations with those in both flux and polarization at optical wavelengths. The sample consists of about three dozen blazars that are selected to be bright at optical, radio, and gamma-ray wavelengths. The correlation between the gamma-ray and optical variations, and its significance and time lag, is calculated using the z-transformed discrete correlation function. A flux-flux correlation that peaks at zero lag supports the hypothesis that optical and gamma-ray emission is temporally, and therefore spatially, related. This could occur if the emission observed at both wavelengths is produced by the same population of high-energy (about 10 GeV) electrons. Additional correlation analysis of the gamma-ray (or optical) flux and optical polarization determines whether there is a relationship between the ordering and mean direction of the magnetic field relative to the jet axis and the acceleration of electrons. This can test whether the particle acceleration is dominated by diffusive shock acceleration or magnetic reconnection. This work is supported by NASA Fermi Guest Investigator grants 80NSSC22K1571, 80NSSC23K1507, and 80NSSC20K1567, and National Science Foundation grant AST-2108622.