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A comprehensive power spectral density analysis of astronomical time series: the gamma-ray light curves of selected Fermi blazars

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We present results of Fermi-Large Area Telescope (LAT) light curve (LC) modelling of selected Fermi blazars. All objects possess densely sampled and long-term LCs. For each blazar we generated three LCs with 7, 10, and 14 days binning, using the latest 4FGL catalogue and binned analysis provided within the fermipy package.
The LCs were modelled with several tools: the Fourier transformation, the Lomb-Scargle periodogram (LSP), the autoregressive moving average (ARMA), the fractional autoregressive integrated moving average, the continuous-time autoregressive moving average (CARMA) processes, the Hurst exponents (H), the A-T plane, and the wavelet scalogram.
Power law indices β calculated from the Fourier and LSP modelling are consistent with each other. Many objects yield β≈1, with PKS 2155-304 even flatter, but some are significantly steeper, e.g. Mrk 501 and B2 1520+31. A power law power spectral density (PSD) is indicative of a self-affine stochastic process characterised by H, underlying the observed variability. Several algorithms for the H estimation are employed. For some objects we observe H>0.5, indicating long-term memory. The ARMA results give in general higher orders for 7 days binned LCs and lower orders for 10 and 14 days binned LCs, implying temporal variations in the LCs are consistently captured by the fitted models. CARMA fits lead to featureless PSDs. The recently introduced A-T plane allows to successfully classify the PSDs based on the LCs alone.

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