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Stochastic blazar variability

Blazars are a rare class of active galactic nuclei (AGN) whose total radiative energy output is dominated by the Doppler-boosted, broad-band and non-thermal processes; synchrotron (radio–to–optical frequncies) and inverse-Compton (IC; ∼X-ray–to–γ−ray frequencies) occurring in relativistic jet. Besides showing extreme luminosities up to ∼ 10^{47-48} erg/s, blazars are also extremely variable on timescales ranging from decades to hours and even down to minutes. The power-law form of variability power spectral densities, $P(\nu_k) = A\nu_k^{-\beta}$, where ν_k is the temporal frequency, A is the normalization and β is the slope, indicate that the variability is generated by the underlying stochastic processes which is of colored noise type (i.e., $\beta \simeq 1-3$). We present the results of our analysis using multiwavelength data sets at TeV (HESS and VERITAS), GeV (Fermi-LAT), X-ray (Swift-XRT and RXTE-PCA), multiband optical/infrared and radio (GHz band from MRO, UMRAO and OVRO programmes) frequencies covering few decades to minutes timescales. The novelty of this study is that at optical frequency, by combining long-term (historical optical light curves) and densely sampled intra-night lightcurves, the PSD characterisitics are investigated for temporal frequencies ranging over 7 orders of magnitude. Our main results are : (1) nature of processes generating flux variability at synchrotron frequencies is different from those at IC freqeuncies (β∼2 and 1, respectively); this could imply, that γ−ray variability, unlike the Synchrotron (radio-to-optical) one, is generated by superposition of two stochastic processes with different relaxation timescales, (2) the main driver behind the optical variability is same on years, months, days, and hours timescales (β∼2), which argues against the scenario where different drivers behind the long-term flux changes and intra-night flux changes are considered, such as internal shocks due to the jet bulk velocity fluctuation (long-term flux changes) versus small-scale magnetic reconnection events taking place at the jet base (intra-night flux changes). Implications of these results are discussed in the context of commonly employed blazar emission models.

Serdecznie zapraszam,
Agnieszka Majczyna