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Blazar variability from radio to TeV photon energies on timescales ranging from decades to minutes

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Variability power spectral densities (PSDs) of blazar light curves, crudly represented as $P(f) = Af^{-\beta}$, where A is the normalization and β is the slope, indicate that the variability is generated due to the underlying {\it stochastic} processes (i.e., $\beta \simeq 1-3$, characteristic of flicker/red noise). We present the results of our power spectral analysis on blazar sources using the standard Fourier decomposition methods as well as modeling the light curve as continuous-time auto regressive moving average (CARMA) process. We use decade-long multiwavelength light curves at very high energy $\gamma-$rays from the H.E.S.S. and the VERITAS, high energy $\gamma-$rays from the {\it Fermi}-LAT, X-rays from the {\it Swift}-XRT and the {\it RXTE}-PCA, multi-band optical/infrared from several ground-based telescopes as well as the {\it Kepler} satellite, and GHz band radio frequencies from MRO, UMRAO, and OVRO monitoring programmes. The novelty of our approach is that, by combining long-term and densely sampled intra-night light curves in the optical regime, we were able to construct for the first time the optical power spectrum of the blazar for a time domain extending from decades years down to minutes. Our analysis reveals that: (1) nature of processes generating flux variability at synchrotron frequencies is different from those at IC frequencies ($\beta \sim$2 and 1, respectively); this could imply, that IC variability 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 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 blazar emission models.

Author: Dr GOYAL, Arti (Astronomical Observatory of the Jagiellonian University)

Presenter: Dr GOYAL, Arti (Astronomical Observatory of the Jagiellonian University)

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