Title: Systematic investigation of AGN jet physics via variability and spectral analysis

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INTRODUCTION:

The physical processes responsible for producing intense flux variability on intra-night timescales in blazar sources (a subset of Active Galactic Nuclei (AGN)) continue to be debated. As the AGN core remains unresolved on the arcsec scale, the variability has served as a prime tool to investigate the extremely efficient energy dissipation processes in these sources. This is because the rapid variations of flux can tightly constrain the physical extent of the emitting region through causality arguments ($r \leq c \times t_{var}$, where r is the size of emission zone, t_{var} is the variability timescale and c is the speed of light), provided the variations are intrinsic. For a blazar source with $\sim 10^8$ Solar mass black hole, flux variations on intra-night timescales corresponds to spatial regions $\sim 10^{14}$ cm, i.e., very close to the jet base. Additionally, the changes in the spectral index during intra-night timescales provide additional constraints for particle acceleration and dissipation processes occurring very close to the jet base. Therefore, the study of flux and spectral evolution during intra-night timescales is crucial for understanding the underlying physical conditions of the jet plasma at the jet launching site.

OBJECTIVES:

The major goals of this study are to detect and time-resolve the structure of the flux and spectral variability of optically bright blazars in the optical band. The results will be interpreted within the framework of current blazar emission models.

METHODOLOGY:

The present study aims to obtain strict constraints on the underlying physical conditions of the jet plasma by studying the total flux and spectral variability in four optical filters, B, V, R, I for the duration lasting for 6 hours, for the uniquely selected sample of optically bright blazar sources in the northern sky. During the project, the candidate will gain expertise in:
(1) optical photometric observations using the 50 cm–Cassegrain telescope; (2) data analysis using IRAF; (3) generation of differential light curves: the selection of optimal aperture for the variability analysis; (4) use of statistical methods to infer microvariability; (5) investigation of color/spectral changes when statistically significant intra-night variability is observed.

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