Optical and radio variability of the northern VHE gamma-ray emitting BL Lac objects

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Motivation

• The most numerous extragalactic VHE gamma-ray sources are high synchrotron peaking BL Lac objects, which are rather little studied in the radio bands (and even optical bands)

• It is rather common that we only look at the “snapshots” for this sources (no long term studies)

• One-zone SSC is extremely widely used to model the blazar spectral energy distributions and typically the radio data is ignored (with a statement that it originates from another region)
The data

- 32 TeV-detected Northern BL Lac objects


- Optical R-band monitoring from Tuorla blazar monitoring ([http://users.utu.fi/kani/1m](http://users.utu.fi/kani/1m))
Optical vs. radio variability

- Radio and optical fluxes correlated
- Optical has larger variability amplitudes than the radio
  - Modulation index = $\sigma / \text{mean}$
Common origin of variations

17 / 27 objects show significant peaks in correlation analysis
  - Median lag 70 days, optical leading radio
  - Radio variations in the “core”!

13 / 31 sources show common rising or declining trends
Common slow variability?

> 50% flux has common origin

> 25% flux has common origin
Nature of the slow variability

• Red noise with the highest frequency variations missing from the radio data? NO

• Radio core that we see with VLBA? YES

Blue: Core flux from MOJAVE (VLBA 15GHz)
SED modeling considerations

In about half of the sample sources at least some of the optical and radio emission (median >27 %) originates in the same emission region

- Single-zone models are not adequate for these objects
- Radio cannot always be ignored in SED modeling

Summary

About half of the Northern TeV-detected BL Lacs show a connection between optical and radio emission

- At least 27% of the emission in a common emission region
- Single-zone SED models not adequate
- Radio cannot be ignored

Looking at the other lower energy properties of the sample of VHE gamma-ray emitting population

- Work in progress
- Poster 19: V. Fallah Ramazani et al.