Active galactic nuclei and blazars

Active galactic nuclei (AGN) standard paradigm:
- supermassive black hole at the center;
- accretion disk and dust torus;
- relativistic jet.

Blazars are active galactic nuclei (AGN) with a boosted emission due to the alignment of the jet with the line of sight. They are strong gamma-ray sources which happen to be variable from radio to TeV.

Blazars can be separated into 2 sub-classes:
- Flat Spectrum Radio Quasars (FRSQ): more luminous but emitting at higher frequencies which happen to be variable from radio to TeV.

Blazars are active galactic nuclei (AGN) with a peaked BL Lac (HBL) type source, one of the brightest blazars in the γ-ray sky. Its variability can be seen over the whole energy range, from radio to TeV.

Characterizing time variability of the photon flux allows to:
- distinguish between different acceleration and emission models (such as leptonic versus hadronic);
- study extreme physical processes occurring in blazars;
- study connections between the jet, the black hole and the disk.

The present work aims to characterize the long term variability of the quiescent state of PKS 2155-304 using multi-wavelength (MWL) data. Therefore, all Target of Opportunities observations of PKS 2155-304 are used within a dedicated period of 7 years (2006–2013).

Variability energy distribution (VED): \( F_{\text{var}}(E) \)

\( F_{\text{var}} \) (Vaughan et al. 2003) is used to quantify the variability of the quiescent state of PKS 2155-304, it can be read as a normalized standard deviation of the light curve with correction from the error measurements.

- The variability increases in the X-ray and H.E.S.S. ranges and looks slightly constant for SMARTS and Fermi-LAT.
- In an SSC model of HBL, the optical-X-ray part of the VED (spectral energy distribution) is Synchrotron emission while the γ-ray part is Inverse Compton (IC). Here the same variability behavior seems to happen both in Synchrotron and IC domains.

Conclusions/Discussion

- Lognormal behavior was first found in X-ray binaries, linking lognormality to accretion disc (Juttley & McHardy 2001). It was already found for:
  - the flaring state of PKS 2155-304 of 2006 in TeV (H.E.S.S. Collaboration 2010)
  - BL Lacertae in X-ray (Giebel & Degrange 2009)
  - Markarian 501 in TeV (Chakraborty et al. 2015)
  - the Seyfert 1 galaxy IRAS 13 244-3809 in X-ray (Gaskell 2004)

Lognormality seems to be an intrinsic characteristic of PKS 2155-304 as it can be seen at least in TeV, in X-ray and for the first time in optical.

The variability appears not to be the same in each probed energy ranges. The shape of the VED is important to help distinguishing between different blazars' emission models.

Next steps: correlation between the MWL light curves and modeling of the VED using a dynamic Synchrotron Self Compton (SSC) model.