PATTERNS OF VARIABILITY IN GAMMA-RAY BLAZARS

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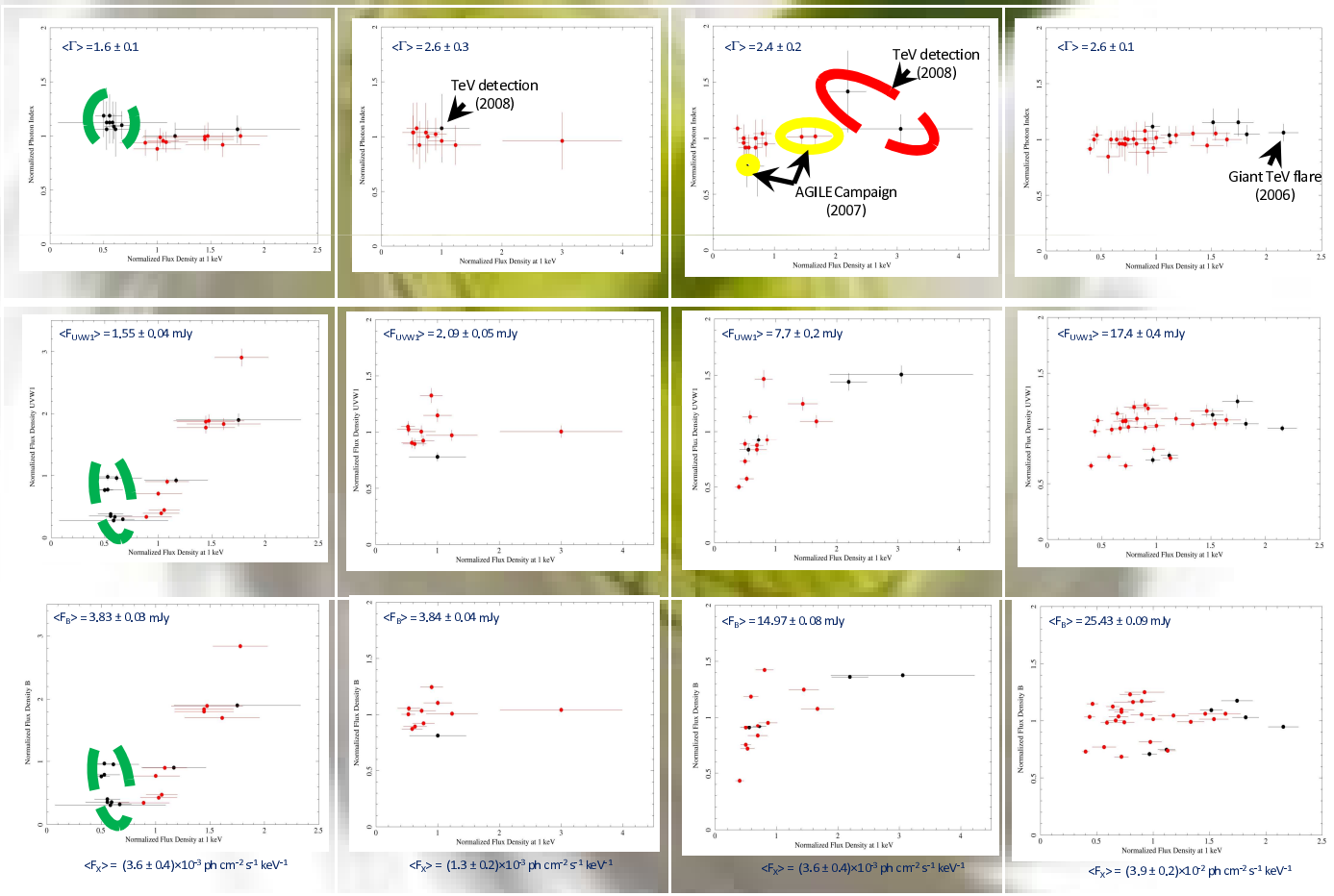
INTRODUCTION: Active galactic nuclei with relativistic jets pointed to or within a few degrees the observers' direction are generally named ***blazars***. However, this name collects a variety of phenomena, most of them are still to be understood. The **spectral energy distribution** (SED - ν vs νF_ν) of these sources always displays a shape, which is the result of two types of emission: the first one, extending from radio to soft X-rays, is thought to be due to the **synchrotron emission** from relativistic electrons; while the second one, peaking at energies in the X-/γ-ray band, is generally attributed to **inverse-Compton (IC) emission**, resulting from the transfer of energy from the same population of relativistic electrons impinging on low-energy seed photons. The latter population of photons can be the same synchrotron radiation (Synchrotron Self-Compton, SSC) or a source external to the jet, like the accretion disk or the broad-line region (External Compton, EC). Fossati et al. (1998) and Ghisellini et al. (1998) found that blazars follow a trend – the ***blazar sequence*** – where sources with low bolometric luminosity have both peaks at high frequencies (soft X-rays for synchrotron and TeV for IC), while, as the luminosity increases, both peaks shift to lower frequencies. Blazars are known to be the most variable sources, displaying variability at all the wavelengths. Here I present preliminary results of a study of the simultaneous optical/UV/X-rays variability of a sample of γ-ray blazars (detected both at MeV/GeV and TeV energies) to search for some common patterns of variability.

BLAZAR SEQUENCE

High Power, Low Frequency Synchrotron Peak → **Low Power, High Frequency Synchrotron Peak**

FSRQ: 3C 279 (z=0.5362) | **LBL: ON+231 (z=0.102)** | **LBL: S5 0716+71 (z=0.31)** | **HBL: PKS 2155-304 (z=0.116)**



$\langle F_X \rangle = (3.6 \pm 0.4) \times 10^{-3}$ ph cm^{-2} s^{-1} keV^{-1} | $\langle F_X \rangle = (1.3 \pm 0.2) \times 10^{-3}$ ph cm^{-2} s^{-1} keV^{-1} | $\langle F_X \rangle = (3.6 \pm 0.4) \times 10^{-3}$ ph cm^{-2} s^{-1} keV^{-1} | $\langle F_X \rangle = (3.9 \pm 0.2) \times 10^{-2}$ ph cm^{-2} s^{-1} keV^{-1}

THE POWER OF *SWIFT* SATELLITE:

- The advent of the *Swift* satellite, with UVOT (optical/UV), XRT (X-rays), and – sometimes – BAT (hard X-rays), gave us the possibility to perform simultaneous optical/UV/X-ray studies of cosmic sources.
- The good performances of the instruments are coupled with a proper policy, which emphasize the value of *Swift*. The possibility to perform snapshots on many sources, together with all the data made available to the public immediately, made it possible to have a huge and exceptional archive.

SAMPLE SELECTION AND ANALYSIS:

- Blazars are generally studied with multiwavelength (MW) campaigns, which are triggered by events of outburst and therefore the quiescence state is often neglected. However, to understand blazars, it is necessary to know how the source behaves during all its lifetime. Therefore, I focus on bright blazars, which can be almost always observed by *Swift*, both during quiescence and outburst.
- It is also necessary to select blazars observed many times (to have a sufficient number of points) and with the same instruments settings (to have the same type of MW information). For the moment, I found sufficient data for the 4 blazars here shown.
- To emphasize the source variability and minimize the systematic or contaminating effects, the selected parameters (**Γ**, **X-ray**, **UV**, and **Optical flux densities**) have been normalized to their average value (indicated between <>).
- **Red points** refer to X-ray spectra fitted with a single power-law model; **Black points** are instead for observation fitted with broken power-law model.

NOTES ON INDIVIDUAL SOURCES:

3C 279: the observations were performed during two MW campaigns, one in mid-January 2006 (Böttcher et al. 2007) triggered by high optical state (R = 14.5), while the second one was performed in January 2007, when optical observations measured R ≈ 13. The black points indicate the presence of low-energy spectral flattening in the X-ray spectrum. The spectral flattening is mostly confined in a "branch" separated by the remaining (green dashed line). A similar effect, i.e. changes in the spectral flattening, has been already noted by Bianchin et al. (2008) in the case of the blazar PKS 2149-306.

ON +231: The black point indicates an observation performed on March 14, 2008, just one day after the detection of a VHE flare by VERITAS (Swordy et al. Atel 1422). The X-ray spectrum shows a flattening at low energies.

S5 0716+71: Black points indicates fit with a broken power-law model. The points inside the red dashed line were measured a few days after the VHE detection by MAGIC (Teshima et al. Atel 1500; see also Giommi et al. Atel 1495), while the points inside the yellow continuous lines were from observations during the AGILE pointings (Giommi et al. arXiv:0806.1855).

PKS 2155-304: also in this case, the black points refer to a fit with a broken power-law model. The points at highest fluxes were from the follow-up of the giant TeV flares observed by HESS in July-August 2006 (Foschini et al. 2007).

More details in Foschini (2008, submitted)

Stay tuned: work in progress!