THE OPTICAL-GAMMA CORRELATION IN BL LACERTAE

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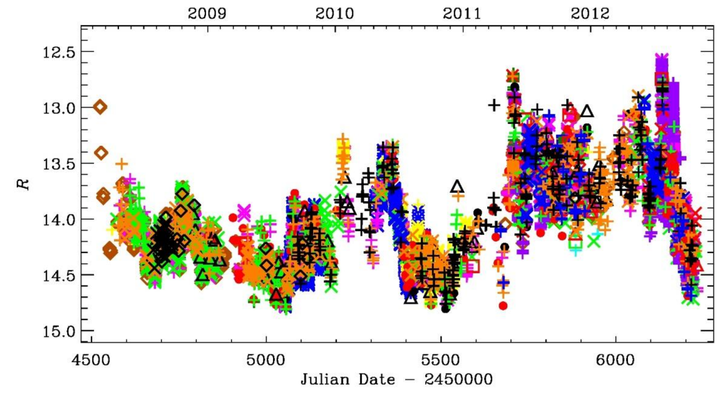
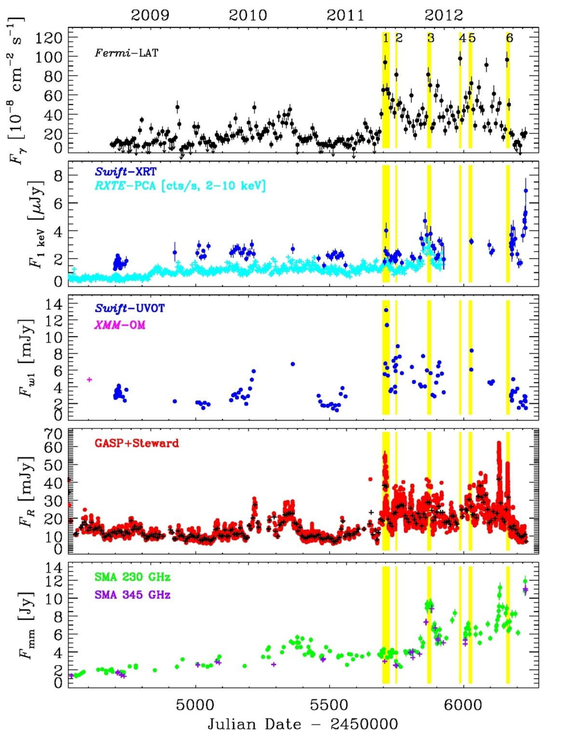
for the GASP-WEBT collaboration

The GLAST-AGILE Support Program (GASP) of the Whole Earth Blazar Telescope (WEBT; http://www.oato.inaf.it/blazars/webt/) collaboration was started in 2007. The aim was to perform continuous monitoring of selected blazars at low frequencies to compare with the high-energy observations of γ-ray satellites. BL Lacertae is one of the sources followed by the GASP and Fermi has provided a continuous γ-ray light curve since 2008.

Starting from the launch of Fermi, BL Lacertae has been moderately active at γ rays as well as at optical frequencies until May 2011, when it started a series of strong flares in both bands lasting about 18 months. This flaring activity provided a good opportunity to study the optical-γ correlation.

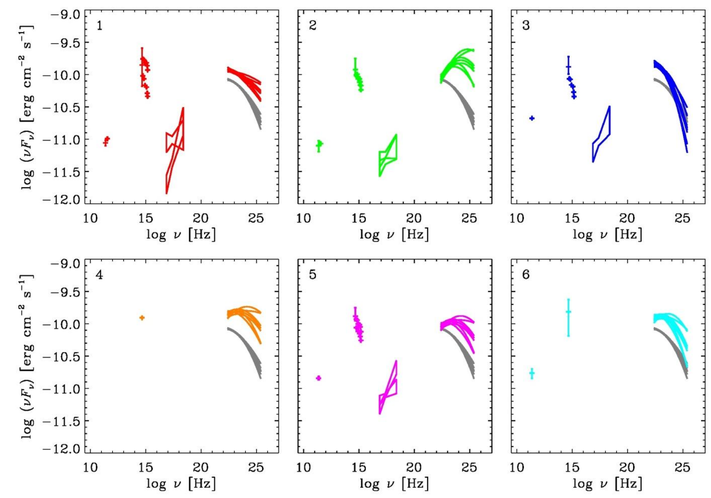
The R-band light curve on the right was obtained by carefully assembling data from the following observatories: Abastumani, AstroCamp, Belogradchik, Calar Alto, Crimean, Galaxy View, Kitt Peak (MDM), Lowell (Perkins), Lulin, Mt. Maidanak, New Mexico Skies, ROVOR, Roque (KVA and LT), Rozhen, Sabadell, San Pedro Martir, Skinakas, St. Petersburg, Steward, Talmassons, Teide (IAC80), and Tijarafe.
It includes 10103 data points.

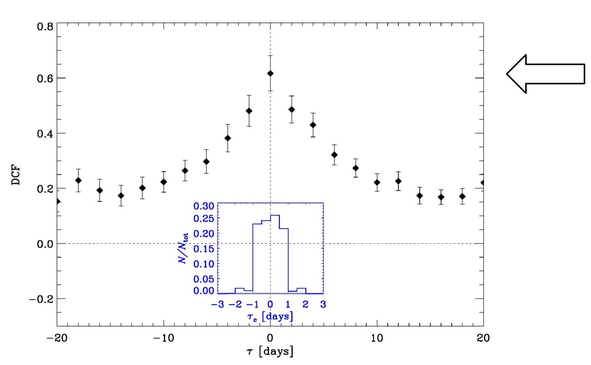




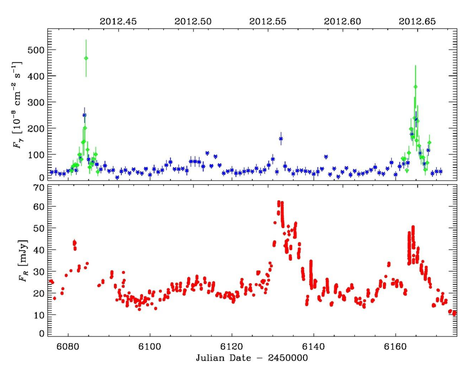
The figure on the left shows the multifrequency behaviour of the BL Lacertae flux. From top to bottom we see :
-The weekly-binned γ-ray flux in the 0.1-100 GeV energy range;
-The X-ray light curve from Swift-XRT (flux density at 1 keV) and PCA (cts/s in the 2-10 keV range, properly rescaled).
- The UV flux density in the Swift-UVOT w1 band, after correction for the Galactic extinction and subtraction of the host galaxy contribution.
-The R-band flux density, after correction for the Galactic extinction and subtraction of the host galaxy contribution.
-The millimetre flux light curve built with data acquired with the SubMillimeter Array (SMA)

We selected six periods (yellow stripes) where there was enough statistics to perform a spectral analysis of the γ-ray flux. The figure on the right shows the spectral energy distribution of BL Lacertae in these periods built with simultaneous data. The grey γ-ray spectrum is the result of considering the whole outburst, from 2011 May 1 to 2012 August 31.
The γ-ray spectrum displays noticeable variability, suggesting that the peak of the inverse-Compton emission component moves from the MeV to the GeV range. Notice in Period 1 the optical specral steepening in low flux state corresponding to an X-ray spectral hardening.

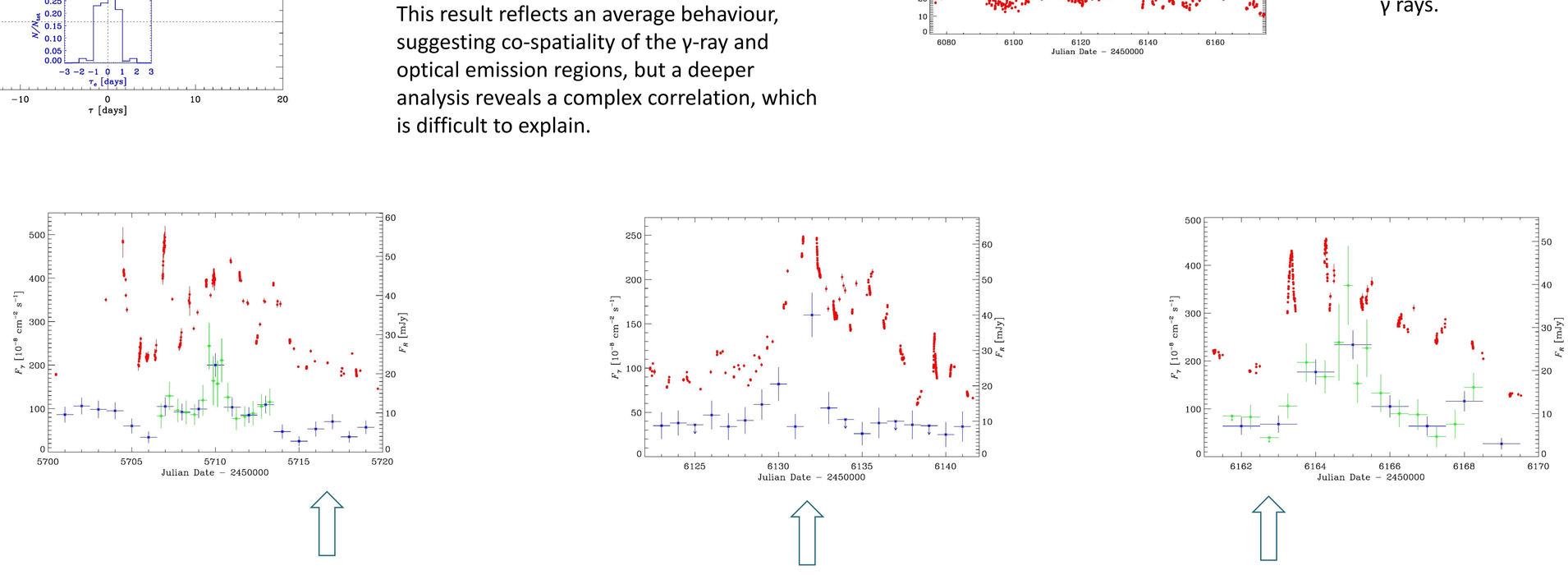




A cross-correlation analysis of the γ-ray and optical light curves by means of the Discrete Correlation Function (DCF) reveals a fair correlation between the γ and optical flux variations, with no time lag. Monte Carlo simulations allow us to define an unceratainty of ±1 day on the time lag.
This result reflects an average behaviour, suggesting co-spatiality of the γ-ray and optical emission regions, but a deeper analysis reveals a complex correlation, which is difficult to explain.



A zoom on the γ-ray (top) and optical (bottom) light curves at the culmination of the 2012 outburst. Sub-daily binned γ-ray fluxes (green diamonds) are superposed to the daily-binned ones (blue crosses)
The most prominent optical flare has just a modest counterpart at γ rays.



In general, optical flares present more spikes and develop on longer time scales than the γ-ray ones.
A better definition of the γ-optical correlation is prevented by the extremely fast variability of the source that makes even small gaps in the sampling damaging.

More on this soon in Raiteri et al. (in preparation)