



1ES1218+304  
update

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# Investigating the HBL 1ES 1218+304 since recent reports of flaring activity

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# A brief introduction of 1ES 1218+304

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1ES 1218+304 is a high-frequency-peaked BL Lac object which was discovered by MAGIC in 2005–2006. Since its discovery VERITAS has reported detection of VHE  $\gamma$ -rays [Acciari et al(2009)]. Although no evidence of variability was found during the initial observations made by VERITAS, later reports by Imran(2009), Acciari et al.(2010) establish the variability of 1ES 1218+304 in VHE regime.

During some of the most recent observations made by VERITAS [January(3–5) 2019] the source was found to exhibit high activity. Based on these observations we undertook a thorough investigation of 1ES 1218+304 as observed by *Fermi*–LAT for a duration extending from 2016 to 2019.



# Specifications of 1ES 1218+304

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- Redshift = 0.182
- Right Ascension = 185.341, Declination = 30.177
- Energy range being presently investigated (100 – 300000) MeV.
- Time range being investigated 2016-01-01 – 2019-04-15.

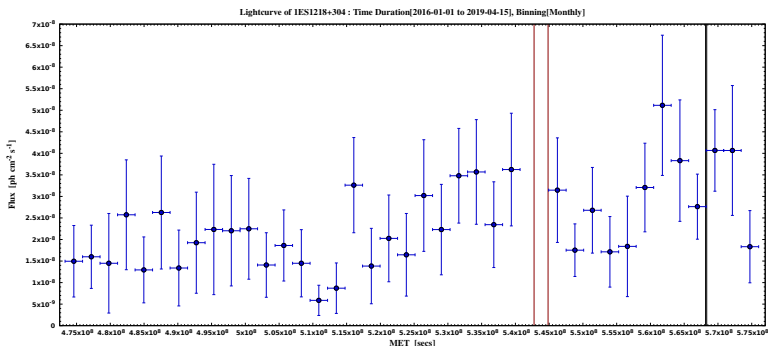


# Light Curve of 1ES 1218+304(monthly binning) [2016-01-01–2019-04-15]

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The Fermi detector suffered from a solar panel issue from 2018-03-16 to 2018-04-08. As a result there is no data during that period. The period enclosed within the red lines in the figure shows this period. Whereas the thin black strip is the period from 2019-01-03 to 2019-01-05 during when VERITAS detected the recent flare.



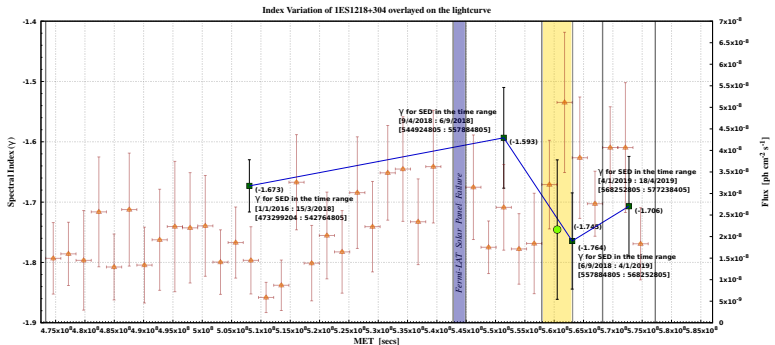


# Light Curve analysis contd.

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As we can see there is a hint of 1ES 1218+304 reaching higher flux compared to its general state as seen by *Fermi*-LAT. It is also worth noticing that this escalation in the flux readings does not exactly coincide with the VERITAS report but is instead a precursor. Noticing the general trend of the lightcurve we selected 4 different zones and investigated the spectral indices for them separately.





## Light Curve analysis contd.

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The grey vertical lines demarcate the time periods for which the spectral indices pertaining to the SEDs for the same period were evaluated.

The spectral index depicted by the fluorescent green point is for the timepatch in pale yellow. The SEDs for the 4 separate zones are given below in clockwise orientation following the natural passage of time.

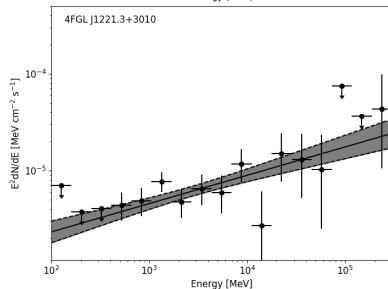
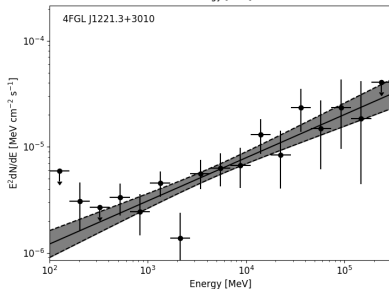
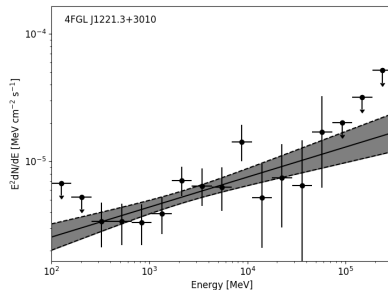
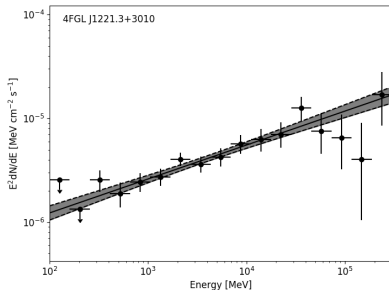
The SEDs are arranged as follows SED-1 – [473299204 – 542764805], SED-2 – [544924805 – 557884805], SED-3 – [557884805 – 568252805], SED-4 – [568252805 – 577238405].



# Light Curve analysis contd.

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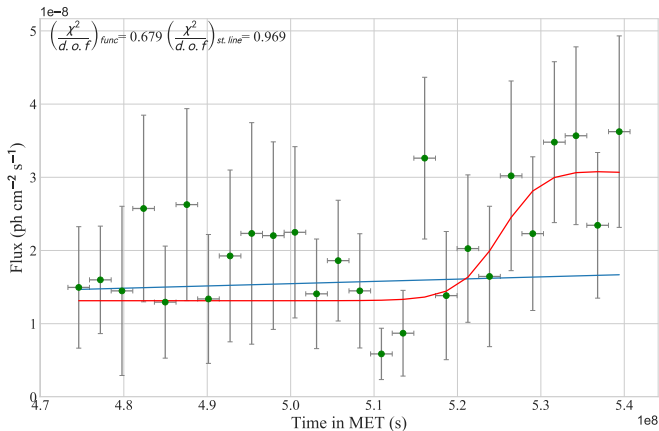


# Light Curve analysis contd.

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Fitting the lightcurve(from 2016-01-01 to March 2018 when the failure in Fermi's solar panel occurred) with the sum of exponentials.





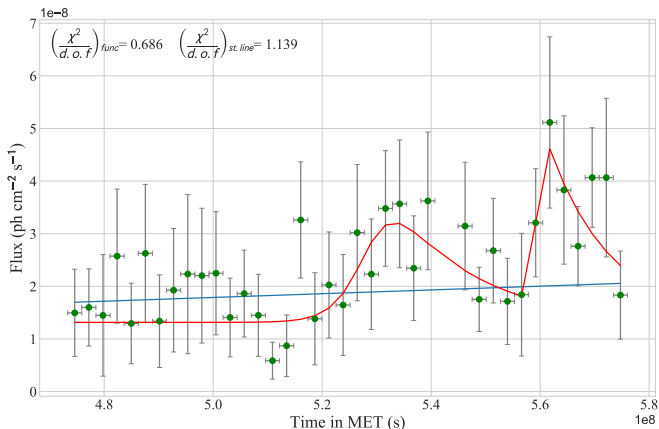


# Light Curve analysis contd.

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Fitting the lightcurve (from 2016-01-01 to April 2019 when the failure in Fermi's solar panel occurred) with the sum of exponentials.





## Light Curve analysis contd.

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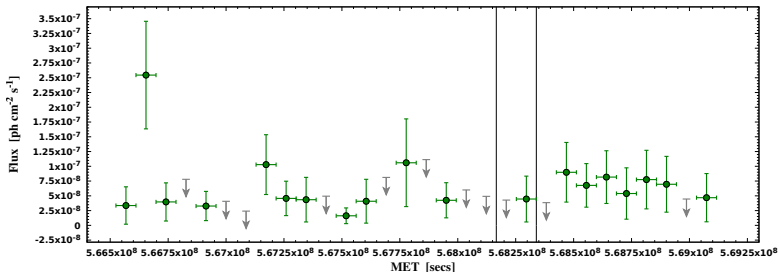
It may be noted that the value of  $\frac{\chi^2}{d.o.f} \simeq 1$  while fitting with both st.line and with the sum of exponential functional form. However it is evident that the functional form accounts for datapoints much better than the st.line. As the reported

VHE flares were around the time period of 2019-01-03 – 2019-01-05 some lightcurves were constructed to investigate the state of 1ES 1218+304 focussing on the vicinity of the same time period data collected by *Fermi*-LAT. The figures are provided in the next slides.

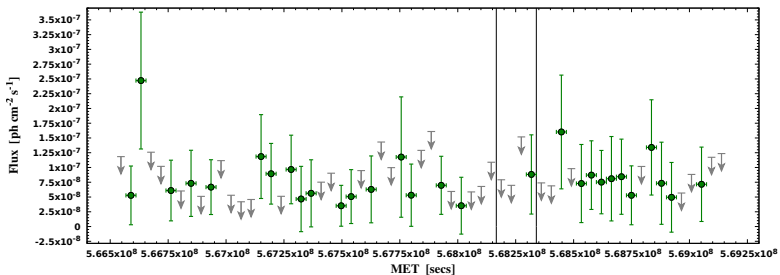


# Light Curve analysis contd.

Lightcurve of 1ES1218+304 : Time Duration[2018-12-15 to 2019-01-15], Binning[Daily]



Lightcurve of 1ES1218+304 : Time Duration[2018-12-15 to 2019-01-15], Binning[12hr]



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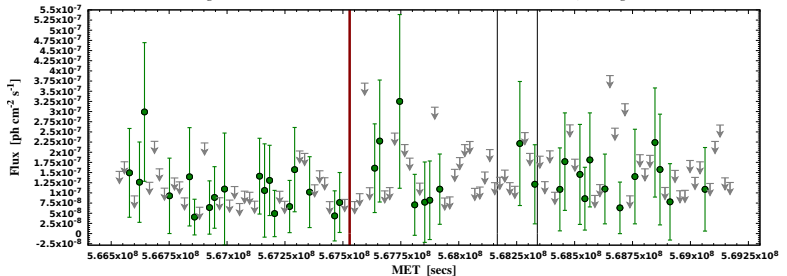


# Light Curve analysis contd.

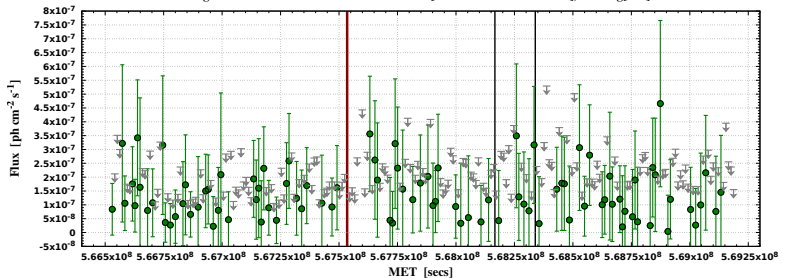
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Lightcurve of 1ES1218+304 : Time Duration[2018-12-15 to 2019-01-15], Binning[6hr]



Lightcurve of 1ES1218+304 : Time Duration[2018-12-15 to 2019-01-15], Binning[3hr]

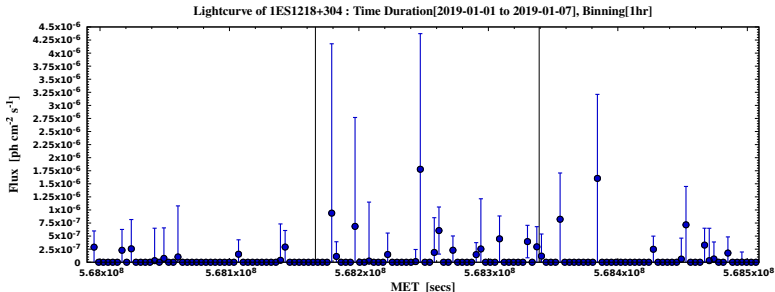




# Light Curve analysis contd.

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In all the five figures above the space between the black vertical lines is indicative of the time period when VERITAS reported the flaring activity from 3 Jan 2019 to 5 Jan 2019. For the last figure with 1 hr binning the number of upper limits(TS = 4) is huge. Hence they have not been presented in the plot. Basically all the points lying on the X-axis will be replaced with the upper limits.



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# The End