Monitoring the synchrotron and Compton emission of PKS 2155-304: one year of observations with RXTE and *Fermi*

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Gamma-ray Space Telescope

PKS 2155-304 is a well known GeV and TeV source and one of the brightest blazars in the *Fermi* sky. We present the result of one year of data taking with *Fermi* producing the longest light curve on this object. Together with a long time X-ray monitoring program with RXTE, these data give a better picture of the emission mechanisms on long time scales of PKS 2155-304.

1 Introduction

In TeV blazar emission models, the X-rays are produced by synchrotron radiation of the most energetic electrons whereas the γ-rays come from inverse-Compton (IC) scattering. Correlations between X-ray and TeV photons has already been reported for many objects and, in particular, for PKS 2155-304 [3]. Such correlations agree with the common idea that both are emitted by the most energetic electrons. Nevertheless, the relationship between GeV photons (emitted by lower energy electrons) and X-rays is not well known but allow to probe acceleration and cooling mechanisms. Since February 2009, PKS 2155-304 has been the target of an unprecedented joint RXTE-*Fermi* monitoring campaign to characterize its emission on time scales of a week or more.

2 Light curves and correlation

Fermi data (200 MeV - 300 GeV) have been analyzed with the latest version of `Science Tools` (version V9R15P4, [4]). The lightcurve from MJD 54688 to MJD 54087 comprises 58 bins each of 7 days (Fig. 1). The source is clearly variable ($\mathrm{F_{var}} = 0.24 \pm 0.03$), with variations of a factor of 4 in one month.

In the same time, RXTE (2-10 keV) observed PKS 2155-304 for 4ks, approximately every 3 days since MJD 54894. The lightcurve was produced with the same time bins as the *Fermi* one in order to allow correlation studies.

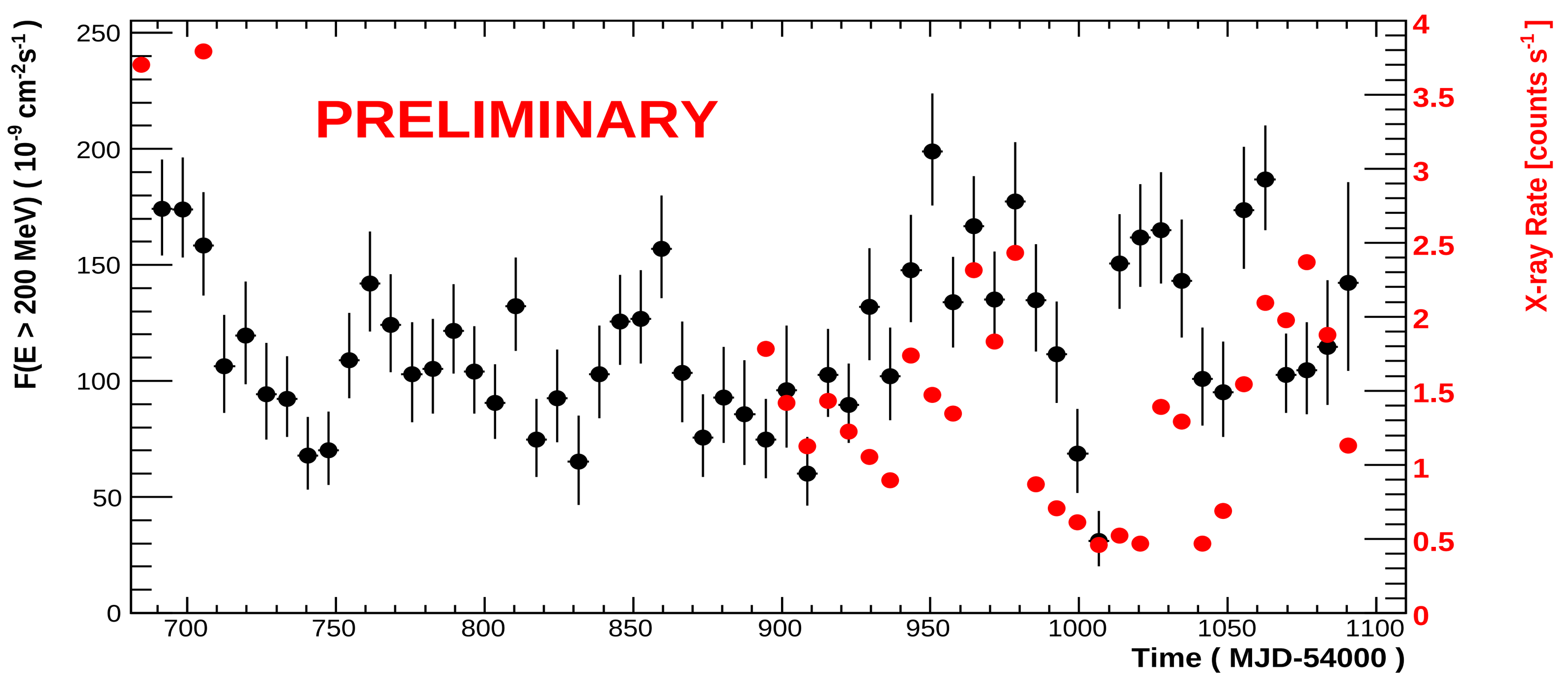

Figure 1 : 7 days bin lightcurves of PKS 2155-304. In black, the *Fermi* data and in red the RXTE flux.

The lightcurves appears to be correlated (Figure 1). Indeed, the Pearson correlation factor is $r = 0.39 \pm 0.08$.

In order to better understand this correlation, time bins corresponding to different X-ray fluxes have been defined. The *Fermi* data corresponding to each of those bins, were then analyzed. Figure 2 shows the results for 4, 7 and 11 bins. At low flux, both emissions are correlated but this seems not to be true at higher X-ray fluxes ($> 2\ \mathrm{counts\ s^{-1}}$).

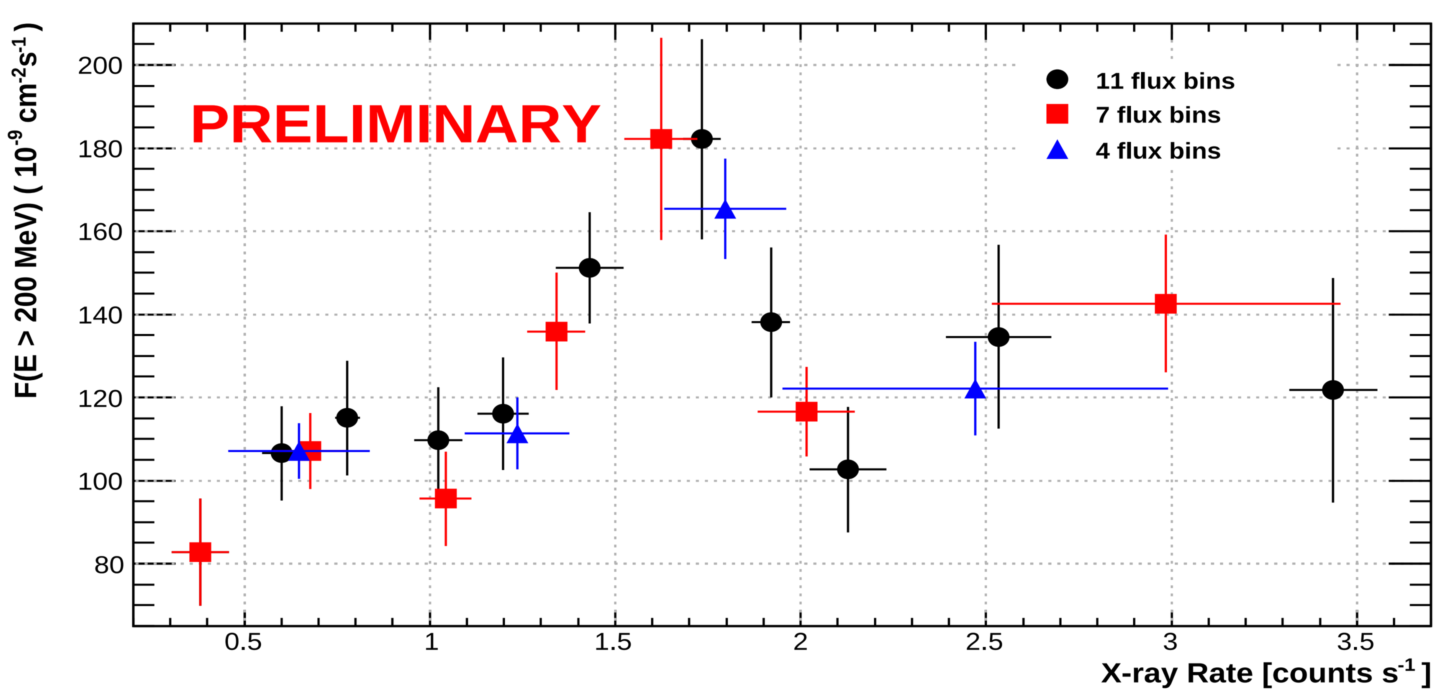

Figure 2 : *Fermi* flux as a function of the X-ray flux.

3 Spectral analysis

The time-averaged *Fermi* spectrum is compatible, with a probability of 98%, with a logparabola[1] with $\alpha = 1.79 \pm 0.05$ and $\beta = 0.024 \pm 0.011$ for a total flux $F(\mathrm{E} > 200\mathrm{MeV}) = 11.1 \pm 0.4 \cdot 10^{-8} \mathrm{ph\,cm^{-2}\,s^{-1}}$, consistent with [2]. The peak of the emission, in $\nu F \nu$ representation, is around 20 GeV.

The X-ray spectrum is well described by a simple power law between 2 and 10 keV. The flux is $2.6\,\mathrm{erg\,cm^{-2}\,s^{-1}}$, 2 times lower than in August 2008 [2] with a spectral index of $\Gamma_X = 2.92 \pm 0.01$.

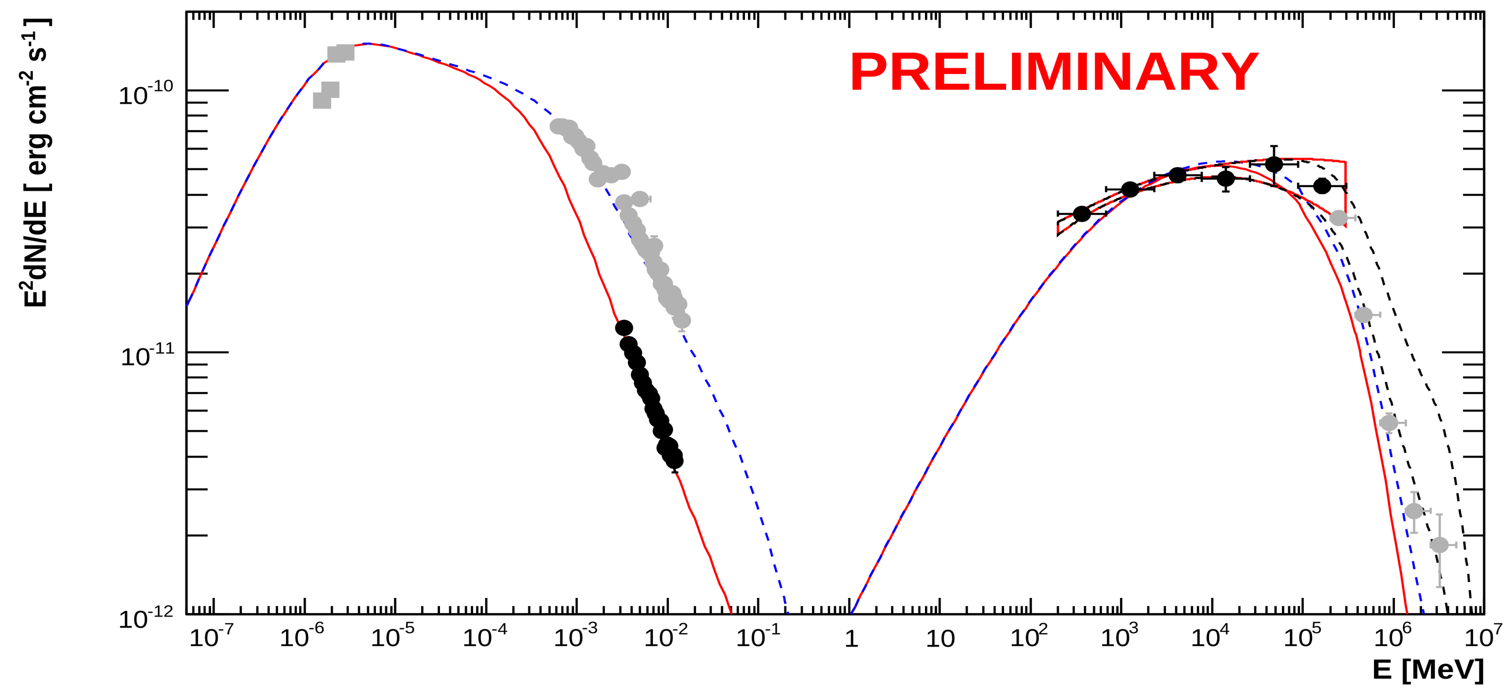

Figure 3 : Time-averaged SED. RXTE and *Fermi* data points are in black, Grey points are archival data from the MWL campaign in August 2008. In blue, the SSC model form [2] and in red the same model adjusted for the present data.

Figure 3 shows the spectral energy distribution (SED) of PKS 2155-304. The *Fermi* 68% error contour, extrapolated to 10 TeV and corrected for EBL absorption with the model of Franceschini et al [5] is in good agreement with the H.E.S.S data (low state [2]). The SED has been fitted with same SSC model, only γ_2 has been divided by 1.5 and $p_2 = 4.9$ in order to fit the X-ray data.

4 Conclusion

We show preliminary results from the ongoing RXTE-*Fermi* observation campaign on PKS 2155-304. The X-ray and γ-ray lightcurves are, as in August 2008, correlated even though the X-ray flux is significantly lower. Nevertheless, the strength of this correlation seems to vary with the X-ray flux not allowing to have a clear picture of what actually happens. Furthermore, the spectral analysis shows the IC peak to be around a few tens of GeV. These results are compatible with the H.E.S.S data taken at the beginning of the *Fermi* mission. With these data we have, for the first time, constrained the shape of the IC peak of PKS 2155-304.

The 2008 MWL campaign, surprising correlations

PKS 2155-304 was the target of the first *Fermi*-H.E.S.S multiwavelength campaign [2]. A large part of the electromagnetic spectrum has been covered : From optical (BVRI, ATOM), through the X-ray (0.5-10 keV, *Swift*-RXTE) up to γ-rays (*Fermi*-H.E.S.S).

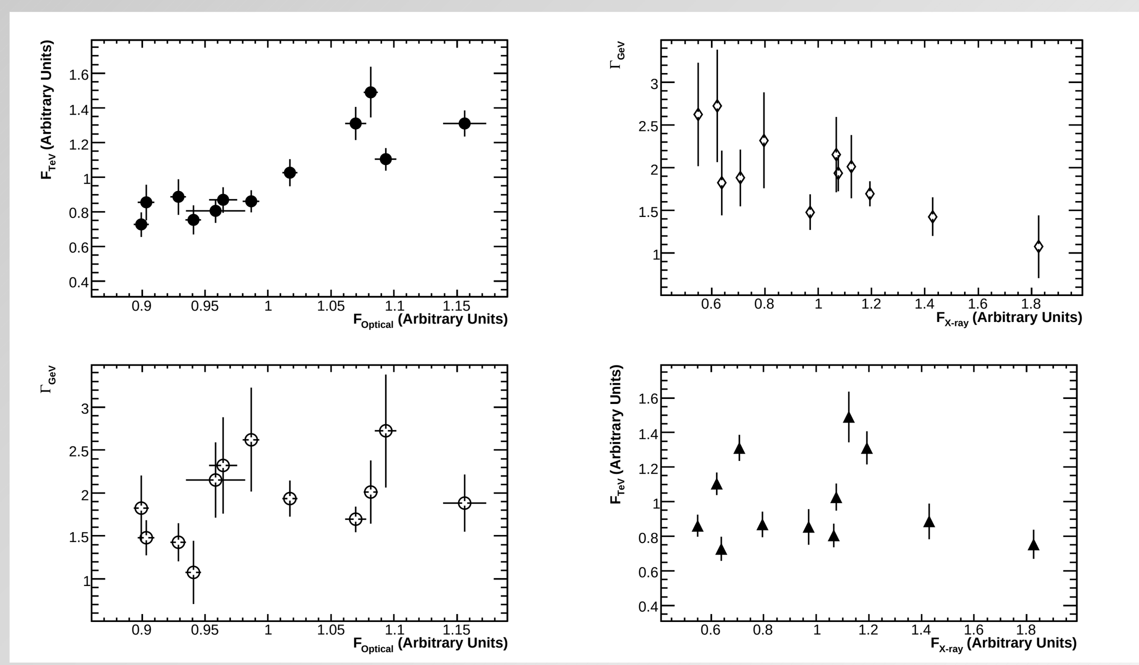

Figure 4 : Correlation patterns form the 2008 MWL campaign.

The sensibility of the different instruments allowed us to make lightcurves with 1-day bins. Figure 4 summarizes the correlations found between all of the energy bands. Correlated variability, never observed, between the optical and TeV emission and between the X-ray and GeV emission have been observed.

References

[1] Abdo, A. A., et al. 2009, ApJ, 700, 597

[2] Aharonian, Abdo, et al. (H.E.S.S. and *Fermi* Collaborations) 2009, ApJL, 696, L150

[3] Aharonian, et al., 2009, ApJ, submitted, ArXiv : 0906.2002

[4] Atwood, W. B., et al., 2009, ApJ, 697, 1071

[5] Franceschini, A, et al., 2008, A&A, 487, 837

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[1] The logparabola function is defined by $F(E) = N_0 E_*^{-(\alpha+\beta\, log_{10} E_*)}$ où $E_* = E/300\mathrm{MeV}$