Evidence for γ-Ray Flares in 3C 279 and PKS 1622-297 at $\sim$10 MeV

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Abstract. The EGRET experiment aboard the Compton Gamma-Ray Observatory (CGRO) has observed at energies above 100 MeV strong gamma-ray flares with short-term time variability from the gamma-ray blazars 3C 279 [1] and PKS 1622-297 [2]. During these flaring periods both blazars have been detected by the COMPTEL experiment aboard CGRO at photon energies of $\sim$10 MeV, revealing simultaneous γ-ray activity down to these energies. For both cases the derived fluxes exceed those measured in previous observations, and 3C 279 shows an indication for time variability within the observational period. Both sources show evidence for 'hard' MeV spectra. In general the behaviour of both sources at γ-ray energies is found to be quite similar supporting the conclusion that the underlying physical mechanism for both γ-ray flares might be the same.

INTRODUCTION

The EGRET experiment aboard CGRO has detected more than 60 blazar-type AGN [3] thereby greatly widening the field of extragalactic γ-ray astronomy. Most of them are observed to be time variable and several sources showed remarkable flares. During the last two years the two most intense flares along the whole EGRET mission have been observed from the sources 3C 279 [1] and PKS 1622-297 [2], which occured on top of an already high γ-ray flux level.

The COMPTEL experiment [4], measuring 0.75-30 MeV γ-rays, has detected 8 of these $\sim$60 EGRET blazars [5]. Among them are 3C 279 and PKS 1622-297. In this paper we report first results on these sources for the time periods for which these flares have been observed by EGRET at energies above 100 MeV.

OBSERVATIONS AND DATA ANALYSIS

The γ-ray flare events have been observed during a three week observation of the Virgo sky region from January 16 to February 6, 1996 for 3C 279 in CGRO Cycle 5 during the viewing periods (VPs) 511.0 and 511.5, and for PKS 1622-297 during a four week observation towards the Galactic Center region from June 6 to July 10, 1995 in CGRO Cycle 4 covering the VPs 421-423.5.

We have applied the standard COMPTEL maximum-likelihood analysis method (e.g. [6]) to derive detection significances, fluxes, and flux errors of γ-ray sources in the four standard COMPTEL energy bands (0.75-1 MeV, 1-3 MeV, 3-10 MeV, 10-30 MeV), and a background modelling technique which eliminates in a first approximation source signatures but preserves the general background structure [7]. For the 10-30 MeV range the improved COMPTEL data cuts [8], increasing its' sensitivity, have been applied. To derive source fluxes, several sources located in the surrounding sky region (e.g. 3C 279 and 3C 273 in Virgo) have been simultaneously fitted in an iterative procedure, leading to a simultaneous determination of the fluxes of several potential sources and a background model which takes into account the presence of sources. For the analysis of PKS 1622-297 a diffuse emission model has been included in the fitting procedure as well.

RESULTS

3C 279

The blazar 3C 279 is detected by COMPTEL with a significance of $\sim 4\sigma$ during this observational period of three weeks on Virgo in CGRO Cycle 5 (Fig. 1). The observed flux level in the 10-30 MeV band is the highest ever detected. This is the first redetection of 3C 279 by COMPTEL for energies above (>3 MeV) since 1991, when the blazar showed another γ-ray flare observed simultaneously by EGRET and COMPTEL ([9,10]). Subdividing the three week period into the individual VPs 511.0 (two weeks) and 511.5 (one week) reveals evidence for a flux jump by roughly a factor of 4 (Fig. 2) within 10 days. The flux value of 3C 279 measured in VP 511.5 is the largest ever observed by COMPTEL. The significance that the two fluxes are different is 2.6σ, and represents the shortest time varibility yet observed by COMPTEL from any blazar. This rise in flux is consistent with the EGRET observations at energies above 100 MeV. During VP 511.0 3C 279 was redetected by EGRET at a high flux level and rose up to the largest value ever in VP 511.5 [1].

The spectral analysis shows positive evidence for the source only at energies above 3 MeV. Together with the upper limits derived at the lower energy bands, this indicates a 'hard' (photon spectral index α <2) energy spectrum at MeV energies (Fig. 3).

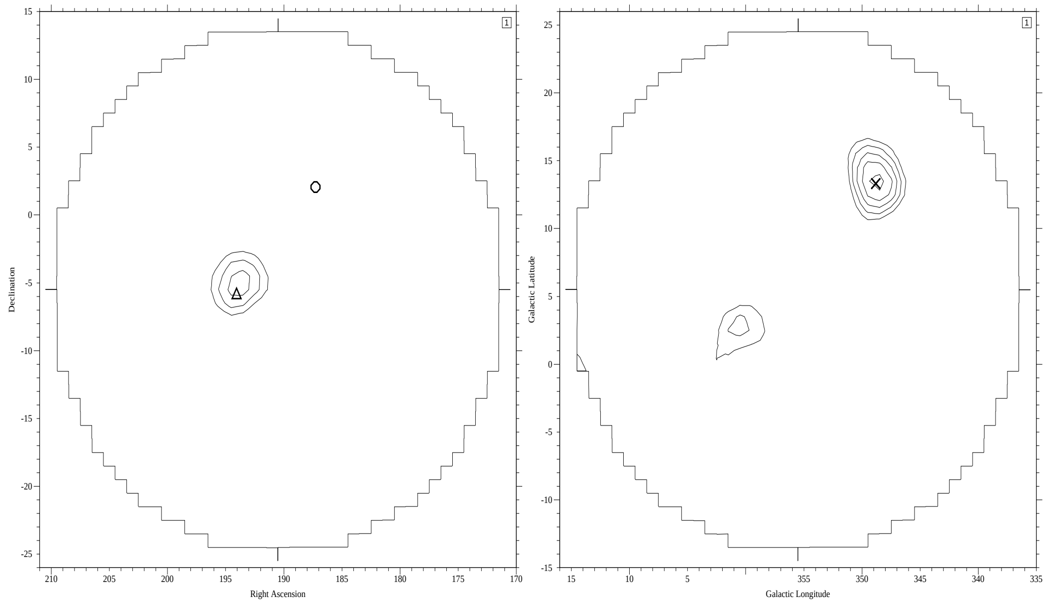

FIGURE 1. COMPTEL 10-30 MeV skymaps (detection significances) of the Virgo region (left) and the galactic center (right) for the relevant time periods. The contour lines start at a detection significance of 3.0σ with a step of 0.5σ assuming χ^2_1-statistics for known sources. The locations of 3C 279 (Δ), 3C 273 (**o**), and PKS 1622-297 (**x**) are indicated.

PKS 1622-297

The blazar PKS 1622-297 is detected with a significance of $\sim 5\sigma$ during the four week pointing towards the Galactic Center in CGRO Cycle 4 (Fig. 1). This is the first detection of this blazar by COMPTEL as was the case for EGRET [2]. The COMPTEL light curve, even though the flux variations are not statistically significant, follows the general trend reported by EGRET at energies above 100 MeV. There is evidence for the source during all four individual VPs showing MeV flaring of PKS 1622-297 for at least one month (Fig. 2). The largest flux value is observed during VP 423.0 consistent with the time period of the major flare observed by EGRET. A flux drop by a factor of ~ 2.5 between the two last VPs, again consistent in trend with EGRET, is a hint for MeV variability as well.

The spectral analysis shows that the source is mainly detected in the highest COMPTEL energy band (10-30 MeV), which, together with the upper limits derived at lower energies, indicates a 'hard' (photon spectral index α <2) spectrum on average (Fig. 3). However, we like to point out that the source is located just above the plane near the galactic center region, which is a difficult region for quantitative analysis, especially for energies below 3 MeV, due to the diffuse MeV emission of the Galaxy. Although a diffuse emission model was included in the analysis procedure, the presented spectral results should be considered as preliminary.

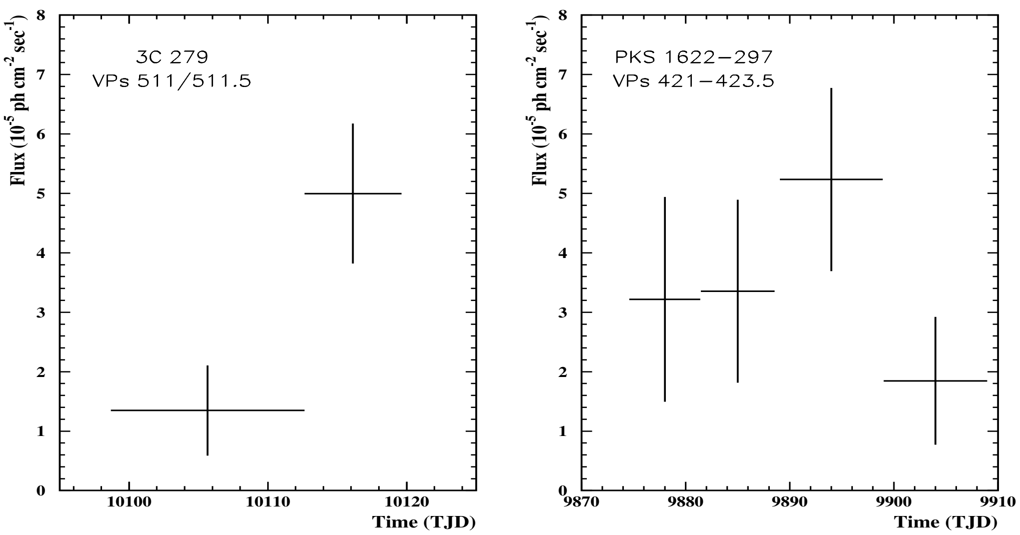

FIGURE 2. Light curves in the 10-30 MeV range of 3C 279 (left) and PKS 1622-297 (right). The fluxes are given for the individual CGRO VPs. The error bars are 1σ. The flux change of 3C 279 by a factor of 3.7 within 10 days is the shortest time variability yet observed from any blazar by COMPTEL. The fluxes measured during these flaring intervals are the largest ever observed from any blazar by COMPTEL in this energy band.

SUMMARY

We have reported first results of COMPTEL observations of two blazars, 3C 279 and PKS 1622-297, for time periods for which EGRET (>100 MeV) observed the two strongest γ-ray flares ever occuring on top of an already high flux level. Although there are differences in detail, the general MeV behaviour of both sources resembles each other surprisingly accurately. Both sources are detected during these periods of high γ-ray activity at high γ-ray energies, which by itself demonstrates simultaneous MeV-flaring activity. Note, that PKS 1622-297 is detected for the first time by COMPTEL. Both sources are only detected at the highest COMPTEL energies. This, together with the upper limits derived at the lower energies, leads to evidence for hard (photon spectral index α <2) MeV spectra. The 10-30 MeV flux follows for both sources the general flux trend as seen by EGRET with evidence for time variability in the case of 3C 279 and a hint in the case of PKS 1622-297. These similarities support the conclusion that the underlying physical mechanism for γ-ray activity is the same for both sources.

Detailed COMPTEL analyses, concentrating on subsets of these observations are in progress to derive informations on possible time-shifts between the high-energy EGRET and the low-energy COMPTEL γ-ray emission. Especially PKS 1622-297 is a promising candidate for such investigations because

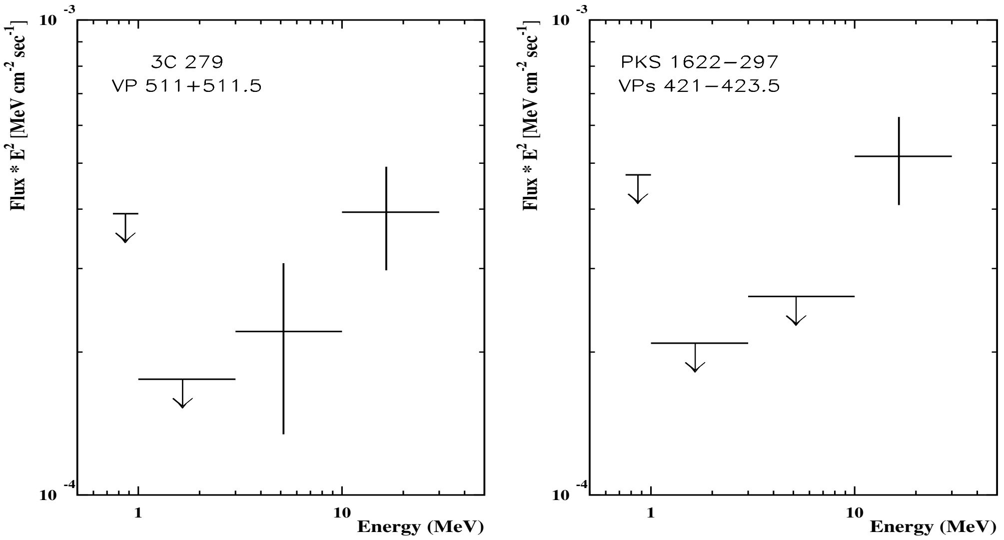

FIGURE 3. Energy spectra of 3C 279 (left) and PKS 1622-297 (right) are shown. The spectra, averaged over the whole 3- and 4 week observations of both blazars, are presented in a differential flux $\times$ E^2 representation. The error bars are 1σ and the upper limits are 2σ. Both sources are mainly detected at the upper COMPTEL energy bands, which, together with the upper limits at lower energies, indicates a 'hard' MeV spectrum for both cases.

the observation covers a time period of high γ-ray activity in which a flux spike is observed. For 3C 279 the observations are only available at the rising part of the flare. It remains unclear whether the top of the MeV emission is covered by COMPTEL.

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