Multifrequency Observations of the Virgo Blazars 3C 273 and 3C 279 in CGRO Cycle 8

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Abstract. We report first observational results of multifrequency campaigns on the prominent Virgo blazars 3C 273 and 3C 279 which were carried out in January and February 1999. Both blazars are detected from radio to γ-ray energies. We present the measured X- to γ-ray spectra of both sources, and for 3C 279 we compare the 1999 broad-band (radio to γ-ray) spectrum to measured previous ones.

INTRODUCTION

We report on simultaneous multifrequency observations of the prominent Virgo blazars 3C 273 and 3C 279 during CGRO Cycle 8. Because both blazars are known γ-ray sources, which have been detected by the CGRO experiments several times before, we proposed for simultaneous CGRO (OSSE, COMPTEL) and RXTE high-energy observations. The prime goal was to simultaneously measure their high-energy spectra from about 2.5 keV to 30 MeV. Because of the shortage of spark chamber gas, the EGRET experiment is hardly available anymore and therefore was not requested in the proposals. After the proposed simultaneous high-energy observations were approved and scheduled, additional simultaneous observations

TABLE 1. Summary of the satellite observations of both Virgo blazars during the campaigns in 1999. The observation periods as well as the coverage in energy are given.

Source	Experiment	Obs. Period in '99	Energy Band
3C 273	EGRET	Jan. 20 - Feb. 2	30 MeV - 10 GeV
	COMPTEL	Jan. 5 - Feb. 2	750 keV - 30 MeV
	OSSE	Jan. 19 - Jan. 26	50 keV - ~1 MeV
	RXTE [a]	Jan 19, 26, Feb. 1	2.5 keV - ~200 keV
3C 279	EGRET[b]	Jan. 20 - Feb. 2	30 MeV - 10 GeV
	COMPTEL	Jan. 5 - Feb. 2	750 keV - 30 MeV
	OSSE	Jan. 5 - Jan. 19	50 keV - ~1 MeV
	OSSE[b]	Jan. 26 - Feb. 2	50 keV - ~1 MeV
	RXTE[a]	Jan 5, 12, 17	2.5 keV - ~200 keV

[a] 3 individual pointings of ~13 ksec each
[b] 3C 279 ToO observation; not reported here

were performed from ground-based observers extending the energy range of the campaigns to lower energies.

In this paper we report first observational results of the campaigns with emphasis on the X- and γ-ray part. In particular we present the measured X- to γ-ray spectra of both sources.

OBSERVATIONS

The multifrequency observations were carried out between 1999 January 5 and February 2. The observational strategy was that both blazars are within the COMPTEL field-of-view for the whole 4 weeks reaching the optimal sensitivity for the γ-ray observations, and OSSE observes simultaneously each source for 2 weeks. Within these two-week OSSE periods, three RXTE pointings were scheduled for each source covering simultaneously the X- and hard X-ray part of the spectrum and providing information on the X-ray variability. To supplement these high-energy observations both sources were simultaneously observed in different optical and radio bands. On 1999 January 15 the optical flux of 3C 279 reached a high level which – after some discussion – triggered target-of-opportunity (ToO) observations of this source. This resulted in a switch-on of EGRET which led to EGRET observations of both quasars during roughly the second half of the campaigns. Because of the 3C 279 ToO, the OSSE 3C 273 observation was stopped after one week, and OSSE observed 3C 279 again. These EGRET and OSSE ToO observations of 3C 279 are property of a different CGRO proposal and therefore their results are not reported here. The detailed high-energy observational log is given in Table 1.

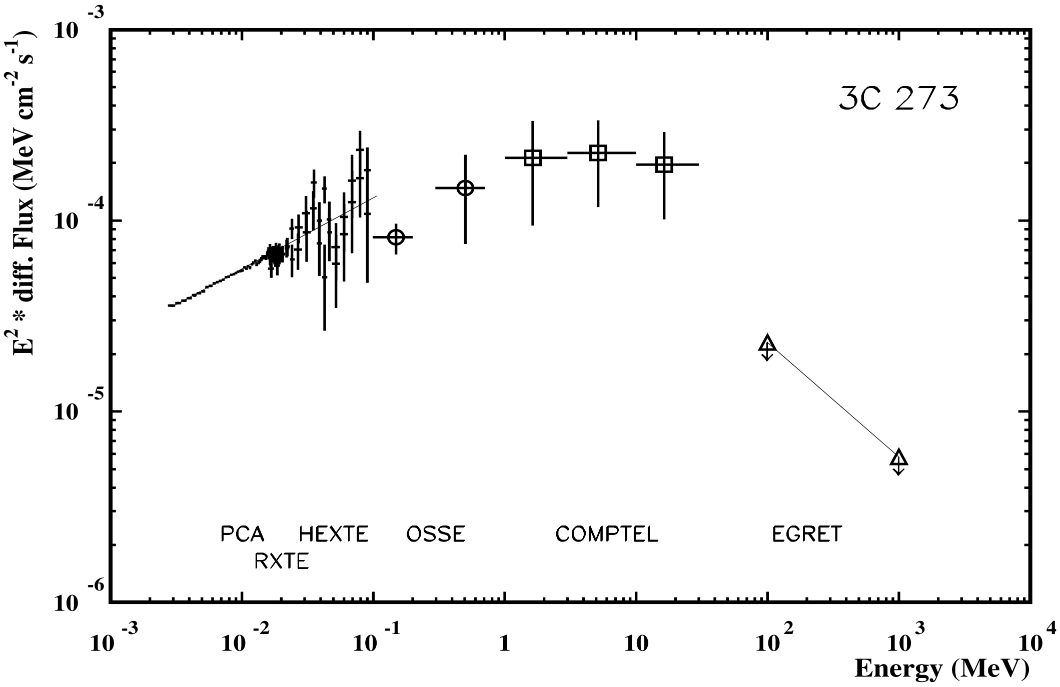

FIGURE 1. Simultaneous X-ray and γ-ray spectrum of 3C 273 as observed during the January/February 1999 campaign. The data points from the different experiments are derived from their total observation times during the campaign, which are given in Table 1. The RXTE (+) spectral points are derived from the observation sum of the three individual pointings, and are shown together with the best-fit power-law spectrum (solid line). EGRET did not detect the quasar at energies above 100 MeV providing an upper limit on the flux. For the upper limit line, drawn between 100 MeV and 1 GeV, a spectral power-law shape with photon index of 2.6 is assumed. The error bars are 1σ.

RESULTS

3C 273

3C 273 is significantly detected in all observed low-energy (radio, optical) bands. At high energies the quasar is significantly detected in X- and hard X-rays by RXTE from about 2.5 to ~100 keV, showing a power-law spectrum with a photon index ($E^{-\alpha}$) α of 1.6. OSSE detects the source in the one-week observation at a significance level of $\sim 5\sigma$. Therefore its spectrum had to be rebinned severely to reach two significant spectral points. COMPTEL detects the blazar in the sum of the 4-week observation at the $\sim 5\sigma$ level. However, despite the COMPTEL detection at MeV-energies, EGRET – covering only half of the COMPTEL observation time – does not detect 3C 273 at energies above 100 MeV. The combined – more or less simultaneous – high-energy spectrum of 3C 273 is shown in Figure 1. The

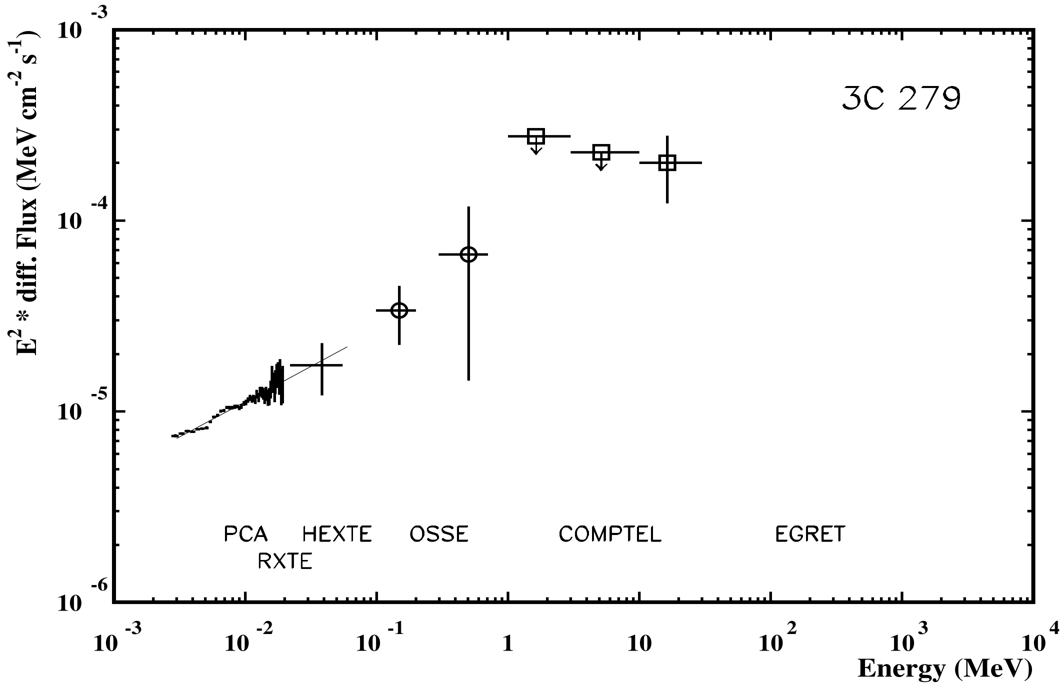

FIGURE 2. Quasi-simultaneous keV- to MeV-spectrum of the γ-ray blazar 3C 279 as observed in early 1999. The data points from the different experiments are derived from their total observations times during the campaign, which are given in Table 1. The RXTE (+) spectral points are derived from the observation sum of the three individual pointings, and are shown together with the best-fit power-law spectrum (solid line). The error bars are 1σ and the upper limits are 2σ. Simultaneous EGRET observations exist (Table 1), which will be reported elsewhere. The spectrum can be described by a single power-law shape from about 2.5 keV to 30 MeV.

well-known bending (e.g. [1], [2]) at MeV-energies is visible. The most surprising result however, is the non-detection by EGRET at high-energy γ-rays, despite the COMPTEL detection at MeV-energies. This requires a strong spectral turnover between 30 and 100 MeV, and might hint at different generation mechanisms for the MeV and >100 MeV photon populations.

3C 279

3C 279 is significantly detected at the radio and optical bands, showing strong time variability and flaring activity in the optical. At X-rays the blazar is significantly observed up to 20 keV by the RXTE/PCA, and is detected in hard X-rays between 20 and 50 keV by RXTE/HEXTE with a significance of about 5σ. The RXTE/PCA spectrum is well fitted by a single power-law model with an index α of 1.6. At higher energies the detection significances become marginal. OSSE

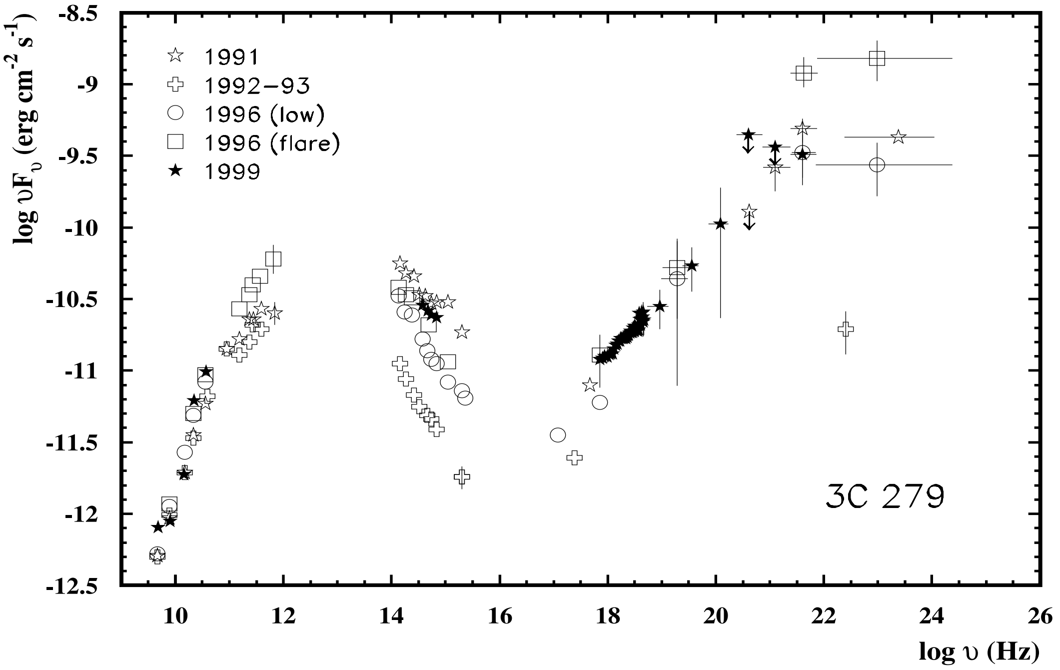

FIGURE 3. Broad-band spectrum of 3C 279 for different epochs. The 1999 results (filled stars) reported here fit nicely to the two previous measurements in 1991 and 1996 when 3C 279 was in a γ-ray high state. The spectral points of the earlier measurements are taken from [4].

found 3σ-evidence for the source only at their lower energies (near 100 keV), and COMPTEL – also at the 3σ level – only at their upper energies. At energies above 100 MeV EGRET has significantly detected 3C 279 ([3]), however these data are not reported here. The measured X- to γ-ray spectrum of 3C 279 is given in Figure 2. It shows that 3C 279 was observed in a bright γ-ray state. The flux at the COMPTEL upper energies is at the same level as measured during the two previous γ-ray high states in 1991 and 1996 (Figure 3). The spectral power-law shape measured from $\sim$2.5 to 20 keV can – according to the current state of analysis – be extrapolated up to 30 MeV without any obvious breaks or bendings. This suggests that this part of the spectrum, which is considered to be non-thermal inverse-Compton radiation, is emitted by a single emission component or mechanism.

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