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EGRET Observations of 3C 273

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Abstract. — The quasar 3C 273 was detected by COS-B in the 1970's. EGRET observations of this sky region in June and October 1991 revealed a flux from 3C 273 lower than that measured by COS-B. The flux observed by EGRET in the June period is approximately 3 x 10^{-7} $cm^{-2}sec^{-1}$ for energies greater than 100 MeV. During the October observation it appears to be even lower. For the first observation a preliminary spectrum has been derived which has a photon index of 2.4.

Key words: gamma rays - Quasars: 3C 273 - Instrument: EGRET

1. Introduction

The optically very bright quasar 3C 273 (z=0.158) is a well known source in all energy regimes ranging from the radio, infrared, optical and UV up to the X-rays. Intense studies, including simultaneous multiwaveband observations, are made in all these bands to reveal the nature of this object (see e.g. Courvoisier 1987).

The currently favored model discussed for AGN's is a supermassive black hole surrounded by an accretion disk. This scenario is believed to be able to provide the enormous luminosities of the order of 10^{42-46} erg/sec and the observed time variabilities of the order of weeks (or even hours) in the X-ray range. The major problem, however, is to find mechanisms which are able to explain in detail the generation of the emitted radiation. Several possible processes have been proposed, among them Bremsstrahlung, blackbody radiation, synchrotron radiation, inverse Compton scattering and Penrose processes.

3C 273 has been detected in γ-rays by COS-B in two 4-week observations in July 1976 and June 1978. The flux of 3C 273 was about 0.6x10^{-6} $cm^{-2}sec^{-1}$ for E $\geq$ 100 MeV. No variation of the flux was observed within the 50% uncertainty (Swanenburg *et al.* 1978, Bignami *et al.* 1981).

Here, preliminary results from two observations of 3C 273 with the EGRET instrument aboard the Compton Observatory are reported.

2. Observations

EGRET is a spark chamber experiment in which photons with energies from 30 MeV to 20 GeV are detected via their conversion into electron-positron pairs. For a more detailed description of the instrument see e.g. Hughes *et al.* 1980 or Kanbach *et al.* 1988. The effective area of EGRET reaches ~1500 cm^2 at 500 MeV, about a factor of 20 larger than that of COS-B. Since EGRET is designed to have practically no internal background, only the celestial background will limit the detection of weak sources.

The instrument response functions have been determined at the Stanford Linear Accelerator (SLAC) and the results of the calibration are given by Thompson *et al.* , 1992.

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The Compton observatory has observed the sky region which contains the quasars 3C 279 and 3C 273 from June, 15th - 28th and from October, 3rd - 17th, 1991.

3. Results

The incident photon directions were binned into maps with a pixel size of 0.5 deg x 0.5 deg for four different energy intervals and have been analysed with a cross-correlation method. This method searches for point sources by looking for photon arrival distributions consistent with the expected response of EGRET to point-like sources.

First, the very strong source 3C 279 (Hartman *et al.* 1992) about 11° away from 3C 273 has to be subtracted in order to analyse 3C 273. Otherwise it is totally suppressed by the strong source. The result of this subtraction is shown in figure 1 for the energy range 200 - 500 MeV and the June period. The cross-correlation algorithm is applied to the four energy intervals with a photon index of 2.3 for the source. For this index the number of cross-correlated counts reached their maximum in each energy interval.

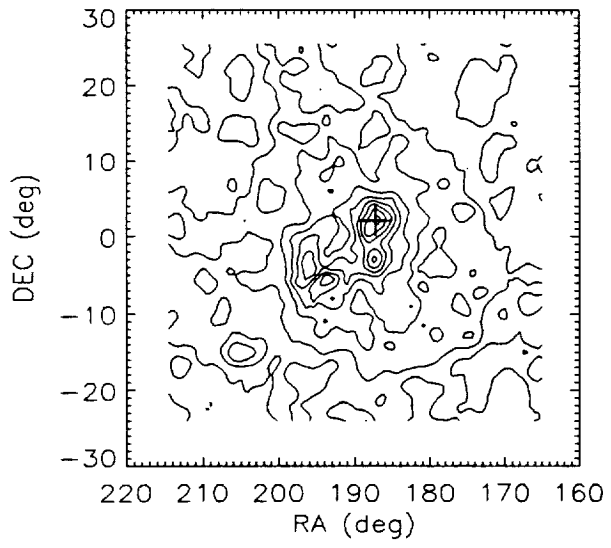

FIGURE 1: Contour map of cross-correlated counts for 3C 273 (3C 279 subtracted) in the energy range 200 - 500 MeV (June 1991).

The position for 3C 273 is then determined from the average of the positions derived from the energy intervals. It is found to be RA = (187.5 ± .6) deg and DEC = (1.98 ± 0.16) deg, about 0.2 degrees (or 12 arcmin) from the known position of 3C 273: RA = 187.3 deg , DEC = 2.05 deg (epoch 2000). This is consistent with the uncertainty in the EGRET position determination for a low intensity source.

The energy intervals, the number of correlated counts and the corresponding positions for 3C 273 are given in table 1.

TABLE 1. *Energy intervals, cross-correlated counts and positions for 3C 273.*

E (MeV)	corr. counts**	RA(deg)	DEC(deg)
70 - 200	156	186.8	1.94
200 - 500	56	187.5	2.16
500 -2000	9	188.1	1.85
2000 -5000	1	(186.7)	(2.25)

** assuming $E^{-2.3}$ spectrum

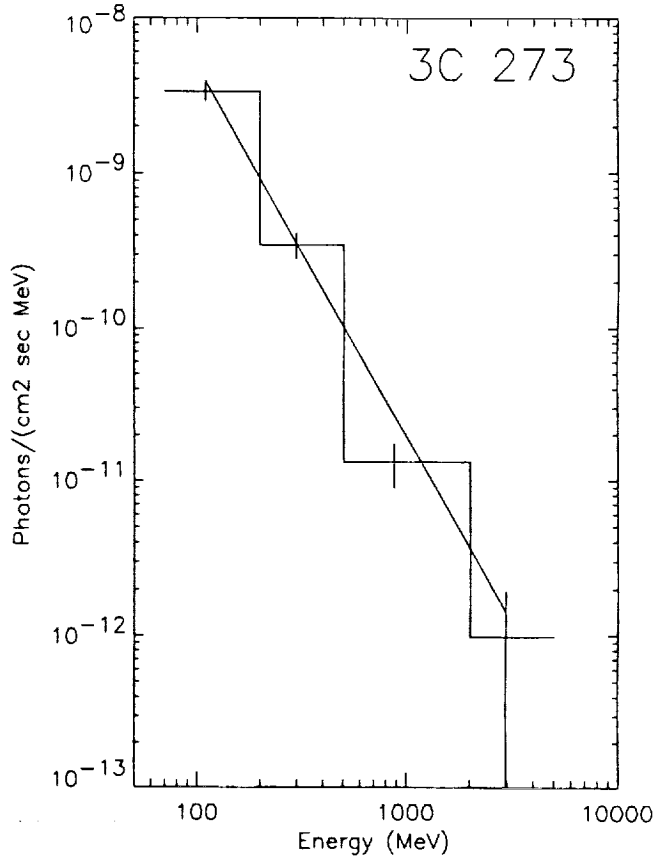

FIGURE 2: Preliminary spectrum of 3C 273 during the observation period in June, 1991.

In order to reproduce the measured counts a powerlaw spectrum has been convolved with the energy resolution of the instrument and the appropriate exposure for the June observation. The number of counts obtained from this model is then compared and fitted to the cross-correlated counts.

The spectrum (figure 2) can be represented by a power law of the form:

$$\frac{dI}{dE} = (3.0 \pm 1.7)\, 10^{-4}\, E^{(-2.39 \pm 0.13)} \frac{ph}{cm^2 sec MeV} \quad (1)$$

This implies a flux of about (3 ± .5) 10^{-7} cm^{-2} sec^{-1} for E ≥ 100 MeV.

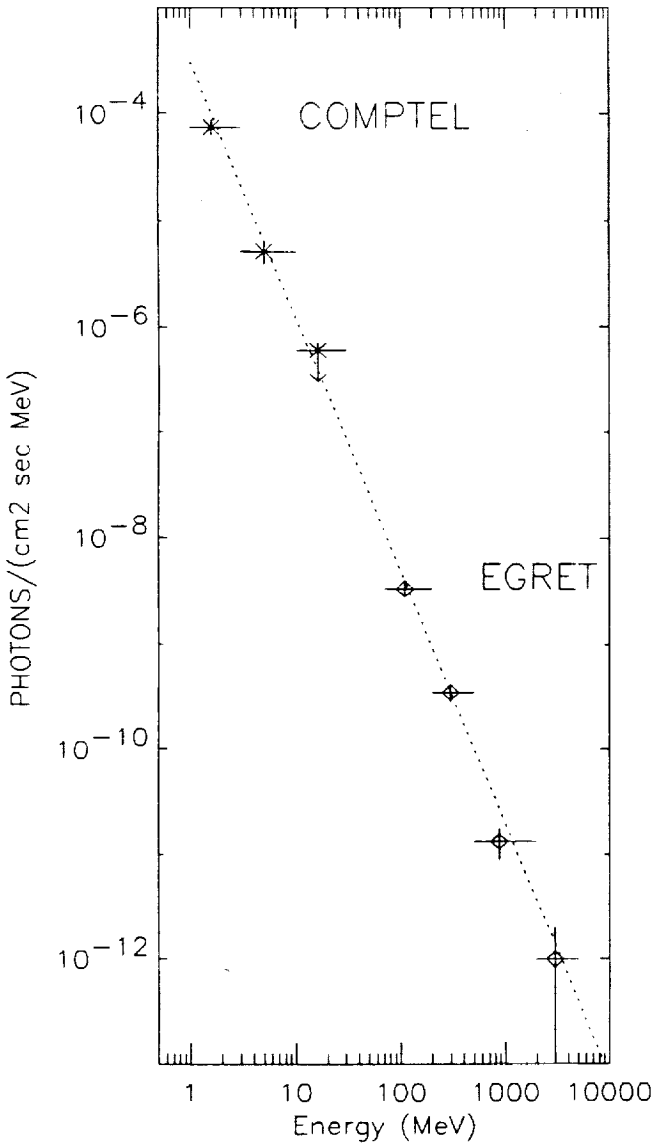

FIGURE 3: Comparison of the COMPTEL and EGRET spectra for 3C 273 in June, 1991. The dotted line represents the powerlaw fit to the EGRET data given by equation (1).

The comparison with the COMPTEL spectrum (figure 3) shows that the EGRET spectrum fits well (see also: Hermsen *et al.* 1992), although the extrapolation of the EGRET powerlaw comes up too high in the COMPTEL regime. However, since the energy region between 30 and 100 MeV is crucial, the analysis of the EGRET data in this energy domain has to be done very carefully and will be the subject of further study.

During the October observation 3C 273 appeared to be less intense than in June. But due to the very low intensity and the decrease in the spark chamber efficiency because of gas age a more detailed study is neccessary to confirm this suggested decrease in intensity.

4. Acknowledgements

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