

SEARCH FOR GAMMA-RAY EMISSION FROM AGN WITH COMPTEL

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ABSTRACT

The COMPTEL data (~ 0.7 -30 MeV) were searched for emission from AGN. Four sources have been detected so far: the quasars 3C 273, 3C 279, PKS 0528+134, and the radio galaxy Centaurus A. 3C 273 and 3C 279 were detected in CGRO observation period 3 with quite different spectral shapes. There is also evidence for 3C 273 at a weak flux level in observation period 11. The quasar PKS 0528+134 was detected above 3 MeV as part of a search for AGN already observed by EGRET. Cen A was seen up to 3 MeV by combining data from different observation periods.

INTRODUCTION

The imaging Compton telescope COMPTEL is sensitive in the low energy γ -ray range from about 0.7 MeV to 30 MeV. A detailed description of the COMPTEL characteristics is given by Schönfelder et al¹.

COMPTEL's MeV energy range is particularly interesting for investigations into the physics of AGN. Measurements in the neighbouring energy ranges indicate that some AGN might have their peak luminosity in this range and that there might be breaks in the spectra at MeV energies. Moreover, before COMPTEL only three AGN were detected at MeV energies: NGC 4151², MCG 8-11-1³, and Cen A⁴. Because each new detection increases our knowledge significantly, the COMPTEL data were searched for evidence of emission from AGN. The possibility of simultaneous measurements in neighbouring energy bands with CGRO would make AGN detections by COMPTEL even more valuable for the understanding of AGN physics.

In this paper we report on the results of the search for γ -ray emission from AGN in the COMPTEL data. In particular, the search was done for promising objects, with emphasis on AGN already detected by the EGRET experiment aboard CGRO. This paper represents a progress report with largely preliminary results. A more complete analysis for the different sources is underway.

THE QUASARS 3C 273 AND 3C 279

During the first year of its mission, the quasars 3C 273 and 3C 279 were

in the COMPTEL field of view twice: in the observation period 3 (June 91) and 11 (October 91). In observation period 3, both quasars were detected by COMPTEL, as already reported⁵. 3C 273 was detected mainly in the lower part of the COMPTEL energy range (1 - 10 MeV), while at the highest energies (10-30 MeV) only an upper limit could be derived. In contrast, 3C 279 was detected at the higher COMPTEL energies (3-30 MeV) while at lower energies (1-3 MeV) only an upper limit could be derived. In figure 1 the COMPTEL fluxes for the three energy intervals together with the spectral shapes measured by EGRET and OSSE (simultaneously for 3C 273) are given for both quasars. The error bars on the COMPTEL spectral points are statistical only. For 3C 273 the OSSE spectrum (photon index -1.8^6) is harder than the EGRET spectrum (photon index -2.4^7) indicating a break somewhere in the MeV region. The COMPTEL data are consistent with a spectral steepening around 1 MeV. For 3C 279, EGRET and COMPTEL measurements together indicate a spectral break around 10 MeV⁵.

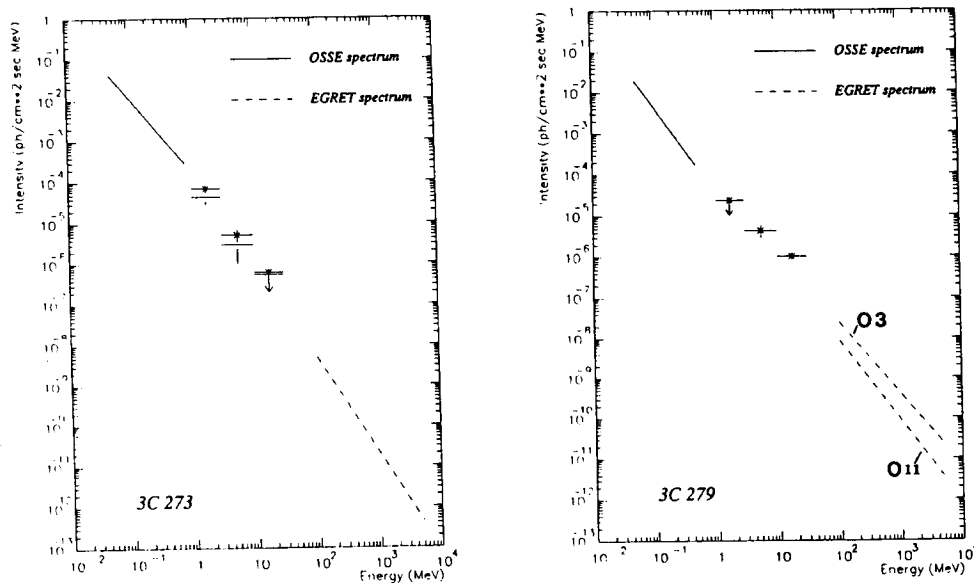


Figure 1. CGRO spectra of 3C 273 and 3C 279. a) Simultaneously (obs. 3) measured energy spectra of 3C 273 by OSSE⁶, COMPTEL⁵, and EGRET⁷. The lower COMPTEL spectral points are from October 91 (obs. 11). b) Spectra of 3C 279. The OSSE spectral shape was measured in September 91⁶, COMPTEL in June 91⁵, and EGRET in June and October 91⁸.

In observation period 11, the COMPTEL data show evidence for 3C 273 at a weak flux level. The 1-3 MeV skymap of this region shows a feature with a significance of $\sim 4\sigma$ (figure 2). In the 3-10 MeV band a marginally significant feature ($\sim 2.4\sigma$) appears. Both excesses are consistent with the location of 3C 273. The derived flux level is $\sim 50\%$ of that observed in observation period 3 (same upper limit for the 10-30 MeV band). The spectral points including only the statistical errors are also given in figure 1. A more detailed analysis is underway.

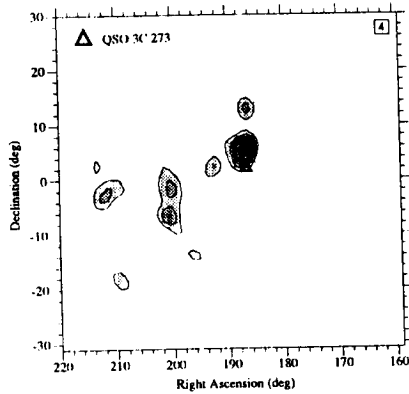


Figure 2. 1-3 MeV skymap of the Virgo region for observation period 11 (October 91). There is evidence ($\sim 4\sigma$) for 3C 273 at a weak flux level.

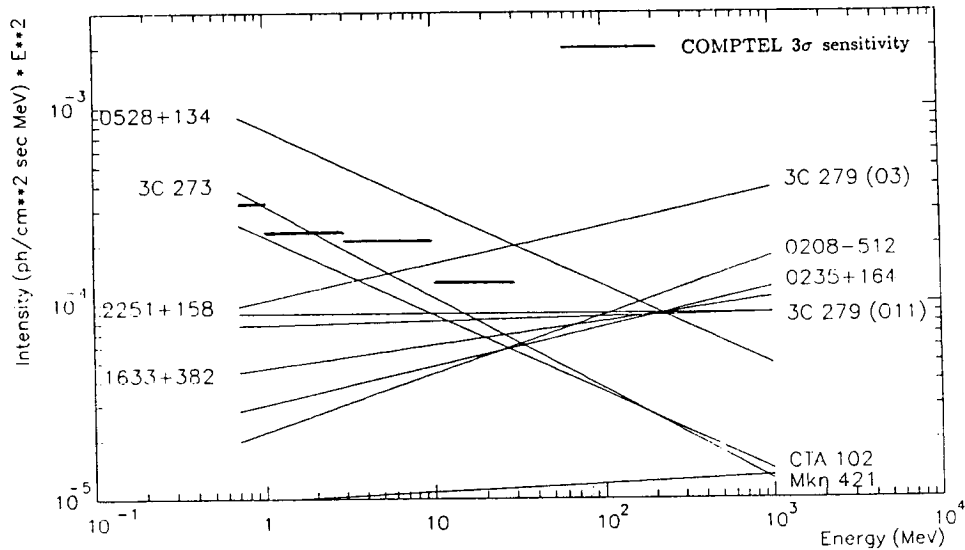


Figure 3. Extrapolation of the measured EGRET AGN spectra (≥ 100 MeV) into the COMPTEL energy range. For clarity the flux is multiplied by E^2 . The horizontal lines indicate the conservative COMPTEL 3σ sensitivity limits¹ for the 4 standard energy intervals assuming an E^{-2} power law spectrum.

SEARCH FOR AGN DETECTED BY EGRET

Up to now EGRET has announced the detection of 16 AGN⁹ mainly at energies above 100 MeV. For most of them spectral parameters are available. A search in the COMPTEL data for these AGN has been started. To select the promising candidates, the measured EGRET spectra were extrapolated into the COMPTEL energy range for comparison with the conservative COMPTEL sensitivity limits (figure 3).

Besides 3C 273 and 3C 279 in observation period 3, there is only one other promising candidate: the quasar PKS 0528+134. The extrapolation of

the measured EGRET spectrum passes well above the sensitivity limits for all four COMPTEL standard energy intervals. A search for this quasar led to its detection during the CGRO validation period and also in the survey observation period 1. Skymaps for the energy ranges 3-10 MeV and 10-30 MeV from the galactic anticentre region during 9 days of the CGRO validation period (April 28 - May 7, 1991) are given in figure 4. A clear excess at the position of the quasar PKS 0528+134 is visible in both skymaps. Because of the very recent detection of PKS 0528+134 and its proximity to the Crab ($\sim 8^\circ$), a precise flux value has not yet been determined. A first estimate leads to a flux level of the order of 10%-20% of the Crab flux for both energy ranges. No obvious signal from this source could be found so far for energies below 3 MeV, indicating a spectral break. A detailed analysis of this source is in progress.

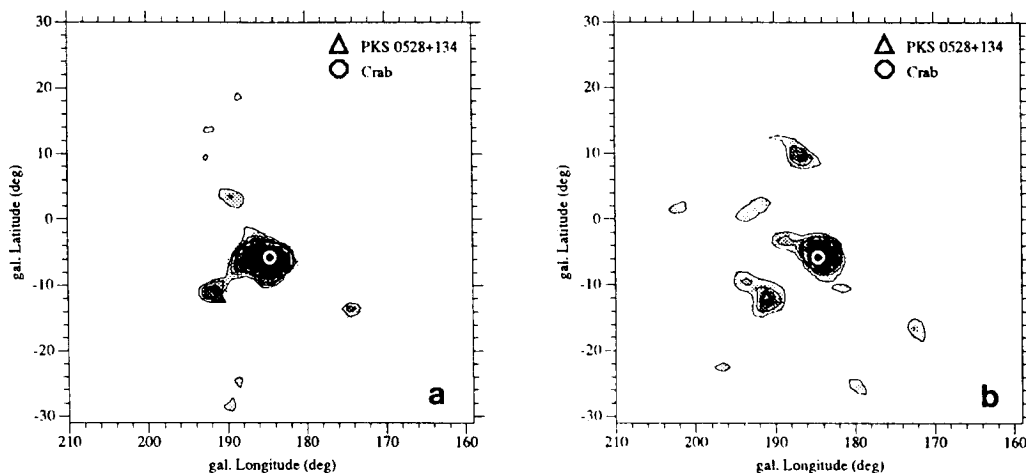


Figure 4. Skymaps of the galactic anticentre (April 28 - May 7, 91) for the energy ranges 3-10 MeV (a) and 10-30 MeV (b). In both images the Crab is saturated for better visibility of the image structure at lower intensity levels. In both energy ranges an excess at the position of the quasar PKS 0528+134 is visible.

The search for other AGN measured by EGRET is currently being pursued. No other AGN have been detected by COMPTEL so far. The recent EGRET result for the superluminal quasar CTA 102, having the softest spectrum¹⁰ (photon index -2.6) of all AGN detected by EGRET, makes this source a candidate for COMPTEL.

THE RADIO GALAXY CENTAURUS A

The CGRO observation period 12 (October 1991) was devoted to the sky region containing the active radio galaxy Centaurus A (Cen A). Because Cen A has been observed before at MeV energies⁴, it was a prime candidate for COMPTEL. Only an upper limit could be determined for observation period 12¹¹. However, by combining the data of several pointings (Cen A was in the COMPTEL field of view several times) Cen A was detected up to 3 MeV in

the COMPTEL data. Evidence for the detection can be found in ¹². The COMPTEL spectral points, together with spectral results of other experiments are shown in figure 5.

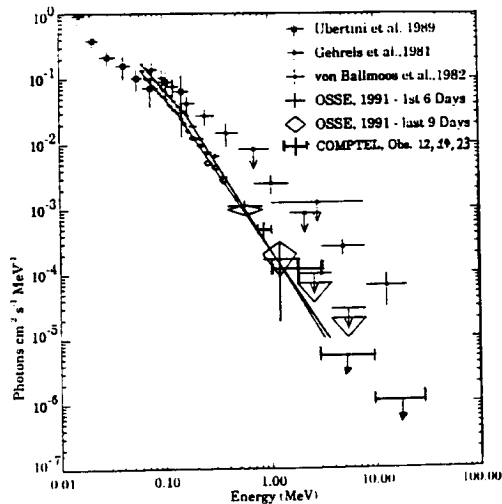


Figure 5. Spectral measurements of Cen A (from ¹³ with COMPTEL results added). The COMPTEL spectral points are derived from a combination of several pointings. The upper limits for the higher energies are 2σ .

SUMMARY

By searching the COMPTEL data for AGN in the energy range 0.7-30 MeV, 4 different objects have been detected so far: the quasars 3C 273, 3C 279, PKS 0528+134, and the radio galaxy Cen A.

The spectra of these objects are quite different. While two of them, 3C 273 and Cen A, were detected at lower energies, the other two, 3C 279 and PKS 0528+134 were only seen at higher energies, indicating a harder spectrum.

The presented findings are promising for the future of the CGRO mission, especially because of the possibility of simultaneous spectral measurements over about 5 decades in energy by the different CGRO experiments. This capability will surely improve the understanding of the still enigmatic AGN engine.

REFERENCES

1. V. Schönfelder *et al.*, *Ap.J. Supp.* (in press) (1992)
2. F. Perotti *et al.*, *Ap.J.* **247**, L63 (1981)
3. F. Perotti *et al.*, *Nature* **292**, 133 (1981)
4. P. v. Ballmoos *et al.*, *Ap.J.* **312**, 134 (1987)
5. W. Hermsen *et al.*, *Astron. Astrophys. Supp.* (in press) (1992)
6. W.N. Johnson *et al.*, these proceedings
7. C. v. Montigny *et al.*, *Astron. Astrophys. Supp.* (in press) (1992)
8. D. Kniffen *et al.*, *Ap. J.* submitted
9. C. Fichtel *et al.*, these proceedings
10. P. Nolan *et al.*, these proceedings
11. H. Steinle *et al.*, *Advances in Space Research* (in press) (1993)
12. H. Bloemen *et al.*, these proceedings
13. W.N. Johnson *et al.*, *Astron. Astrophys. Supp.* (in press) (1992)