Preliminary COMPTEL Results on the Quasar PKS 0528+134

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ABSTRACT

A search in the COMPTEL data for AGN at MeV energies is in progress. This search comprises all AGN which have already been detected at γ-ray energies with particular emphasis on the Blazar type AGN sources detected recently by EGRET. Up to now four sources have been observed: the quasars 3C 273, 3C 279, PKS 0528+134, and the radio galaxy Cen A. In this paper we report the first COMPTEL results on PKS 0528+134.

1. INTRODUCTION

Before the launch of the Compton Gamma-Ray Observatory (CGRO) only a few AGN had been detected at γ-ray energies above 1 MeV. At γ-rays above 50 MeV, the quasar 3C 273 was the only extragalactic source detected. However, during phase 1 of the CGRO mission (all sky survey lasting for about 18 months), the EGRET experiment (energy range 30 MeV to 30 GeV) has detected several blazar-type high energy γ-ray emitting objects (e.g. Fichtel 1993). These detections triggered a search in the COMPTEL data (0.75 to 30 MeV) at low-energy γ-rays. A detailed description of the COMPTEL experiment can be found in Schönfelder et al. (1993). The COMPTEL energy range is particularly interesting for AGN investigations because some AGN (e.g. 3C 279) have their peak luminosity per frequency decade in this range, and also spectral breaks have been found at MeV energies (e.g. Hermsen et al. 1993).

In order to select the most promising objects, the measured EGRET spectra were extrapolated into the COMPTEL energy range for comparison with the COMPTEL detection limits, assuming continuity in spectral shape (Fig 1). Of the EGRET AGN announced up to the end of 1992, there are three objects which look especially promising for COMPTEL: the quasars 3C 273, 3C 279, and PKS 0528+134. All three sources have already been detected by COMPTEL. For 3C 273 and 3C 279 the detection and first results were given by Hermsen et al. (1993), and for PKS 0528+134 the detection during parts of the instrument verification phase was announced by Collmar et al. (1993). In this paper preliminary quantitative results on PKS 0528+134 will be reported.

2. COMPTEL OBSERVATIONS

During the first few month after the launch of CGRO, the galactic anticentre region containing PKS 0528+134 (l = 191°.37, b = -11°.01) was observed three times: in the instrument verification phase from April 22 to May 7, 1991 (observation period (OP) 0), during the first regular sky survey observation from May 16 to May

30, 1991 (OP 1.0), and during a target of opportunity observation of the sun from June 8 to June 15, 1991 (OP 2.5).

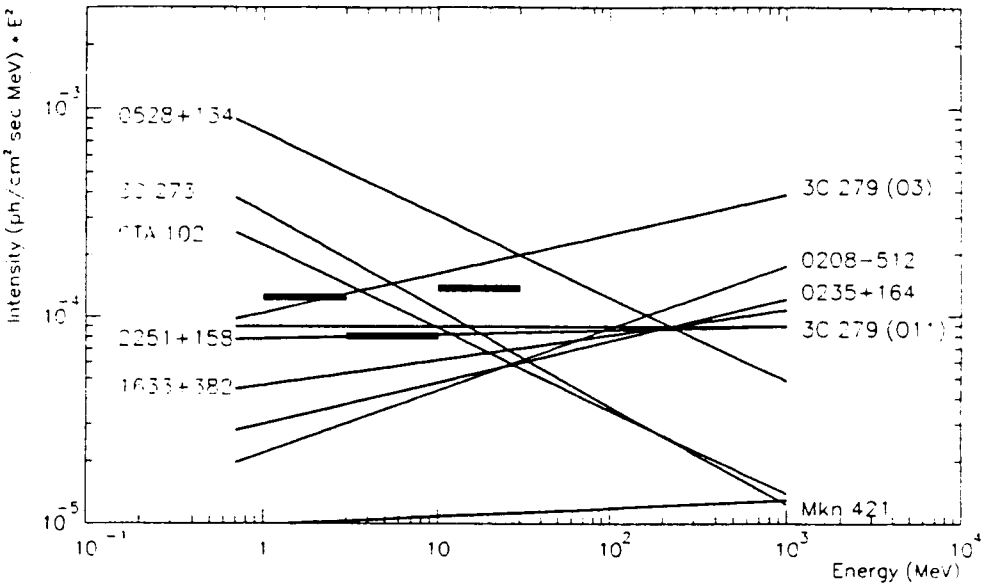

Figure 1: Extrapolation of measured EGRET AGN spectra (≥100 MeV) into the COMPTEL spectral range. For clarity the flux is multiplied by E^2. The COMPTEL limits shown here are consistent with the results (fluxes/upper limits) derived from the October 1991 observation of 3C 273 (Collmar et al. 1993).

3. DATA ANALYSIS

Up to now, only results from the instrumental verification phase (OP 0) and the sky survey observation period 1 (OP 1.0) have been derived. OP 0 could be used for data analysis from April 28 to May 7, 1991 after COMPTEL had reached a stable observation configuration. The data from OP 2.5 still await analysis with respect to PKS 0528+134.

Because PKS 0528+134 is only 8° away from the Crab (the strongest COMPTEL source), it is not straight forward to estimate its flux. In a first step, the Crab flux has to be determined. In a second step, the derived Crab flux has to be convolved with the COMPTEL instrument response to generate a model containing the Crab signature in data space. To estimate the flux of PKS 0528+134 in a third step, this Crab signature has to be added to the overall background model. Since the flux level of the quasar is of the order of only 10% of the Crab flux, small uncertainities in Crab flux result in bigger uncertainities in the flux estimate of PKS 0528+134. This paper reports on work in progress, and therefore the quantitative flux values should not be considered as final. Also, for deriving the flux values, point spread functions assuming an E^{-2}-photon index power law spectrum for PKS 0528+134 were assumed. In a final analysis, the quasar spectrum in the COMPTEL energy range will have to be determined by an iterative process: determining the spectrum, applying corresponding PSFs, and again determining the spectrum.

4. RESULTS

PKS 0528+134 was detected by COMPTEL during the instrument verification phase in the energy ranges 3-10 MeV and 10-30 MeV with flux values of about 9% and 30% Crab flux, respectively. For the energy ranges 0.75-1 MeV and 1-3 MeV

only upper limits could be derived. For observation period 1 there is evidence of the quasar only in the 10-30 MeV range on a 2σ level with a flux of about 15% Crab. In the other COMPTEL standard energy ranges only upper limits could be derived. This agrees in general with the EGRET measurements (Hunter et al. 1993), which also observe a higher quasar flux during the verification period. The measured COMPTEL flux values and derived upper limits are given in table 1. In figure 2a and 2b the COMPTEL differential spectral points together with the EGRET spectrum of observation 1 (Hunter et al. 1993) are shown. Although the derived flux values at the higher energies are of preliminary nature, the non-detection of the quasar at the lower energy ranges - 0.75-1 MeV and 1-3 MeV - clearly indicate the presence of a spectral break in the COMPTEL energy range. A simple extrapolation of the measured EGRET spectrum results in flux values more than a factor of 10 above the COMPTEL 2σ upper limits.

Table 1: Upper limits (<) and fluxes for PKS 0528+134 for 2 observation periods. The fluxes are given in units of 10^{-5} ph cm^{-2} sec^{-1}. The upper limits are 2σ. The quoted errors are not statistical only. Assumptions about systematic errors are included.

Energy (MeV)	OP 0	OP 1.0
0.75 - 1	< 6.1	< 7.2
1 - 3	< 6.8	< 6.2
3 - 10	4.0 ± 2.8	< 4.3
10 - 30	3.2 ± 1.2	2.0 ± 1.2

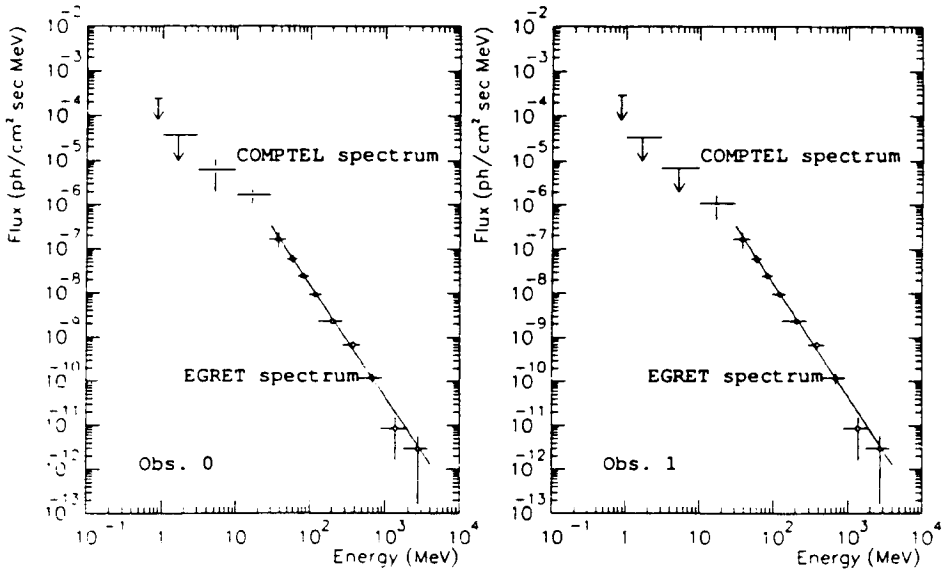

Figure 2: Energy spectra for PKS 0528+134 measured by COMPTEL and EGRET. The COMPTEL spectral points and upper limits derived for the 2 observation periods are shown. In both plots the EGRET spectrum (Hunter et al. 1993) is the spectrum of OP 1.0. The COMPTEL flux values (Table 1) were converted into differential fluxes by assuming an E^{-2} power law spectrum.

5. SUMMARY

The COMPTEL data with respect to the quasar PKS 0528+134 have been analysed partly. PKS 0528+134 is detected by COMPTEL in two CGRO observation periods which are 10 days apart. The detection can only be claimed at the high energy part of the COMPTEL spectral range. Below 3 MeV, only upper limits could be derived so far. These data (coupled with the available EGRET spectrum) suggest a spectral break in the upper part (~10 MeV) of the COMPTEL spectral range. An extrapolation of the measured EGRET spectrum - a power law throughout the EGRET energy range - results in flux values below 3 MeV which are more than an order of magnitude above the derived 2σ upper limits. The evidence for a spectral break becomes obvious when the COMPTEL measurements are inserted in the broad band emission υF_υ-plot for PKS 0528+134 given by Hunter et al. (1993) (Fig. 3).

Up to now COMPTEL has detected three blazar-type quasars: 3C 273, 3C 279, and PKS 0528+134. They are all showing spectral breaks somewhere in the MeV energy range. From this fact, one may conclude, that spectral breaks at MeV-energies are a common feature for this type of sources.

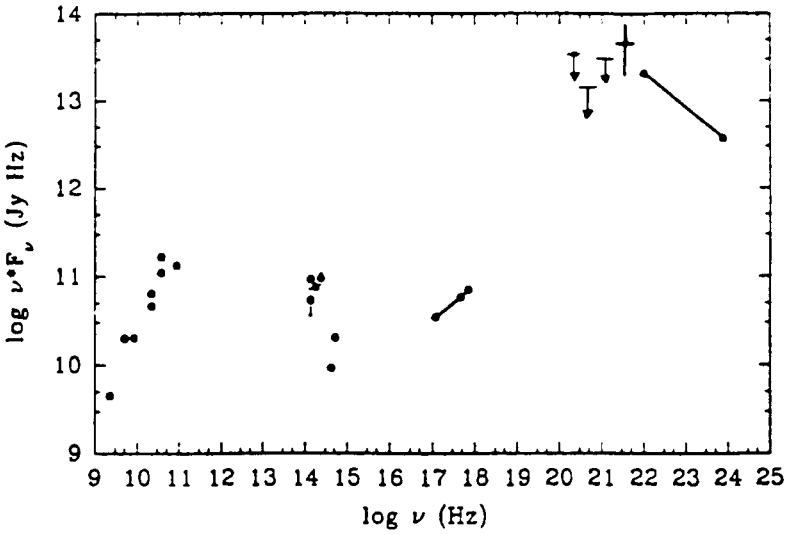

Figure 3: Broad band υF_υ-plot of the emission from PKS 0528+134. The graph was adopted from Hunter et al. (1993) and the COMPTEL results for OP 1.0 have been included. This period was chosen to be compatible with the EGRET data. For references of the individual measurements see Hunter et al. (1993). Only the EGRET and COMPTEL points cover the same time interval.

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