Further COMPTEL observations of the region around GRO J1753+57: are there several MeV sources present?

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Abstract.

GRO J1753+57 was first reported by COMPTEL as a very bright source in the range 1-3 MeV during an observation in November 1992. It was not detected in three other observations of the same region carried out in June 1991, December 1992, and March 1993 and it was not possible to identify a likely candidate at other wavebands which lay within the 3σ location contour.

Six further observations of the region have been made and after co-adding all the available data evidence has emerged for a more complex stucture than previously indicated. In the analysis presented here, we show that the observed signal can be successfully modelled by emission from a combination of two or more point sources which lie outside the original 3σ location contour of GRO J1753+57, at the positions of the blazar 4C 56.27, the EGRET quasar QSO 1739+522, and the unidentified EGRET source GRO J1837+59. All these sources can reasonably be expected to be γ-ray emitters.

However, uncertainties over the origin of the observed emission persist, in part due to the difficulty in unambiguously modelling COMPTEL data in the possible presence of several point sources. Moreover, it has previously been suggested that a diffuse galactic source related to high-velocity clouds may contribute to the observed emission in this region. This possibility would provide an alternative explanation for part of the observed signal and is not excluded by the analysis presented here, since extended emission is particularly difficult to image with COMPTEL.

INTRODUCTION

GRO J1753+57 was first reported by COMPTEL in the range 1-3 MeV during an observation in November 1992 [1]. The detection was consistent with a single, bright, variable point source. It was not detected in three other observations of the same region in June 1991, December 1992, and March 1993. Moreover, it was not possible to identify a convincing candidate at other wavebands within the 3σ location contour, despite a thorough search and follow up optical observations [2].

A total of 10 observations of the region have now been made. Co-adding all the available data and searching for a point source using a maximum likelihood-ratio method [4] results in the maximum likelihood-ratio map (MLM) shown in Fig. 1. The best fit position of GRO J1753+57 from the earlier analysis [1] is marked by a triangle. As has been previously shown [3] the feature visible in the 1-3 MeV range (which contains the greatest likelihoods) is not consistent with a single point source. This has significant consequences for the interpretation of this object since there are a number of interesting potential counterparts which lie inside the feature visible in Fig. 1, but which are outside the original 3σ location contour for a single point source. Namely:

- QSO 1739+522 an EGRET QSO at l,b=79.56,31.74
- GRO J1837+59 an unidentified Egret source at l,b=88.77,25.09
- 4C 56.27 a BL Lac object at l,b=85.7,26.1

MODELLING GRO J1753+57 USING SEVERAL POINT SOURCES

Modelling of COMPTEL data is complicated when several point sources are located within $sim10^o$. We have attempted to model the emission near GRO J1753+57 in terms of two sources, firstly by including sources at the locations of QSO 1739+522 and 4C 56.27 in the background model and secondly by including sources at the locations of QSO 1739+522 and GRO J1837+59 in the background model. The absence of significant residuals in either case show that either combination of sources can account for the observed signal i.e. we cannot distinguish between emission from 4C 56.27 and GRO J1837+59.

Fluxes from two nearby sources can be determined by simultaneously fitting two point spread functions (PSF) at the appropriate locations together with a background model. Fig. 2 shows the 1-3 MeV 'lightcurves' derived from simultaneous fits using PSFs at the locations of QSO 1739+522 and GRO J1837+59. The other standard COMPTEL energy bands (0.75-1.0 MeV, 3.0-10.0 MeV, 10-30 MeV) are omitted since they yield mainly upper limits. If sources at these locations give rise to the observed signal they seem to be

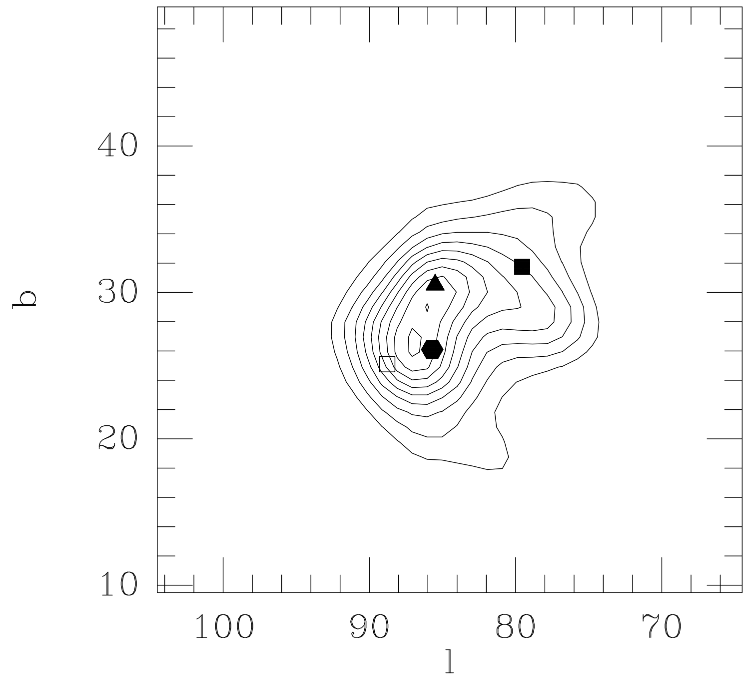

FIGURE 1. MLM of the 1-3 MeV range for all observations. Contours start at 10 with steps of 5. Locations of QSO 1739+522, GRO J1837+59, 4C 56.27 and the best fit position of GRO J1753+57 from the earlier analysis [1] are marked by a filled square, open square, hexagon, and triangle respectively.

variable. There is a tendancy that if one source has a high flux in a given observation, then the other source also has a high flux. This may indicate a systematic problem, or could merely be coincidental.

Similar results have been obtained from simultaneous fits using PSFs at the locations of 4C 56.27 and QSO 1739+522. This is to be expected since we cannot distinguish between emission from 4C 56.27 and GRO J1837+59.

EGRET OBSERVATIONS OF GRO J1837+59

The EGRET observations of GRO J1837+59 reveal it as a credible candidate for some of the MeV emission from this region.

Fig. 2c shows the published EGRET data for GRO J1837+59 [5] to be compared with the COMPTEL 1-3 MeV light curve in Fig. 2a. During the observations in the period TJD 8943-8957, when COMPTEL sees a relatively high flux from this location, EGRET also observes a high flux. However, EGRET also observes a high flux in the period TJD 8406-8415, when COMPTEL sees no signal.

Fig. 3 compares the EGRET data from GRO J1837+59 in the period TJD 8943-8950 with the COMPTEL fluxes from the location of GRO J1837+59 in the period TJD 8943-8957. Within the statistical uncertainties, the COMPTEL fluxes are consistent with an extrapolation of the EGRET spectrum

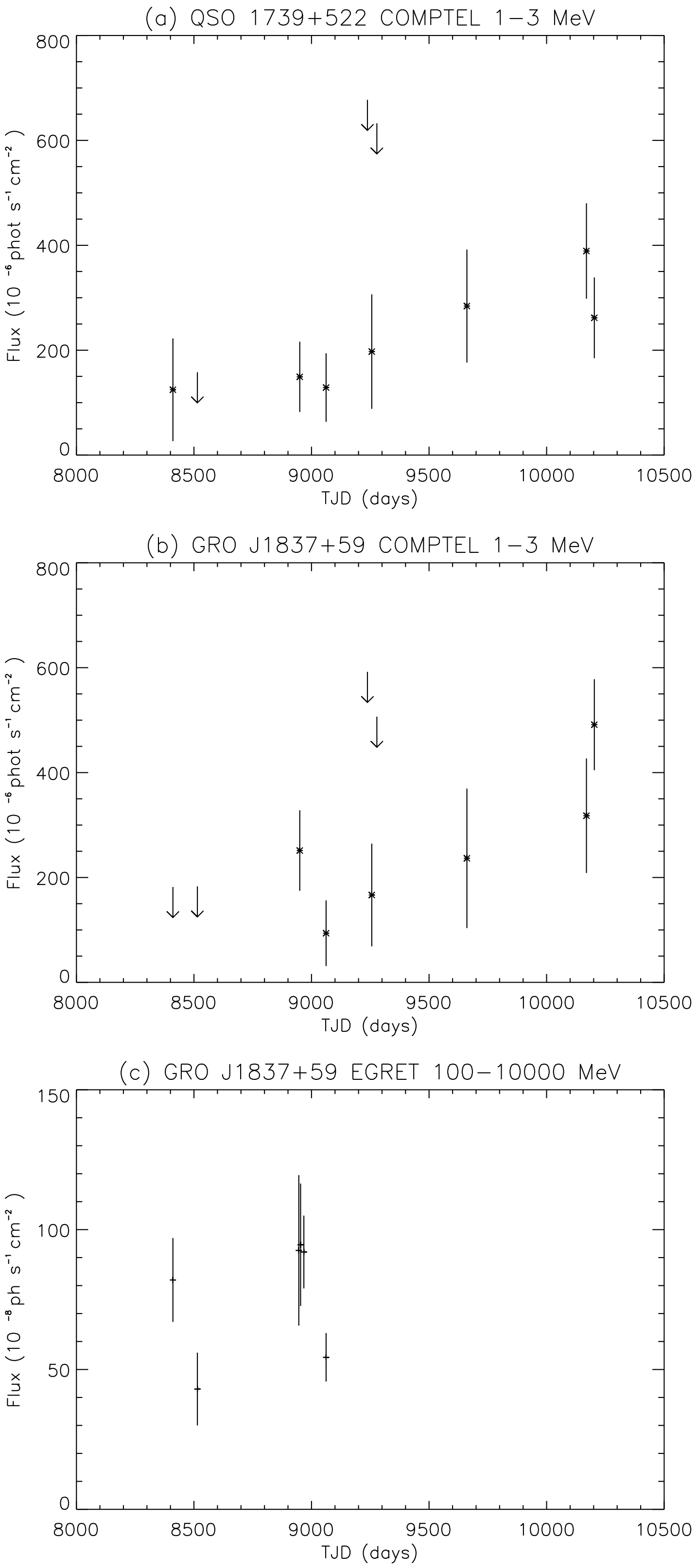

FIGURE 2. COMPTEL 1-3 MeV 'lightcurves' derived from simultaneous fits to **(a)** QSO 1739+522 and **(b)** GRO J1837+59. For comparison the EGRET lightcurve for GRO J1837+59 is shown in **(c)**

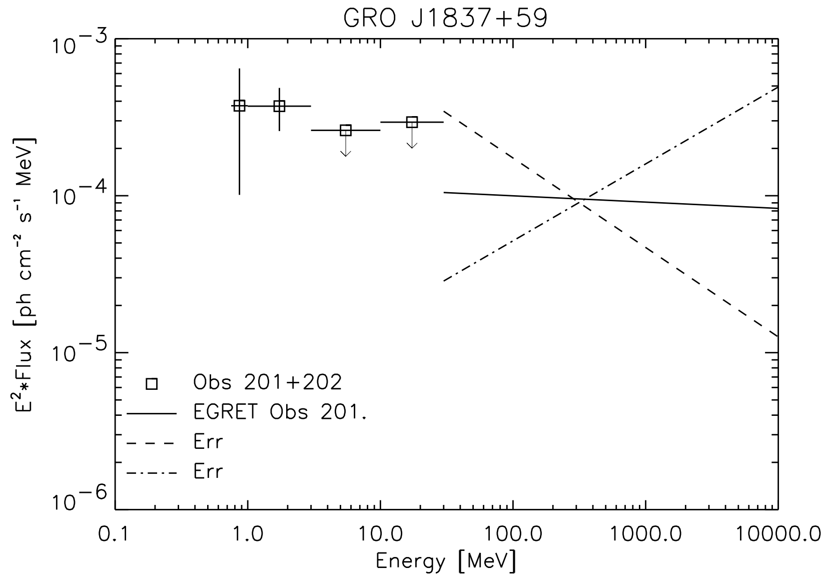

FIGURE 3. EGRET flux from GRO J1837+59 in the period TJD 8943-8950 [5] and the COMPTEL flux from GRO J1753+57 in the period TJD 8943-8957

CONCLUSIONS

In the analysis presented here we show that the observed signal can be successfully modelled by emission from a combination of two or more point sources which lie outside the original 3σ location contour of GRO J1753+57, at the positions of the blazar 4C 56.27, the EGRET quasar QSO 1739+522, and the unidentified EGRET source GRO J1837+59. All these sources can reasonably be expected to be MeV γ-ray emitters.

However, considerable uncertainties over the origin of the observed emission persist, in part due to the difficulty in unambiguously modelling COMPTEL data in the possible presence of several point sources. Moreover, it has previously been suggested that a diffuse galactic source related to high-velocity clouds may contribute to the observed emission in this region [3]. This possibility would provided an alternative explanation for at least part of the observed signal and is not excluded by the analysis presented here, since extended emission is particularly difficult to image with COMPTEL.

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