COMPTEL Observations of a source in the direction of the Galactic centre

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Abstract. During the CGRO mission, the Galactic centre region was well exposed by COMPTEL. There is evidence for a distinct excess near the Galactic centre direction in the COMPTEL energy range 1 – 30 MeV. The analysis for point sources is however complicated by the intense emission from the Galactic ridge. We use data from the full mission to investigate this source, present a multiwavelength spectrum and discuss various possible counterparts, including the microquasar source 1E1740.7 - 2942.

INTRODUCTION

The Galactic centre (GC) region was well observed by COMPTEL in the 1-30 MeV range over the full mission lifetime. Maps of the continuum emission for the entire sky and the Galactic plane have been presented previously [1, 2]; these show intense diffuse emission from the Galactic ridge as well as the principal sources detected by COMPTEL such as Crab, Vela, Cyg X-1, and also apparent source-like excesses at $l = 18^o$ and the Galactic Centre direction. Because of the difficulties associated with the ridge emission, the latter sources have not been the subject of a great deal of attention up to now. All-sky source maps have been presented in [3].

ANALYSIS

The standard COMPTEL source likelihood-analysis tool SRCFIX was used [4], including estimates of the diffuse Galactic emission based on HI, CO maps and inverse-Compton models. However in view of the uncertainty in such models (much of the emission may be unresolved point-sources, see [5, 6]), the analysis is not unique. Especially the GC is problematic because of the large CO peak there which is believed to reflect abnormal conditions in the ISM rather than a large molecular hydrogen mass; hence the CO maps are usually interpolated in some way to remove this peak for use in gamma-ray analysis, and this is also done here, but this procedure is clearly somewhat

TABLE 1. Summary of fitting parameters for source near GC

Energy MeV	l,b of max	-2ln(L/L$_{max}$)*	prob (3 df)	σ	Flux 10^{-5} cm $^{-2}$ s $^{-1\dagger}$
1-3	358.5, -1.5	26.8	6.5 10^{-6}	4.5	5.12 ± 1.0
3-10	359.5, -0.5	3.0	0.39	0.85	0.77 ± 0.49
10-30	359.5, -0.5	12.2	6.7 10^{-3}	2.7	0.60 ± 0.19
1-30	358.5, -0.5	37	4.6 10^{-8}	5.4	6.5 ± 1.1

* at maximum
† at l=358.5^o, b=-0.5^o

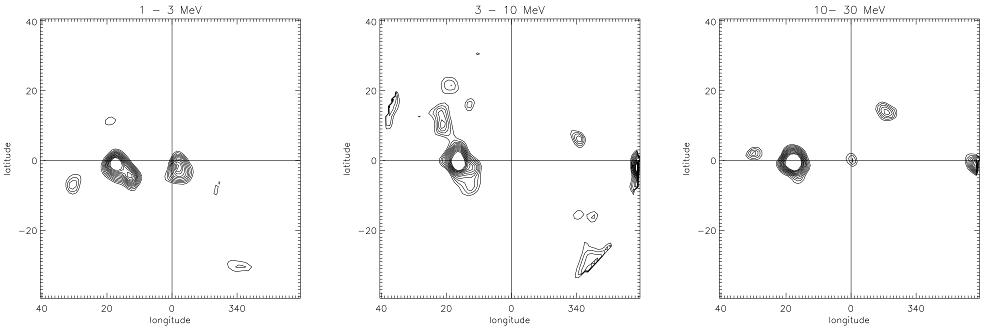

FIGURE 1. Likelihood ratio map of inner Galaxy for 1 – 3, 3 – 10 and 10 – 30 MeV. An estimate of the intense Galactic diffuse emission has been subtracted. The quantity $-2ln\, L/L_{max}$ is contoured at levels 8, 10, 12 ...

ad-hoc [1].

The analysis was performed for the energy ranges 1-3, 3-10 and 10-30 MeV on data from Cycles 1-6 of the mission. Table 1 summarizes the significances and fluxes. The method uses the likelihood-ratio statistic -2$ln(L/L_{max})$; since we have no *a priori* position for the source we have three degrees of freedom (flux, l, b) so that -2$ln(L/L_{max})$ is distributed as χ^2_3 and this is here used to derive probabilities/significances [2].

Fig 1 shows contours of the likelihood-ratio statistic -2$ln(L/L_{max})$ for the energy ranges 1-3, 3-10 and 10-30 MeV, and in Fig 2 summed for 1 – 30 MeV. While the source at l = 18^o is the most prominent feature on these maps, a source is detected near the GC at 4.5σ for 1-3 MeV and 2.7σ for 10-30 MeV with consistent positions; for 3-10 MeV there is no significant detection at this position, although the upper limit is not incompatible with the other ranges.

The maximum value of the total 1–30 MeV lnL-statistic near the GC is 37 corresponding to 5.4σ. While the significances in the individual energy ranges are not very high, the combined ranges add up to a significant detection in 1–30 MeV. The position

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[1] the CO peak was not removed from the model in [3] which may explain the lack of a significant residual γ-ray GC excess in those maps
[2] strictly we should allow for the trials involved in a full-sky search, but we consider the GC region as of sufficient *a priori* interest for independent reasons.

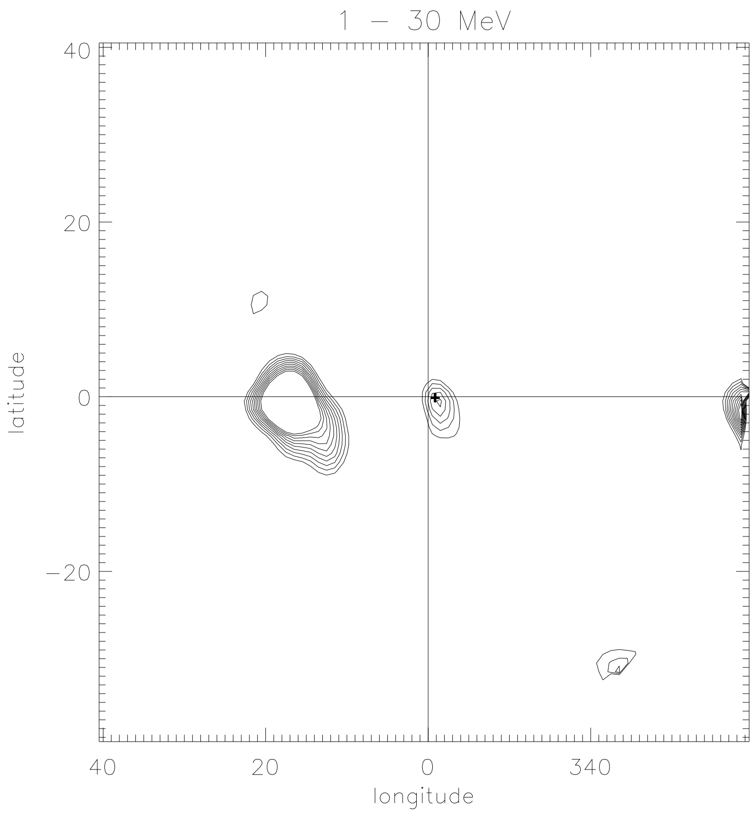

FIGURE 2. Likelihood ratio map of inner Galaxy for 1 – 30 MeV. An estimate of the intense Galactic diffuse emission has been subtracted. The quantity $-\ 2ln\ L/L_{max}$ is contoured at levels 20,24,28,32 corresponding to χ^2_3 probabilities 1.7 10^{-4}, 2.5 10^{-5}, 3.6 10^{-6}, 5.2 10^{-7} The position of 1E1740.7-2942 is marked by '+'.

of the 1–30 MeV maximum is l = 358.5^o, b = –0.5^o with an error circle radius about 2^o (change in lnL-statistic of 6 corresponding to 95% probability). For consistency the spectrum has been derived for this position.

Fig 3 shows the present COMPTEL estimates of the spectrum together with one from EGRET [7] and various hard X-ray spectra as discussed below.

DISCUSSION

The nature of the COMPTEL source in the direction of the GC is not known, but the spectrum is not inconsistent with a steep continuation of the ASCA/SIGMA/SAX spectra of the BH/microquasar source 1E1740.7-2942 [8, 9, 10, 11, 12]. This is a persistent hard X-ray source very near to the GC direction (l = 359.15, b = –0.12) and the position is consistent with the COMPTEL excess, although an identification certainly cannot be claimed. It is the hardest X-ray source in the GC region with a spectrum similar to Cyg X-1 [13]; the latter is known to have a spectrum extending up to a few MeV [14].

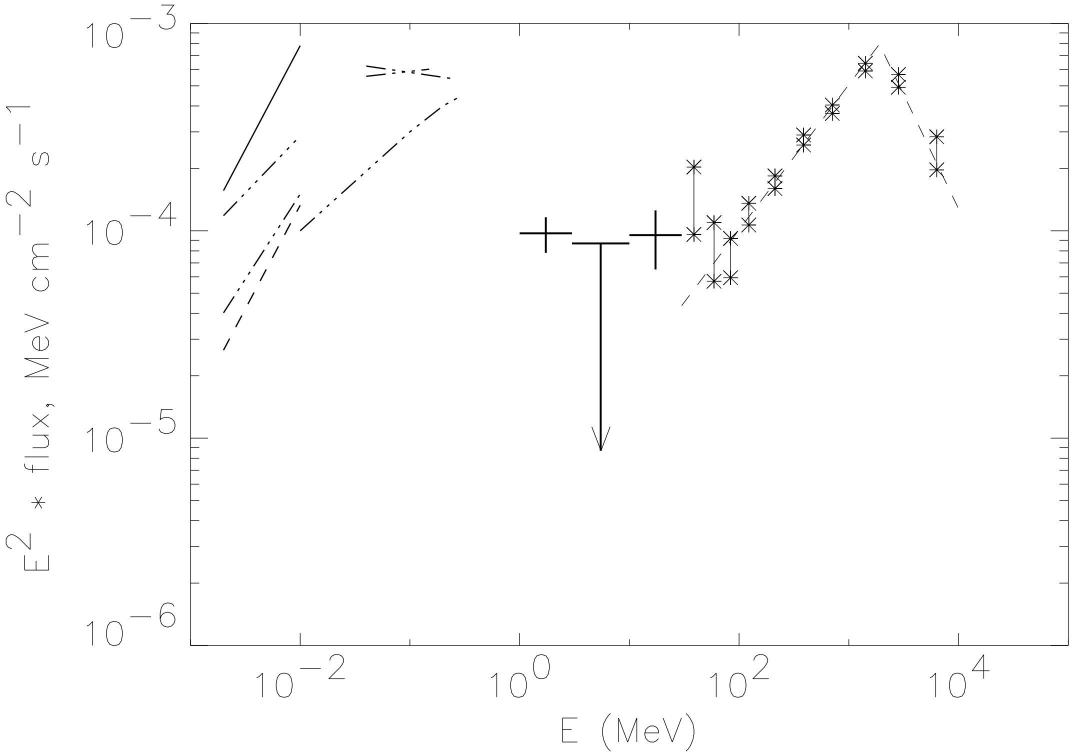

FIGURE 3. Spectrum of sources near to GC. COMPTEL points from Table 1, (3-10 MeV shown as 2σ upper limit). EGRET: [7] and Mayer-Hasselwander, private communication (asterisks). 1E1740.7-2942 (in various states): dash-dot lines, [8, 13] (SIGMA), [11] (ASCA); [10] (ASCA, SIGMA), [12](SAX). X-ray spectra of extended emission in the inner 1^o are shown as full lines [15, 16] (ASCA), and dashed lines [17] (SAX).

The EGRET source position above 300 MeV is not compatible with 1E1740.7-2942 [7], but at lower energies it is consistent; hence there would have to be 2 EGRET sources if one were 1E1740.7-2942 : this is indeed plausible. The COMPTEL and EGRET fluxes are compatible with a continuous spectrum from 1 to 100 MeV. The non-detection in the 3 – 10 MeV band is consistent with the apparent overall minimum in the luminosity spectrum in this range.

Another possible origin of the COMPTEL source is inverse-Compton emission from the electrons in the GC radio arc, as discussed for the EGRET source in [7]. Extended X-ray emission with a hard spectrum has been reported based on ASCA data [15, 16], see also SAX observations [17], which could also be associated with the gamma-ray source.

The possible association with the 1E microquasar is of particular interest because of the proposed identification of the EGRET source at l=18^o with the microquasar LS5039 [18] and in view of the COMPTEL source at this position [19] which would imply the extension of the emission from such objects into the MeV-GeV range.

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