Comparison of GAMMA-1 and COMPTEL spectra for 1991 June 15

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Introduction

The impulsive phase of the 15 June 1991 flare has been unobservable for the orbiting high-energy instruments. Starting about 40 min after flare onset, the satellites GAMMA and CGRO measured HXR/gamma-radiation and neutrons during the extended phase of the flare. We try to construct a composite spectrum using GAMMA-1 and COMPTEL telescope data. This spectrum covers the energy range from about 750 keV to 4 GeV.

GAMMA-1 measurements

The GAMMA-1 spark chamber telescope measures photons in the energy range from about 30 MeV to 4 GeV. During the 15 June flare, GAMMA-1 obtained data (Sun above the horizon and satellite outside the SAA) during the time intervals 8:37 - 9:00 UT and 10:08 - 10:26 UT.
The count rate spectrum, that was measured during the first observation period, is shown in Akimov *et al.* (1994). For the conversion into a flux spectrum, however, different interpretations have been presented:

(A) Akimov *et al.* (1994, 1996):
This study uses an analytical model and fits its foreward-folded spectrum to the measured data points. The assumption of a single power law is not supported by the data. A double power law of the form

$$F(E) = AE^{-\gamma_1}\left[1 + (E/E_0)^2\right]^{(\gamma_1-\gamma_2)/2} \tag{1}$$

allowes a good representation of the measured data. The best fit is formally obtained for $E_0 = 70\text{MeV}$, $\gamma_1 = -6.3 \pm 1.4$ and $\gamma_2 = 3.64 \pm 0.24$. The solution is not very sensitive on the value of E_0. Note that the power law at lower energies describes an increasing function.

(B) Kocharov *et al.* (1994) / Akimov *et al.* (1991):
Kocharov et al. support a deconvolution that has been done earlier by Akimov et al. It agrees with the best fit model given above, but differs for energies below ~ 100 MeV.

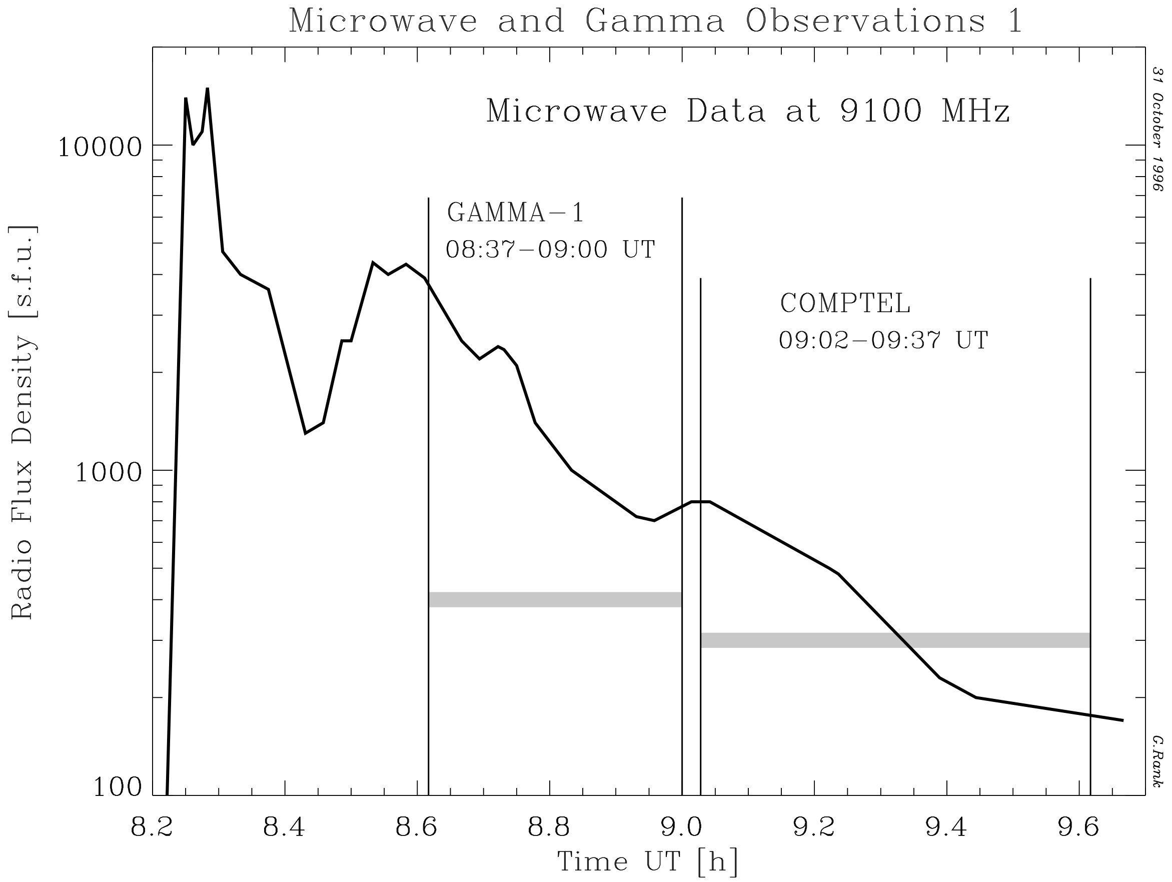

Figure 1: *Microwave and gamma measurements for the June 15 flare.*

(C) Djantemirov *et al.* (1995):
This approach is based on an untraditional iterative method to derive the photon spectrum. It is important to note, that this algorithm assumes a representation by a monotonously decreasing function a priori.

All three spectra are in agreement above about 100 MeV. The spectra given by Kocharov and Djantemirov are in good agreement with each other. The spectrum derived by Akimov agrees well for energies above 100 MeV. At the lower end, however, if falls off distinctly and at about 40 MeV, the flux values differ by more than a factor of 10.

COMPTEL measurements

For the deconvolution of the COMPTEL telescope spectra we use the Maximum Entropie Method (MEMSYS-5 code). The procedure of sampling count rate spectra and deconcolving them has been described in report rep_9608. We use a time interval from 9:02 to 9:37 UT (32500-34600 s).

How to align COMPTEL and GAMMA-1 spectra?

The measurements of COMPTEL and GAMMA-1 have been obtained during different time periods. Therefore, the spectra of both instruments cannot be compared directly. As the COMPTEL measurements are taken later, the flux has already decreased compared to the GAMMA-1 measruements.

To enable a comparison we use the microwave data, that resemble the time profiles of the gamma-radiation very well. Figure 1 shows the 9100 MHz microwave time profile as measured by Zimenki station (from Kocharov *et al.* (1994)). We integrate the microwave flux over the time intervals that refer to the GAMMA-1 and COMPTEL observation periods. We obtain a ratio of 3.95 for the intervals indicated in the figure. Assuming that the gamma-ray flux has decreased by the same factor, we now multiply the COMPTEL spectrum by this scaler.

This method allows to construct a composite spectrum, that is corrected for the effect of a decreasing total flux. It assumes that the gamma-ray flux in the energy range from 0.75 MeV to 4 GeV and the microwave flux at 2100 MHz show the same time profile, at least at time scales of about ten minutes. Further, the combination of both datasets is only meaningful under the assumption that the spectrum does not change in shape during the time periods of interest.

Results

The composite spectrum of GAMMA-1 and COMPTEL is shown in figure 2. The histogram gives the COMPTEL spectrum, scaled up by a factor of about 4. For the GAMMA-1 instrument, all three deconvolved spectra are included: the solid line shows the spectrum by Akimov *et al.* (1996), together with the 1σ uncertainty at the lower boundary, the data points with error bars denote the spectrum given by Kocharov *et al.* (1994) and a model fit as dashed line. Squares represent the spectrum given by Djantemirov *et al.* (1995).

The COMPTEL data show clear emission in the 8-30 MeV band. This flux fits more smoothly to the higher GAMMA-1 values given in the range from about 50-100 MeV. The sharp turnover in the spectrum given by Akimov *et al.* (1996) does not well agree with the high energy COMPTEL data points.

References

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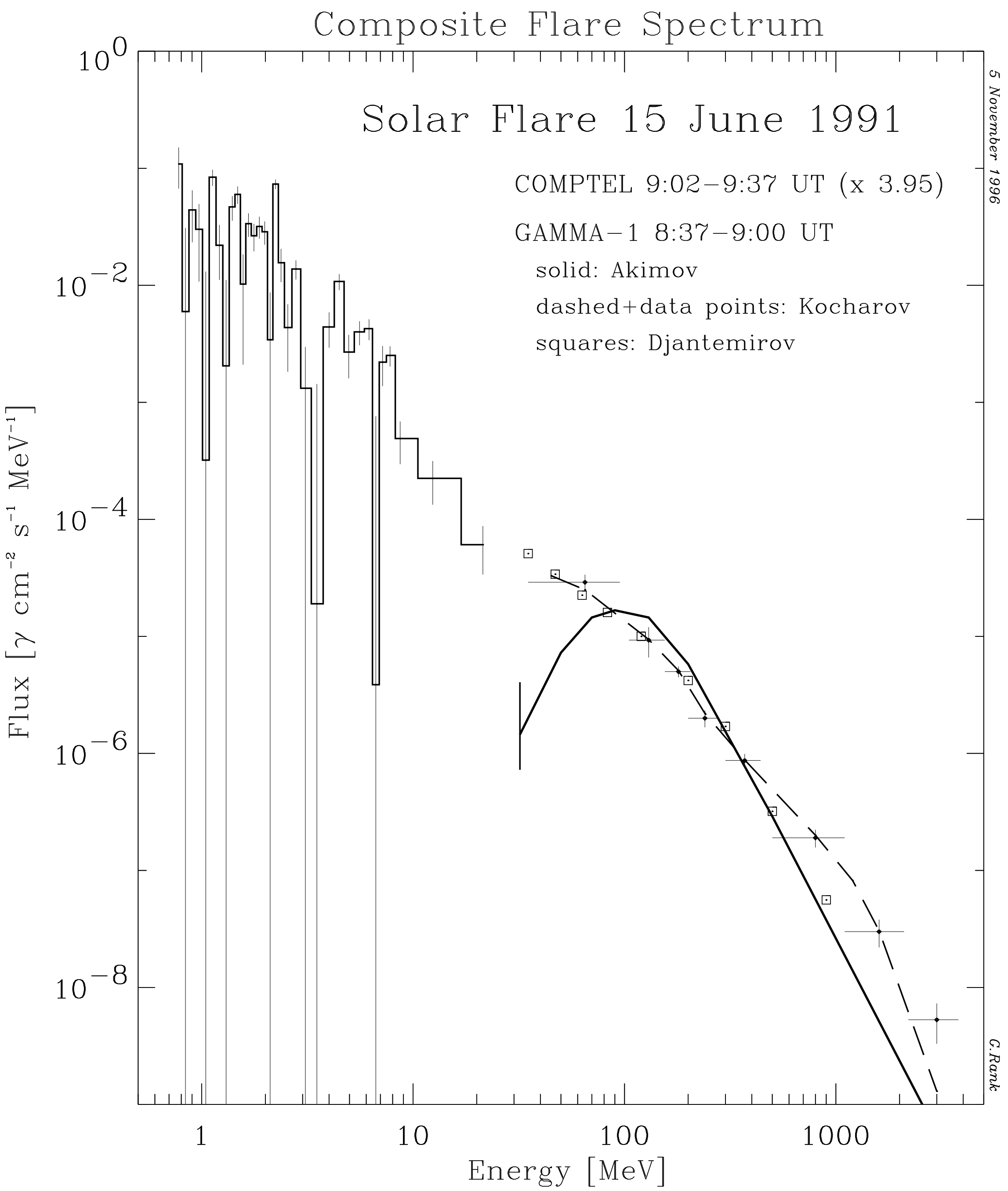

Figure 2: *Composite spectrum of GAMMA-1 and COMPTEL for the June 15 flare.*