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Abstract. — COMPTEL is the first imaging telescope to explore the MeV gamma-ray range (0.7 to 30 MeV). At present, it is performing a complete sky survey. In later phases of the mission selected celestial objects will be studied in more detail. Targets of special interest in the COMPTEL energy range are radio pulsars, X-ray binaries, novae, supernovae, supernova remnants, molecular clouds, the interstellar medium within the Milky Way, active galactic nuclei, and the diffuse cosmic background radiation. The data from the first half year of the mission have demonstrated that COMPTEL performs as expected. The Crab is clearly seen at its proper position in the first images of the anticentre region of the galaxy. The Crab and Vela pulsar lightcurves have been measured with unprecedented accuracy. The quasars 3C273 and 3C279 have been seen for the first time at MeV energies. Both quasars show a break in their energy spectra in the COMPTEL energy range. The 1.8 MeV line from radioactive ^{26}Al has been detected from the central region of the galaxy. Upper limits to gamma-ray line emission at 847 keV and 1.238 MeV from SN 1991T have been derived. Several cosmic bursts within the COMPTEL field-of-view could be located to an accuracy of about 1°. On June 9, 11 and 15, 1991 COMPTEL observed gamma-ray (continuum and line) emission from three solar flares. Neutrons were also detected from the June 9 flare.

Key words: gamma-rays.

1. Introduction.

COMPTEL covers the middle energy range of the four GRO-instruments, namely 0.7 to 30 MeV. This is one of the most difficult spectral ranges to explore in astronomy. Prior to the launch of GRO only a very few celestial objects were known in this part of the electromagnetic spectrum. With COMPTEL the field of MeV gamma-ray astronomy can now be fully explored.

COMPTEL is the first imaging MeV gamma-ray telescope ever flown on a satellite. COMPTEL has a large field-of-view of about 1 steradian - hence about 8 % of the entire sky is viewed in one single observation. Different sources within this field can be resolved if they are separated by more than ~3° to 5°. With its energy resolution of 5 % to 10 % FWHM COMPTEL is well suited to study continuum and line emission. COMPTEL has an unprecedented sensitivity: at 1 MeV celestial objects, which are 15-times weaker than the Crab, can be detected in a 2-week observation period. In addition to gamma rays, solar neutrons above 15 MeV can also be measured by COMPTEL. A comprehensive description of the capabilities and characteristics of COMPTEL is given by Schönfelder *et al.*, 1984 and 1992.

Together with EGRET, COMPTEL is at present performing a complete sky survey - the first in gamma-ray astronomy - in 33 pointings. During the time of the Toulouse Symposium the first 22 of these observations have been completed. Most of the pointings lasted two weeks each. The analysis of the data from these observations is an arduous and difficult process. This is due to the fact that the arrival direction of each photon detected by COMPTEL is not defined unambiguously, but is only known to lie on a circle on the sky. The processing of the raw data is completed for the first half year of the mission. Most of the scientific analysis is still preliminary. An overview of the most important results obtained from this analysis is given here. More detailed descriptions of the individual results are presented in contributed papers in these proceedings.

2. Results.

The preliminary COMPTEL results can be grouped under the following headings:

1 Observation of the anticentre of the Galaxy with the Crab and its pulsar.
2 Observation of the Vela pulsar.
3 Observations of the quasars 3C273 and 3C279.
4 Detection of 1.8 MeV gamma-ray line emission from radioactive ^{26}Al from the central region of the galaxy.
5 Upper limits to gamma-ray line emission from SN 1991T.
6 Localisation of cosmic gamma-ray bursts to an accuracy of about 1° and measurement of burst spectra and time profiles.
7 Observation of gamma-ray and neutron emission from solar flares.

Each of these topics is briefly discussed.

2.1. Crab and Crab-pulsar.

The first celestial COMPTEL image derived from a wide (60° × 60°) field was from the anticentre region of the Galaxy. As described in the paper by Strong *et al.* (1992) images in three different energy bands (1 to 3, 3 to 10, and 10 to 30 MeV) have been reconstructed from the data using the maximum-entropy deconvolution method. The Crab stands out clearly as the only source within this wide field. No other sources are visible. But the addition of overlapping observations in the future will improve the source sensitivity. There is no excess at the position of Geminga (l = 195.1°, b = + 4.5°) in any of the energy ranges. The upper limit to the Geminga flux above 1 MeV is 10^{-4} cm^{-2} s^{-1} (about 7 % of the Crab flux). The total Crab flux is (1.4 ±0.5) × 10^{-3} cm^{-2} s^{-1} between 1 and 30 MeV. The photon energy spectrum of the total Crab emission can be described by a power law with index -2.2.

The Crab pulsar analysis (Bennett *et al.* 1992) from 4 weeks of data yields a lightcurve with strong interpulse emission between the two main peaks which resembles very much that seen at hard x-ray energies. The pulsed fraction of the Crab emission varies between 25 % (1 MeV) and 36 % (30 MeV) of the total emission. There are indications for time variability of the pulsed emission over time-scales of weeks, which at present are being studied.

2.2. Vela pulsar.

Pulsed emission from the Vela pulsar was found only recently in the COMPTEL data. Due to the hardness of the Vela gamma-ray spectrum (as known from the SAS-2 (Thompson *et al.* 1975) and COS-B (Bennett *et al.* 1977) spectra, the clearest signal from the COMPTEL data was found in the 10 to 30 MeV range (see Bennett *et al.*, 1992). The COMPTEL light curve is strikingly different from that obtained during a 1981 balloon flight by Tümer *et al.* (1984) in a comparable energy range. There are indications for time variability of the COMPTEL light curves obtained in May and August 1991.

2.3. Quasars 3C273 and 3C279.

Prior to the launch of GRO quasars and other nuclei of active galaxies were thought to be promising objects in the COMPTEL energy range. Many have hard x-ray spectra, from which one might conclude that at least some of them have their peak luminosity at MeV-energies. The two quasars 3C273 and 3C279 are the first AGN's detected by COMPTEL (see Hermsen *et al.* 1992). Though both objects were rather weak during COMPTEL observation in June 1991 (about 20 % and 10 % of the Crab flux, respectively), their detection was statistically significant (7σ and 4σ, respectively). The data from a second observation of both quasars in October 1991 are not yet analyzed. In the COMPTEL energy range (1 to 30 MeV) 3C273 has a softer spectrum than 3C279. If the COMPTEL data are combined with the EGRET data (and in case of 3C273 also with the OSSE data), then it becomes evident that the energy spectra of both quasars are each composed of two power-law components, which break and steepen between 1 and 3 MeV (3C273) and near 10 MeV (3C279). Whereas the peak luminosity of 3C273 lies between 1 and 3 MeV, that of 3C279 ranges from 10 MeV to 5 GeV (see Hermsen *et al.* 1992).

2.4. Galactic 1.8 MeV ^{26}Al gamma-ray line.

The 1.8 MeV gamma-ray line from radioactive ^{26}Al was discovered more than 10 years ago by HEAO-C (Mahoney *et al.* 1984). Little information was available from those measurements on the location of the line emission except that it came from the general direction of the galactic center region.

^{26}Al is an isotope with a radioactive decay time of 1.04 × 10^6 years. Therefore, one can expect to see the line from the accumulation of all ^{26}Al formation sites over the last million years. It has been suggested that either supernovae, novae or peculiar massive stars or a combination of all three, might be the sites in which ^{26}Al is produced and then ejected into interstellar space.

COMPTEL will eventually be able to provide a map along the entire galactic plane in the 1.8 MeV line. This map may then help deciding which objects produce the line. The map does not yet exist, but the line has clearly been detected by COMPTEL in its observation of the galactic centre region. Diehl *et al.* (1992) have derived a longitude profile of the 1.8 MeV-counts in the range $-30° \leq l \leq 30°$. A deconvolution of this count-rate profile into a flux profile is not yet available; this imaging analysis requires detailed knowledge of response and background models, which is substantially more difficult for extended emission than for point sources. The measured profile is inconsistent with a point-source origin of the entire line emission at the position of the galactic centre. The total line flux from the entire field-of-view (±30° around the galactic centre) is about 4 × 10^{-4} cm^{-2} s^{-1}, consistent with previous measurements.

2.5. SN 1991T.

The search for gamma-ray lines from SN 1991T yields a negative result. The type Ia supernova which occurred on or shortly before April 10, 1991 in the spiral galaxy NGC 4527 at a distance of about 13.5 Mpc was observed by COMPTEL in June and October, 1991. The preliminary 2σ upper limits to the ^{56}Co lines at 846 keV and 1.2383 MeV are 4.4 × 10^{-5} cm^{-2} s^{-1} and 4.1 × 10^{-5} cm^{-2} s^{-1} (June observation) and 3.9 × 10^{-5} cm^{-2} s^{-1} and 3.4 × 10^{-5} cm^{-2} s^{-1} (October observation), respectively. Though these limits are close to predicted line fluxes, they do not yet constrain different theoretical models (see Lichti *et al.* 1992).

2.6. Gamma-Ray Bursts.

Not only did COMPTEL perform the preplanned observations of the survey, but we were also fortunate to observe a number of gamma-ray bursts and solar flares within the COMPTEL field-of-view. The positions of five of the measured gamma-ray bursts could be derived from their maximum-entropy images and maximum-likelihood maps. These are GRB 910503 (Winkler *et al.* 1992) and GRB 910425, GRB 910601, GRB 910627, and GRB 910814 (Connors *et al.* 1992). Energy spectra and time profiles of these bursts (except for GRB 910627) are described by Collmar *et al.* 1992. The combination of the COMPTEL error boxes with the one-dimensional localisation by triangulation using Ulysses and GRO burst arrival times, leads to elongated error boxes of the burst positions, which are a few degrees wide in one dimension and a few arcminutes wide in the other dimension. Based on such an error box, a counterpart search for GRB 910503 has been performed by Boer *et al.* (1992) using ROSAT data. No positive identification is reported from this search.

2.7. Solar flares.

On June 9, 11 and 15 COMPTEL observed three solar flares within its field-of-view. Preliminary results from these flares are described by Ryan *et al.* (1992). In all three flares the gamma-ray spectra show continuum and line components. Lines are seen at 1.6 MeV (^{20}Ne), 2.2 MeV (neutron capture line), and 4.4 MeV (^{12}C). The June 15 flare still showed observable MeV-emission 90 minutes after the onset of the flare, suggesting correspondingly long- lasting particle acceleration time. The detection of the 2.2 MeV neutron-capture line in all three flares indicates that neutrons were produced in these flares. In case of the June 9 flare, these neutrons have already been detected by COMPTEL in the energy range 15 - 80 MeV. The analysis of the neutron data from the other two flares is still in progress. The simultaneous measurements of the 2.2 MeV line and the neutron flux provide a powerful diagnostic tool to study the emission processes and geometries.

3. Conclusion.

The first results from COMPTEL have demonstrated that a multitude of phenomena can be studied at MeV-energies. This energy range is unique and provides information, which other ranges cannot provide. We have learned that strong high-energy sources (those seen by EGRET) are not necessarily strong MeV-sources as well and vice versa. The fact that 3 out of 4 steady objects (the Vela-pulsar and the two quasars 3C273 and 3C279) show a steepening of their spectra just within the COMPTEL energy range, may be a characteristic signature of this part of the electromagnetic spectrum. Most of the objects and phenomena observed by COMPTEL so far are time variable. The sky survey underway may therefore yield results which are different from surveys made in a few years time.

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