PHILOSOPHICAL TRANSACTIONS OF THE ROYAL SOCIETY A MATHEMATICAL, PHYSICAL & ENGINEERING SCIENCES

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The second COS-B catalogue of high-energy γ-ray sources

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The detection by COS-B of 13 high-energy γ-ray sources (Hermsen *et al.* 1977) showed for the first time that copious γ-ray emission is produced in numerous localized regions. The mysterious nature of those objects has persisted owing to a lack of unambiguous identification, except for PSR 0531 + 21 and PSR 0833 – 45. COS-B has continued to operate successfully since its launch in August 1975 and sufficient data have now been accumulated to permit a more systematic search for γ-ray sources in the Galaxy. The results of the survey provide the basis for unbiased investigation of the γ-ray sources which is the first requirement for the derivation of the main characteristics of this population.

The 32 observations, each typically of one month duration, used for this investigation were made in the period August 1975 to December 1978. The region of the sky covered is shown in figure 1. The angular resolution of COS-B below 100 MeV is inadequate to maintain a sufficiently uniform source visibility throughout the Galaxy because of the complex structure of the galactic γ-ray emission, particularly in the intense regions of the inner Galaxy (Mayer-Hasselwander *et al.* 1980). Therefore, only events of measured energy above 100 MeV have been used in this search. The measured arrival directions of the γ-rays have been sorted into $0.5° \times 0.5°$ bins. The resulting sky-map was analysed by using a cross-correlation method in which the distribution of the photon arrival directions was correlated with the distribution expected for a point source. This latter distribution, the intrinsic point-spread function of the instrument, was determined by calibration and confirmed by the flight data for the strong source PSR 0833 – 45. A γ-ray source is thus defined as a significant excess which has a spatial distribution consistent with the point-spread function. Pertinent aspects of the complete analysis have been presented by Hermsen (1980).

The positions of the 25 detected γ-ray sources are shown in figure 1. Parameters of these sources, designated 2CG *l b* after Hermsen *et al.* (1977), are given in table 1. The error radii (*ca.* 90% confidence level) have been derived by using representative simulations. Although the profiles of all the sources are compatible with that expected for a point source, the angular extent of the sources may be up to 2°. Because the sensitive area of the detector varies with energy, the conversion from source counts to source flux depends on the assumed spectral shape. The flux values listed in table 1 have been derived by assuming E^{-2} differential photon spectra because this slope is consistent with the average observed ratio of fluxes above 300 MeV and 100 MeV (see column 7 of table 1). It can be seen that individual spectra deviate from

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TABLE 1. THE 2CG CATALOGUE OF γ-RAY SOURCES

source name	no. of observations used	position l deg	position b deg	error radius deg	flux† ($E > 100$ MeV) 10^{-6} ph cm^{-2} s^{-1}	spectral‡ parameter	comments	CG source Hermsen *et al.* (1977)	identification	reference
2CG006−00	3	6.7	−0.5	1.0	2.4	0.39 ± 0.08				
2CG010−31	1	10.5	−31.5	1.5	1.2	—				
2CG013+00	4	13.7	0.6	1.0	1.0	0.68 ± 0.14				
2CG036+01	3	36.5	1.5	1.0	1.9	0.27 ± 0.07				
2CG054+01	3	54.2	1.7	1.0	1.3	0.20 ± 0.09				
2CG065+00	4	65.7	0.0	0.8	1.2	0.24 ± 0.09		CG64+0		
2CG075+00	5	75.0	0.0	1.0	1.3	—	could be an	CG75−0		
2CG078+01	5	78.0	1.5	1.0	2.5	—	extended feature	CG78+1		
2CG095+04	3	95.5	4.2	1.5	1.1	—				
2CG121+04	3	121.0	4.0	1.0	1.0	0.43 ± 0.12		CG121+3		
2CG135+01	3	135.0	1.5	1.0	1.0	0.31 ± 0.10		CG135+1		
2CG184−05	4	184.5	−5.8	0.4	3.7	0.18 ± 0.04		CG185−5	PSR 0531+21	Kniffen *et al.* (1974)
2CG195+04	3	195.1	4.5	0.4	4.8	0.33 ± 0.04	γ195+5	CG195−4		Thompson *et al.* (1977)
2CG218−00	3	218.5	−0.5	1.3	1.0	0.20 ± 0.08				
2CG235−01	2	235.5	−1.0	1.5	1.0	—				
2CG263−02	4	263.6	−2.5	0.3	13.2	0.36 ± 0.02		CG263−2	PSR 0833−45	Thompson *et al.* (1975)
2CG284−00	1	284.3	−0.5	1.0	2.7	—	could be an			
2CG288−00	1	288.3	−0.7	1.3	1.6	—	extended feature			
2CG289+64	2	289.3	64.6	0.8	0.6	0.15 ± 0.07		CG291+65	3C273	Swanenburg *et al.* (1978); Bignami *et al.* (1980)
2CG311−01	2	311.5	−1.3	1.0	2.1	—		CG312−1		
2CG333+01	3	333.5	1.0	1.0	3.8	—		CG333+0		
2CG342−02	5	342.9	−2.5	1.0	2.0	0.36 ± 0.09				
2CG353+16	4	353.3	16.0	1.5	1.1	0.24 ± 0.09			ρ-Oph	Mayer-Hasselwander *et al.* (1980)
2CG356+00	1	356.5	0.3	1.0	2.6	0.46 ± 0.12	probably variable			
2CG359−00	3	359.5	−0.7	1.0	1.8	—				

† Obtained by assuming E^{-2} spectra.

‡ Intensity($E > 300$ MeV)/intensity($E > 100$ MeV), obtained by assuming E^{-2} spectra in calculating both intensities.

this average (see also Wills *et al.* 1980), and therefore individual fluxes must be considered approximate (*ca.* $\pm$ 30%).

Only four sources of the catalogue have been identified. 2CG184 – 05 and 2CG263 – 02 are identified with the Crab and Vela pulsars through their timing signature (Bennett *et al.* 1977). The other two are identified because of the remarkable positional coincidences, 2CG289 + 64 with 3C273 (Swanenburg *et al.* 1978; Bignami *et al.* 1981), and 2CG353 + 16 with the ρ-Oph cloud complex (Mayer-Hasselwander *et al.* 1980; Bignami & Morfill 1980). For the remaining 21 sources no unambiguous counterparts appear to exist at other wavelengths. With the exception of 2CG010 – 31 all these sources lie close to the galactic disc.

For additional information on the analysis and selection effects and a discussion on the distribution, average luminosity (in the range (0.4–5) $\times 10^{36}$ erg s^{-1}†) and nature of the γ-ray sources and other topics see Swanenburg *et al.* (1981) and Hermsen (1980).

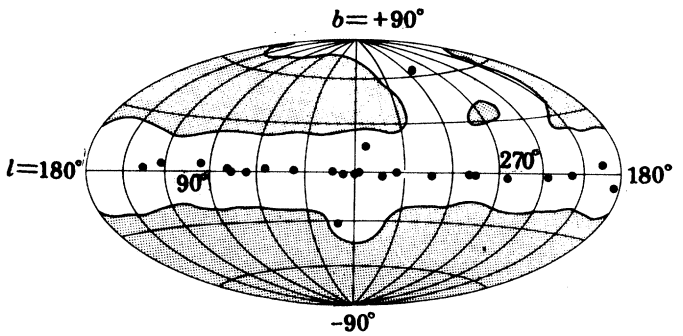

FIGURE 1. Region of the sky searched for γ-ray sources (unshaded), and sources detected above 100 MeV by spatial analysis (●).

† 1 erg s^{-1} = 10^{-7} W.

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