Chapter 7

Gamma-ray astronomy

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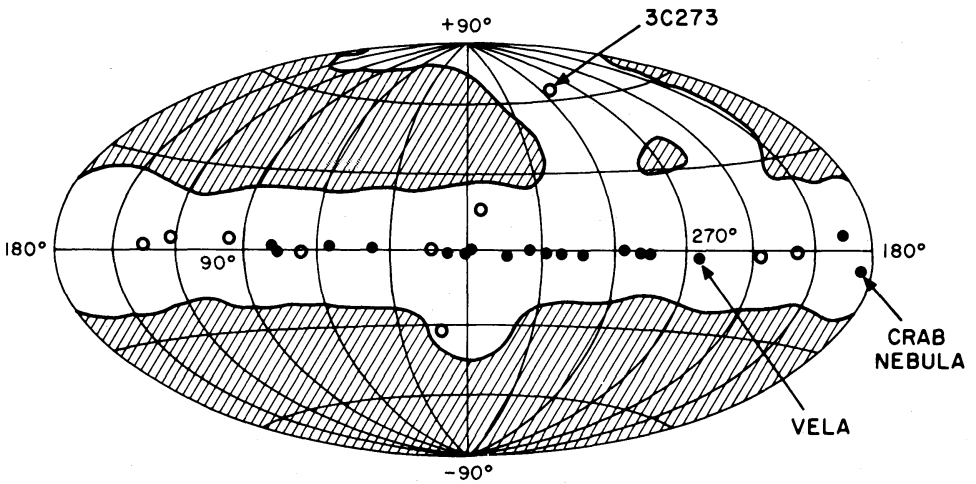
Gamma-ray source map

Region of the sky searched for gamma-ray sources by COS-B (unshaded) and sources detected above 100 MeV. The closed circles denote sources with intensities $\geqslant 1.3 \times 10^{-6}$ photons $cm^{-2}\,s^{-1}$; open circles denote sources below this level. (Adapted from Scarsi, L. *et al.*, *Proc. 12th ESLAB Symp.*, 1977.)



The Second COS-B Catalog of Gamma-ray Sources

Source name	Galactic coord. l (°)	Galactic coord. b (°)	Error radius (°)	Flux[a]	Spectral[b] hardness	Identification
2CG 006−00	6.7	−0.5	1.0	2.4	0.39±0.08	
2CG 010−31	10.5	−31.5	1.5	1.2	...	
2CG 013+00	13.7	+0.6	1.0	1.0	0.68±0.14	
2CG 036+01	36.5	+1.5	1.0	1.9	0.27±0.07	
2CG 054+01	54.2	+1.7	1.0	1.3	0.20±0.09	
2CG 065+00	65.7	0.0	0.8	1.2	0.24±0.09	
2CG 075+00	75.0	0.0	1.0	1.3	...	
2CG 078+01	78.0	+1.5	1.0	2.5	...	
2CG 095+04	95.5	+4.2	1.5	1.1	...	
2CG 121+04	121.0	+4.0	1.0	1.0	0.43±0.12	
2CG 135+01	135.0	+1.5	1.0	1.0	0.31±0.10	
2CG 184−05	184.5	−5.8	0.4	3.7	0.18±0.04	PSR 0531+21 (Crab)
2CG 195+04	195.1	+4.5	0.4	4.8	0.33±0.04	
2CG 218−00	218.5	−0.5	1.3	1.0	0.20±0.08	
2CG 235−01	235.5	−1.0	1.5	1.0	...	

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Source name	Galactic coord. l (°)	b (°)	Error radius (°)	Flux[a]	Spectral[b] hardness	Identification
2CG 263−02	263.6	−2.5	0.3	13.2	0.36±0.02	PSR 0833−45 (Vela)
2CG 284−00	284.3	−0.5	1.0	2.7	...	
2CG 288−00	288.3	−0.7	1.3	1.6	...	
2CG 289+64	289.3	+64.6	0.8	0.6	0.15±0.07	3C 273
2CG 311−01	311.5	−1.3	1.0	2.1	...	
2CG 333+01	333.5	+1.0	1.0	3.8	...	
2CG 342−02	342.9	−2.5	1.0	2.0	0.36±0.09	
2CG 353+16	353.3	+16.0	1.5	1.1	0.24±0.09	ρ Oph Cloud
2CG 356+00	356.9	+0.3	1.0	2.6	0.46±0.12	
2CG 359−00	259.5	−0.7	1.0	1.8	...	

[a] Flux: $E > 100$ MeV (10^{-6} photons cm^{-2} s^{-1}).
[b] Intensity ($E > 300$ MeV)/Intensity ($E > 100$ MeV), assuming E^{-2} spectra in calculating both intensities.

Notes: error radius defines approximately the 90% confidence error circle; fluxes are approximate, since an E^{-2} spectrum is assumed for simplicity.
(Adapted from Swanenburg, B. N. *et al.*, *Ap. J.* (*Letters*), **243**, L69, 1981.)

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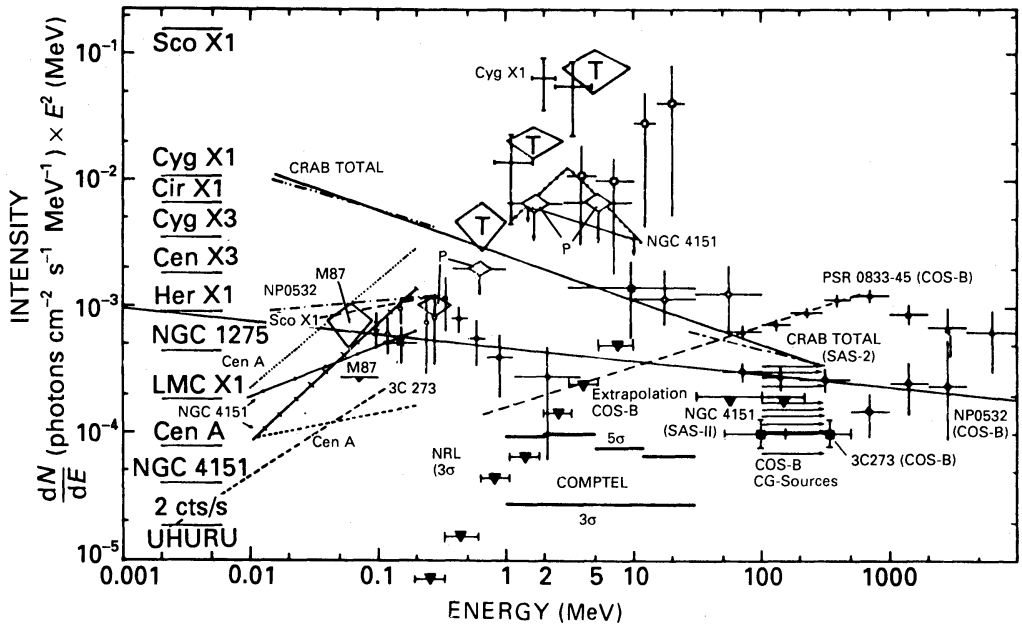
Intensities of X- and gamma-ray sources

Compilation of the intensities of a variety of X- and gamma-ray sources. The ordinate, the number of photons $cm^{-2}\,s^{-1}\,MeV^{-1}$, is multiplied by E^2. (Adapted from Schönfelder, V. in *Non-Solar Gamma-Rays*, R. Cowsik & R. Wills, eds., Pergamon Press, 1980.)



Very high energy gamma-rays

Cen A: $\bar{F}_\gamma\ (\gtrsim 300\,GeV) \simeq (4.4 \pm 1) \times 10^{-11}$ photons $cm^{-2}\,s^{-1}$
(Grindlay, J. *et al.*, *Ap. J.* (Letters), **197**, L9, 1975)
Crab Pulsar: $(\Delta t)F_\gamma(\gtrsim 800\,GeV) = 4.0 \times 10^{-12}$ photons cm^{-2}
(Grindlay, J. *et al.*, *Ap. J.*, **209**, 592, 1976)

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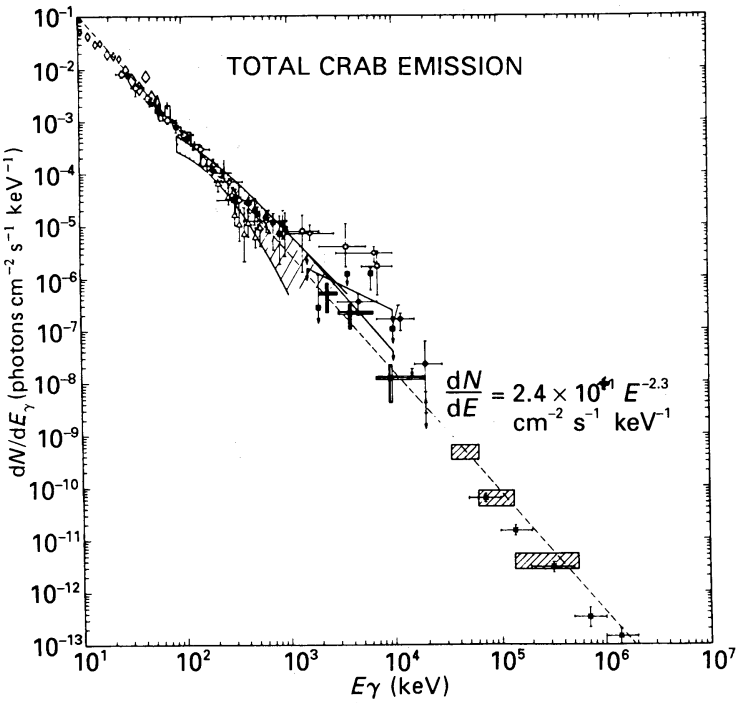
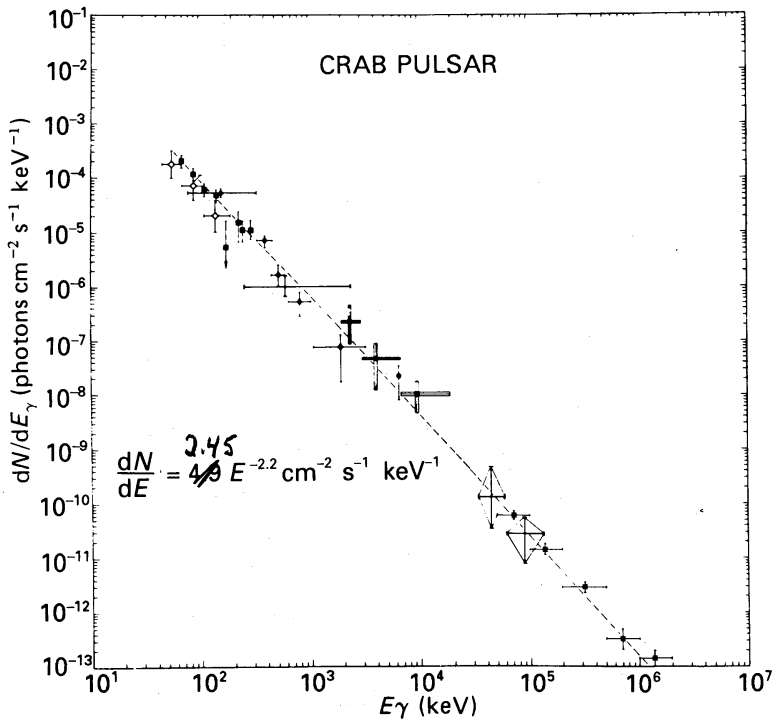
Crab Nebula spectra

Photon number spectrum of the total Crab emission. (Adapted from Schönfelder, V., *op. cit.*, see reference for explanation of symbols.)



Photon number spectrum of the Crab pulsar. (Adapted from Schönfelder, V., *op. cit.*, see reference for explanation of symbols.)



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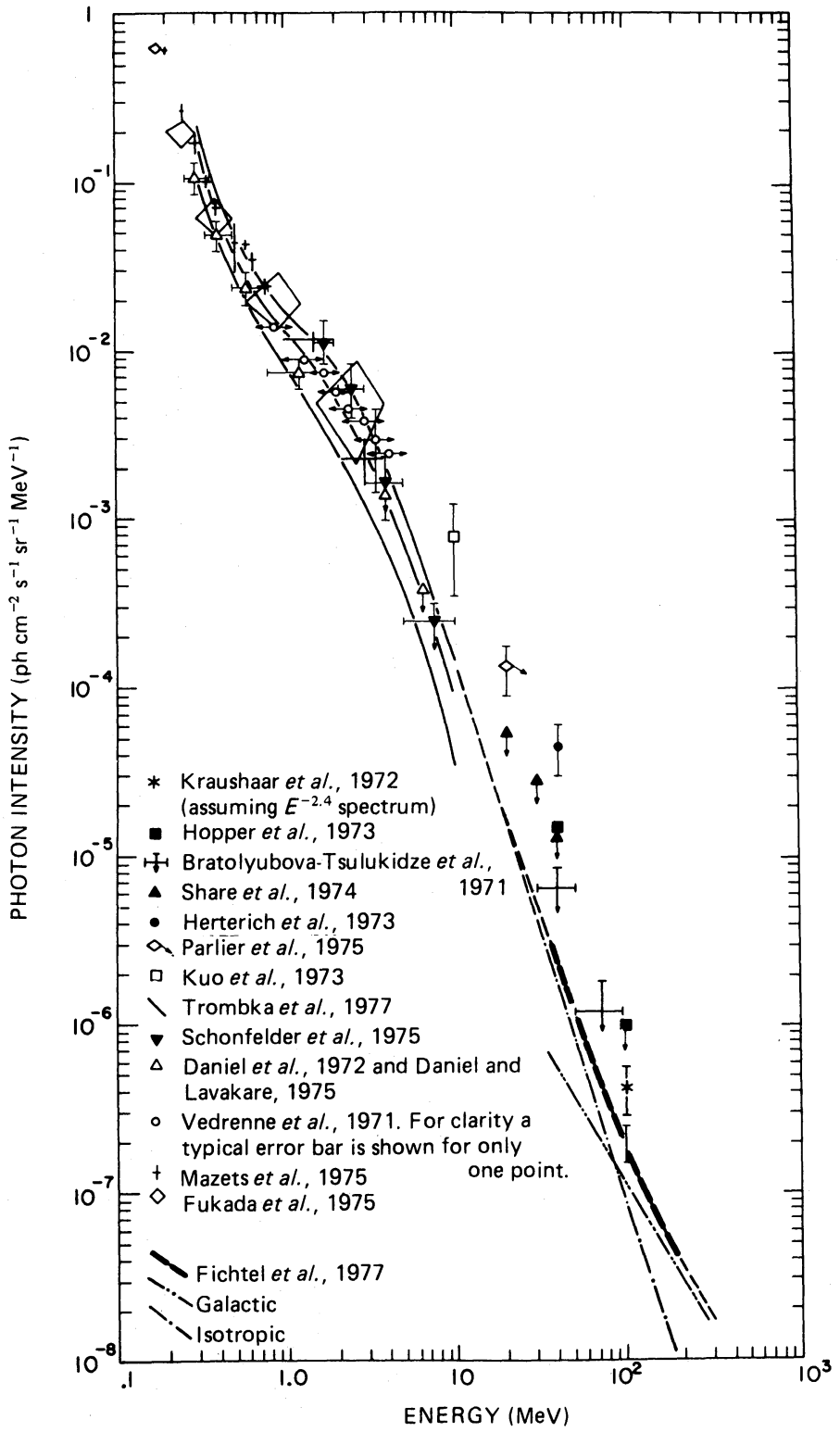
Spectrum of diffuse gamma-ray background. (Adapted from Fichtel, C. E., Simpson, G. A. & Thompson, D. J., *Ap. J.*, **22**, 833, 1978.)



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An incomplete list of astrophysically important gamma-ray spectral features

Identification	Energy (MeV)	Identification	Energy (MeV)
Cf-249	0.34	N-14	2.313
Cf-249	0.39	Ne-20	2.613
Annihil. rad.	0.511	O-16	2.741
Ni-56	0.812	Mg-24	2.754
Fe-56	0.847	Ne-20	3.34
Co-56	0.847	C-12	4.438
Fe-56	1.238	N-14	5.105
Mg-24	1.369	O-16	6.129
Ne-20	1.634	Si-28	6.878
Si-28	1.779	O-16	6.917
Al-26	1.81	O-16	7.117
Neutron capture	2.23		

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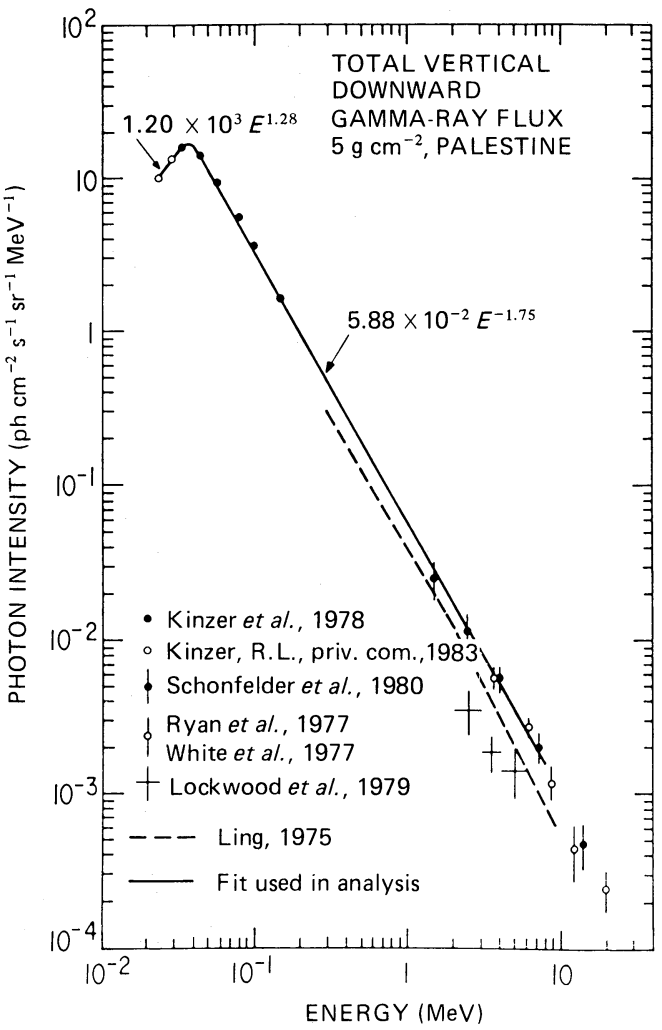
Downward gamma-ray flux

Measurements of the total downward gamma-ray flux at $5\,g\,cm^{-2}$ over Palestine, Texas. See original work for references. (From Gehrels, N., Instrumental background in balloon-borne gamma-ray spectrometers and techniques for its reduction, *NASA Technical Memorandum 86162*, 1985.)



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