V. E. Nesterov and O. F. Prilutskiĭ. *Discrete sources of cosmic gamma radiation.* Although the existence of the diffuse gamma radiation was predicted long before the advent of observational gamma astronomy, the discovery of strong discrete cosmic gamma-ray sources came as something of a surprise. Data on the discrete sources remained very spotty during the early development of observational gamma astronomy, for two reasons. First, even though the intensities of the sources are relatively high, the photon fluxes are very small, in the range from 10^{-6} to 10^{-5} photon/cm^2 · sec at energies above 100 MeV. Secondly, the angular resolutions of satellite gamma-ray telescopes are very poor by contemporary astronomical standards: the total half-height directional-pattern width of the COS-B telescope, from which the basic information on the discrete sources was obtained, is about 6° at 100 MeV. Poor angular resolution and limited observational statistics present serious difficulties in the search for astrophysical objects associated with gamma-ray sources.

The first more or less reliable results on discrete cosmic gamma-ray sources were obtained from the special-purpose SAS-2 satellite, which was functional for 7 months in 1972–1973.[1] Gamma radiation from the two fastest radiopulsars, PSR 0833-45 and NP 0532, was detected. The previously unidentified source γ195 +5, whose emission was found to pulsate with a 59-second period, was discovered in the region of the Galactic anticenter; the period was increasing at the rather high rate $\dot{P} \sim 2 \cdot 10^{-9}$ sec/sec. The announcement that gamma radiation from the pulsars PSR 1747-46 and PSR 1818-04 had been registered was quite unexpected; to explain the observed intensity of these objects, it would be necessary to assume that most of the energy released on deceleration of the rotating neutron star is converted to gamma-radiation energy. Finally, indications of gamma radiation coming from the unusual x-ray and radio source Cyg X-3 were obtained from the SAS-2 satellite,[3] as they had been somewhat earlier with the balloon-borne telescope of the Soviet MIFI (Moscow Engineering Physics Institute) group.[2]

A new phase in the development of gamma astronomy began with the launching of the second special COS-B satellite in August, 1975. This satellite is still functioning, although its design lifetime was only one year. One of the main results of observations made with its telescope was the detection of a large number of discrete gamma sources. Analysis of the data obtained during the satellite's first 2.5 years of service resulted in a 25-source catalog.[4] The parameters of these sources are given in Table I, while the figure indicates their distribution on the sky. The discovery of so many sources resulted primarily from the increased observational statistics: while SAS-2 registered about 5000 photons from the plane of the Galaxy, the number registered on COS-B had reached 64 000 by 1978. Observations made with the more sensitive "Gamma" telescope should result in many additions to the list of discrete gamma-radiation sources.

Only three of the 25 sources in the catalog have been identified: the pulsars PSR 0833-45 and NP 0532 and the quasar 3C 273. One more source, 2GC 353 +16, may be associated with a gigantic cloud of gas and dust in Ophiuchus. The nature of the remaining sources remains unknown, and we can discuss only the statistical-average characteristics of these objects at the present time. The salient feature of the population of discrete Galactic gamma sources is their exceptionally strong

TABLE I. 2Gc catalog gamma-radiation sources.

Designation of source	Statistical significance	Galactic coordinates		Position error	Flux, $E \geq 100$ MeV (10^{-6} photon/cm^2 sec)	Spectral parameter
2CG006—00	10.2	6.7	—0.5	1.0	2.4	0.39
2CG010—31	5.7	10.5	—31.5	1.5	1.2	
2CG013+00	5.3	13.7	0.6	1.0	1.0	0.68
2CG036+01	4.9	36.5	1.5	1.0	1.9	0.27
2CG054+01	5.3	54.2	1.7	1.0	1.3	0.20
2CG065+00	5.5	65.7	0.0	0.8	1.2	0.24
2CG075+00	5.8	75.0	0.0	1.0	1.3	
2CG078+01	11.9	78.0	1.5	1.0	2.5	
2CG095+04	4.9	95.5	4.2	1.5	1.1	
2CG121+04	4.9	121.0	4.0	1.0	1.0	0.43
2CG135+01	4.9	135.0	1.5	1.0	1.0	0.31
2CG184—05	20.6	184.5	—5.8	0.4	3.7	0.18
2CG195+04	27.1	195.1	4.5	0.4	4.8	0.33
2CG218—00	6.2	218.5	—0.5	1.3	1.0	0.20
2CG235—01	5.0	235.5	—1.0	1.5	1.0	
2CG263—02	35.7	263.6	—2.5	0.3	13.2	0.36
2CG284—00	6.5	284.3	—0.5	1.0	2.7	
2CG288—00	4.8	288.3	—0.7	1.3	1.6	
2CG289+64	6.5	289.3	64.6	0.8	0.6	0.15
2CG311—01	5.6	311.5	—1.3	1.0	2.1	
2CG333+01	5.4	333.5	1.0	1.0	3.8	
2CG342—02	8.9	342.9	—2.5	1.0	2.0	0.36
2CG353+16	5.1	353.3	16.0	1.5	1.1	0.24
2CG356+00	5.3	356.5	0.3	1.0	2.6	0.46
2CG359—00	6.3	359.5	—0.7	2.0	1.8	

Note. The spectral parameter is the ratio of the fluxes in the ranges $E \geq 300$ MeV and $E \geq 100$ MeV.

TABLE II. Characteristics of unidentified gamma sources

Angular diameters	Less than 1-2°
Intensity, $E > 100$ MeV	$(1\text{-}5) \cdot 10^{-6}$ phot/cm² sec
Energy flux, $E > 100$ MeV	$(0.4\text{-}2) \cdot 10^{-12}$ W/m²
Spectrum	Various, averaging E^{-2}
Variability in time	Not excluded
Distance to sources	2-7 kpc
Luminosity, $E > 100$ MeV	$(0.4\text{-}5) \cdot 10^{39}$ W
Luminosity in other ranges	$L_X < 0.1 L_\gamma$
	$L_{rad} \ll L_\gamma$

concentration near the plane of the Galaxy. Table II[4] lists the statistical-average characteristics of the unidentified Galactic gamma sources.

At this time, the main obstacle to identification of discrete gamma sources is the inadequate angular resolution of the gamma-ray telescopes. Observations made with the "Gamma" telescope will advance solution of this problem, firstly because of the higher angular resolution of the instrument's track detectors and secondly because of the new process that will be used for gamma-ray imaging. This process, which was proposed by the Cosmic Ray Institute of the USSR Academy of Sciences (IKI AN SSSR)[5] and independently at Southhampton University,[6] uses an aperture-coding technique and is capable in principle of improving the angular resolution of gamma-ray telescopes to one minute of arc or better.

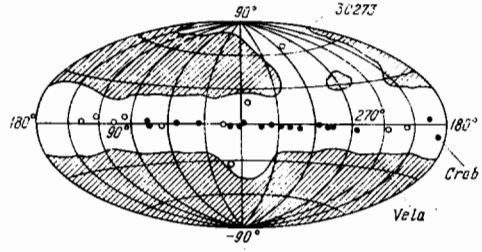

FIG. 1. Distribution of sources in 2GC catalog over celestial sphere. The figure shows the boundaries of the region in which discrete sources were looked for.

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[5]O. F. Prilutskiĭ, in: Proc. XXII COSPAR Session, Bangalore, 1979, p. 33.
[6]D. Ramsden, *ibid.* p. 33.