OBSERVATION OF GAMMA RADIATION OF THE SOURCE CYG X-3 IN OCTOBER 1972

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The paper deals with the observation of gamma radiation of energy higher than 40 MeV, from the cosmic source in the Cygnus constellation, from which several flares of radio and IR emission were registered in September and October 1972. The results were obtained with a high-aperture gamma telescope with spark chambers, carried aloft with a high-altitude balloon. The measured value of the gamma flux from the source is given. It is indicated that the source may be variable.

Great interest attaches to the region of the Cygnus constellation from which several strong radio and IR emission were registered in September and October 1972 [1, 2]. The location of the source is given by the coordinates $\alpha = 307.65°$ (right ascension) and $\delta = 40.78°$ (declination) [2]. The flares are assumed to come from the x-ray source Cyg X-3, the coordinates of which coincide with the location of the flares [1], although the x-ray flux from the source did not change noticeably during that time [3]. We present here preliminary results of a gamma-telescope study of the northern-hemisphere sky, which indicates definitely that a flux of cosmic gamma quanta of energy higher than 40 MeV exists and comes from the region of Cyg X-3.

The gamma quanta were registered with a high-aperture telescope with spark chambers [4]. The telescope consisted of two coincidence scintillation counters, a directional Cerenkov counter, and an anticoincidence counter. The direction of arrival of the gamma quantum was determined from tracks in a six-gap spark chamber with thin steel electrodes, in which the gamma-quantum conversion took place. The total converter thickness was about 0.9 radiation lengths. For a more reliable identification of the events we used a shower spark chamber, the electrods of which comprised 3.6 radiation lengths of lead. The geometric registration area of the gamma telescope was 250 cm^2, and the half-aperture angle was about 40°. The entire information from the telescope, including the picture of the event in the spark chambers, the readings of the intensity meters and of the navigation instruments, was recorded on photographic film.

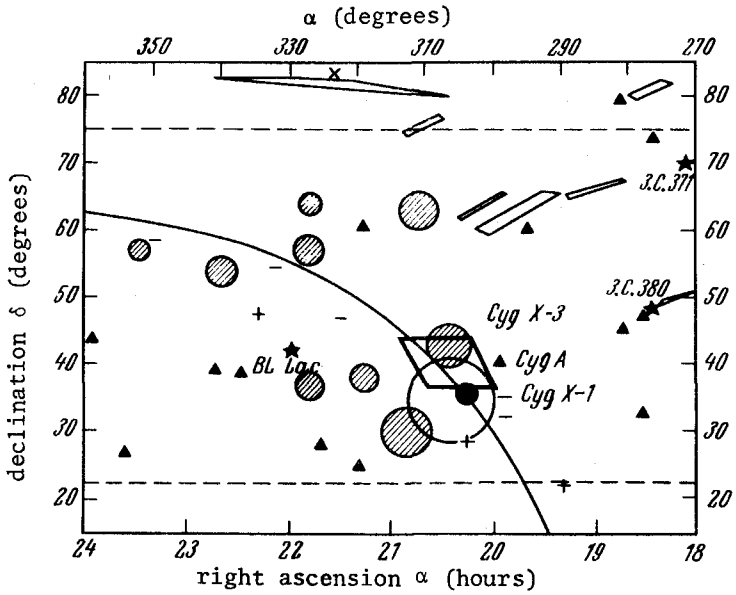
On 12 October 1972 the gamma telescope was lifted by a high-altitude balloon at the geographic latitude 52°N, and operated for 13 hours at a height corresponding to 7 - 10 g/cm^2 of residual atmosphere. In the interval from 13.00 to 17.00 UT, the telescope "surveyed" the region of Cygnus. During that time there were registered about 1000 gamma events, for each of which we calculated the celestial coordinates of the arrival direction, the right ascension α and the declination δ.

The surveyed region of the sky, with limits $\alpha = 270 - 360°$ and $\delta = 22 - 75°$, in which some 85% of the events occurred, was broken up into 50 equal bins. The bin dimension 7.5×7.5° (at $\delta = 0$) was determined by the multiple scattering of the pair components in the converter. For each bin we determined the number N of gamma quanta that entered it, and also the expected number of background events B, which were taken to be the atmospheric gamma quanta and made up the bulk of the telescope count. The distribution of the background events over the celestial coordinates was calculated from the distribution of the events with respect to the track angles in the spark chamber and from the readings of the navigation instruments, as registered during the flight. In one bin we obtained an appreciable excess of gamma quanta over the background, N = 37 as against the expected B = 20.8 ± 0.8, or an overshoot equivalent to 3.6 effective standard deviations. The probability of the random appearance of an excess in the given bin is

$$p = 1 - \sum_{k=0}^{N-1} \frac{B^k e^{-B}}{k!} \approx 8 \cdot 10^{-4},$$

and the probability of such a fluctuation occurring in one of the 50 bins is $P = 1 - (1 - P)^{50} \approx 50P = 4\times10^{-2}$. Since this quantity is quite small, and on there hand there are no apparent methodological reasons for an excess in only one of 50 bins, we believe that we have observed a discrete source of cosmic gamma quanta. Owing to the multiple scattering of the pair components, the image of the source is "blurred" over the sky on the area of the bin.

The figure shows a map of the surveyed region of the sky, which indicates the possible sources of gamma radiation (x-ray sources, pulsars, etc.), and also the places from which excess gamma-quantum fluxes were registered. Cyg X-3 is located practically at the center of the bin with the excess, whose position is determined by the coordinates $\alpha_e = 307 \pm 5°$ and $\delta_e = 40 \pm 3.5°$. This agreement gives grounds for identifying the gamma source with the peculiar object Cyg X-3. The integral radiation flux is $I(\geq 40\ \text{MeV}) \approx 2\times10^{-4}\ (\text{cm}^2\text{sec})^{-1}$ with a statistical error $\sim$40%. However, the possible systematic errors in the calculation of the telescope efficiency can either increase or decrease the flux by an approximate factor of two.



Map of surveyed sky region: dashed lines - boundaries of surveyed region, solid - equatorial plane of galaxy, rectangles - x-ray sources [6], crosses - pulsars, asterisks - variable radio sources, triangles - radio galaxies, x - quasar; possible gamma sources: ○ - [7], ◎ - [8], ● - [10], ▱ - present work

Excess fluxes of high-energy gamma quanta were previously registered from this region of the sky in [7 - 9]. It is possible that they were gamma rays from the same source Cyg X-3 during different phases of its activity, which may explain the difference between the flux intensities. A variable source of extra hard radiation ($E_\gamma \geq 10^{12}$ eV) was observed in [10].

The results indicate, with a high degree of reliability, that a high-energy gamma emission is produced by the object Cyg X-3 during the period of its enhanced activity. This is one more proof of the variability of the gamma radiation from cosmic sources, which was first pointed out in [11] with respect to the source Tau γ-1, tentatively identified with the radio galaxy 3C120.

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