ed by the inherent design features of the target chamber. This chamber, specifically designed for producing a very thin gas target for use in high-resolution, high-yield experiments, prevented us from acquiring better statistics. However, a new target chamber is near completion that is intended to overcome many of the present disadvantages. Its 5-liter liquid-helium reservoir should nearly triple our present 90-min running time, and changes in design have been incorporated which should permit production of a thicker target. Using the new apparatus, a more detailed experiment is scheduled for the future.

The fact that the present experiment already shows not only the predicted anomaly, but also a more complex behavior than that evidenced in Moore's experiment, is, we feel, especially significant in view of the great current interest in analog states. We would like to express thanks to Dr. L. C. Biedenharn and Dr. W. P. Beres for helpful discussion.

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*This work was supported in part by the U. S. Atomic Energy Commission.

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REPORTED COSMIC GAMMA-RAY SOURCE IN CYGNUS*

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(Received 19 December 1966)

Recently Duthie, Cobb, and Stewart[1] have presented evidence for a source of cosmic gamma rays at 304° right ascension and +35° declination with an intensity of $(1.5\pm0.8)\times10^{-4}$ γ's cm^{-2} sec^{-1}. In this Letter we wish to report the results of three high-altitude balloon flights with a γ-ray spark chamber which observed this same region of the sky. Two of these exposures were made prior to the Rochester flight while the third was nine months later. On none of the three flights did we observe any increase over the atmospheric background in the designated direction. Our conclusion is that either the Rochester result was due to a statistical fluctuation or an undetermined instrumental effect, or the source has increased in intensity by at least a factor 2 in nine months and then decreased again by at least a factor 10 in the following nine months.

Some results from our first flight have already been published[2] and the equipment is described in detail elsewhere.[3] The same system was used for the second flight except that the bottom counter in the coincidence telescope was changed to a Cherenkov counter. The sensitivity of this system was approximately the same as of that of the Rochester group. However, the uniform design, in contrast to their having a thick target followed by thin spark-chamber plates, provided better angular resolution, a lower energy threshold, and a rough energy determination. The third flight was made with an enlarged spark chamber whose sensitivity was greater by an order of magnitude.[4] The side anticoincidence panels (Fig. 1) are outside the acceptance cone of the coincidence counters. They greatly reduce spurious triggerings of the chamber by wide-angle

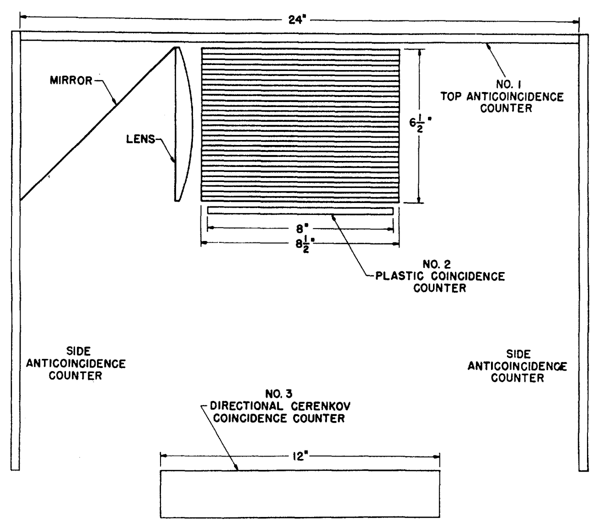

FIG. 1. The arrangement of the spark chamber and triggering counters is shown. There are 30 gaps of 0.5-cm spacing and the plates are 0.050-cm stainless steel.

Table I. The flight characteristic and spark-chamber parameters for the three Case flights and, for comparison, the Rochester flight.

Flight	Launch site	Reached ceiling altitude at	Time at ceiling (min)	Altitude (mbar)	Area-solid angle factor of spark chamber (cm^2 sr)	Conversion efficiency for $E_\gamma = 100$ MeV (%)	Energy threshold (MeV)
Case No. 1	Palestine, Texas	1500 U.T., 6 February 1964	74	3.5	53	12.4	≈30
Case No. 2	Page, Arizona	1550 U.T., 27 January 1965	400	3.2	48	12.4	≈50
Rochester	Palestine, Texas	1944 U.T. 23 October 1965	>570	4	25.8	15	≈60
Case No. 3	Palestine, Texas	0500 U. T. 19 July 1966	225	2.3	175	32.4	≈50

charged particles which scatter or interact in one of the counters in such a way that the telescope is triggered. The relevant parameters of each spark chamber and the flight data are summarized in Table I.

For each flight the effective area presented to the source direction is calculated as a function of time, as described previously.[2] Then the number of pairs, N_p, predicted by the flux of 1.5×10^{-4} γ's cm^{-2} sec^{-1} is calculated. It should be noted that N_p is independent of the assumed energy of the γ rays when we use the pair conversion efficiency at 75 MeV as Duthie et al. did. The predicted numbers are 2.9, 14.0, and 96 pairs for our three flights (Table II).

The solid angle over which these pairs would be distributed is, of course, determined by the angular resolution of the apparatus. Previously the resolution in the chamber was calculated to be ±2.5° at 100 MeV.[3] Similarly at 290 MeV it becomes ±1.3°. We have recently checked this latter point with the tagged-photon beam at the Cornell synchrotron and find it to be ±1.1°. Therefore when the chamber resolution is combined with that of the direction monitor (see below) the over-all resolution becomes ±3° at 100 MeV and ±4° at 75 MeV.

One of the puzzling features of the Rochester result is that their excess counts occur over a large area, an 18°×18° square. Therefore we have chosen to look at the results for three different areas: (1) a 3° cone which is the area over which a point source with a mean energy of 100 MeV would be distributed in our chambers, (2) a 4° cone which is the predicted angular resolution for 75 MeV, which the Rochester group took as the mean energy for their anomalous events, and (3) an 18°×18° square to compare directly with the Rochester angular interval.

In Table II, N_0, the number of pairs actually observed in a given solid angle, is to be compared to the sum of N_p, the number pre-

Table II. N_p is the number of pairs which would be produced by a flux of 1.5×10^{-4} γ's cm^{-2} sec^{-1} with $E_\gamma = 75$ MeV. N_B is the number of background pairs expected in the given solid angle from the atmospheric background. N_0 is the number of pairs actually observed in the given solid angle. F_{95} is the upper limit to the γ-ray flux at the 95% confidence level, in units of 10^{-5} γ's cm^{-2} sec^{-1}.

Flight No.	N_p	3° cone N_B	3° cone N_0	3° cone F_{95}	4° cone N_B	4° cone N_0	4° cone F_{95}	18°×18° square N_B	18°×18° square N_0	18°×18° square F_{95}
1	2.9	1.1	1	<18	1.9	2	21	10	11	<33
2	14.0	2.5	4	<6.7	4.5	5	<6.0	23.8	27	<15
3	96	15.1	14	<0.9	26.7	25	<1.2	141	142	<3.9
3[a]	≲96	...	...	...	10.5	10	<0.9	55.5	51	<1.7

[a]$E_0 < 100$ MeV.

dicted from the flux of 1.5×10^{-4} γ's cm^{-2} sec^{-1}, and N_B, the number expected from the observed atmospheric background. In no case is there any significant departure from the atmospheric background. Flight No. 1 was at altitude for too short a time to show a statistically significant difference from the Rochester flux. However, the data from the second and third flights do allow the setting of upper limits at the 95% confidence level which are well below 1.5×10^{-4} γ's cm^{-2} sec^{-1}. Flight No. 2 yields an upper limit for a 3° cone of 6.7×10^{-5} γ's cm^{-2} sec^{-1}. Similarly, for flight No. 3 the limit is 0.9×10^{-5} γ's cm^{-2} sec^{-1}. These limits do not depend on the exact position assumed for the source but are substantially the same anywhere in the 18°×18° square.

Duthie, Cobb, and Stewart also noticed a different energy spectrum for their anomalous events.[1] Although an energy determination is not possible with their thick target, they saw an opening-angle distribution which was flatter for the Cygnus-associated events than for the usual atmospheric background, which indicated a softer spectrum. Since an electron or positron below 500 MeV will show an appreciable scattering in our 30-gap chamber, we can readily compute an energy, E_0, for the pair from the observed separation of the pair prongs, if it is assumed that the electron and positron share the photon energy equally. This is essentially the method of track-to-track scattering[5] and E_0 is the minimum energy the photon can have, i.e., $E_\gamma \geqslant E_0$. Therefore if we restrict ourselves to events where $E_0 < 100$ MeV, none of the events with $E_\gamma < 100$ MeV will be eliminated, although, of course, the sample will still contain some events where $E_\gamma > 100$ MeV. The same directional analysis was done for this restricted class of events, and, as is shown in the last line of Table II, the number of events observed again does not differ from the atmospheric background.

The ability to detect an anisotropy in this experiment depends crucially upon the accuracy of the direction monitor. If it malfunctions, the apparatus becomes merely a wide-angle counter telescope, and the sensitivity is reduced by several orders of magnitude, since the recognition of a point source above a two-dimensional uniform background varies inversely with the square of the angular resolution. Therefore we checked the operation of the magnetometers[3] on flight No. 2 by measuring the azimuthal angle of the sun directly. The two methods agreed to 0.6°±1.6° which was the reading accuracy of the sun monitor. The combination of this result with the synchrotron calibration makes us confident that the ±3° resolution at 100 MeV is realistic.

Another check on the operation of the new spark chamber during flight No. 3 is furnished by the measurement of the vertical γ-ray flux in a 30° cone as $(3.7\pm0.4)\times10^{-3}$ γ's cm^{-2} sec^{-1} sr^{-1} at 2.3 mbar. If it is assumed that the flux is proportional to residual atmosphere, the agreement is good with the previous measurement of $(5.2\pm0.5)\times10^{-3}$ γ's cm^{-2} sec^{-1} sr^{-1} at 3.5 mbar.[2]

In conclusion, we have found no evidence for a γ-ray source in Cygnus. The exact value of the upper limit depends on the angular resolution and hence the energy. We believe that ±4° is a conservative value to take even allowing for a soft spectrum and therefore the upper limits for a primary γ-ray flux from $\alpha = 303°$, $\delta = +35°$ can be set as 6.0×10^{-5} γ's cm^{-2} sec^{-1} on 27 January 1965 and 1.2×10^{-5} on 19 July 1966.

The authors are indebted to Dr. L. H. Smith for his collaboration during the earlier phases of this work; to A. A. Hruschka, J. L. Maynard, and W. R. Morgan for the construction of much of the equipment and assistance on the flight operations; to W. A. Oran and Miss Gertrude Chi for many of the calculations; and to the scanning group for their painstaking efforts. We wish to thank F. McCreary and the staff of the National Center for Atmospheric Research Balloon Base, Palestine, Texas, for their skilled support and Professor R. R. Wilson at Cornell University for the synchrotron exposures.

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*Work supported in part by the U. S. Atomic Energy Commission and the National Aeronautics and Space Administration.

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