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OBSERVATION OF THE COSMIC RAY ELECTRON-POSITRON RATIO FROM 100 MEV to 3 BEV in 1964*

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** NASA-Trainee.

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A determination of the charge ratio of the primary cosmic ray electrons provides important evidence for the origin of the electron component. In 1963 DeShong, Hildebrand and Meyer (DeShong, et al, 1964a) reported the results of an experiment designed to measure this ratio in the energy interval from 100 to 1000 MeV. They found an excess of negative electrons which led them to conclude that the electron component consists mainly of directly accelerated particles. Their data gave an upper limit for the contribution of electrons and positrons which are produced by proton - proton collisions in the galaxy.

In this note we present further results from an experiment carried out at balloon altitude over Ft. Churchill, and using the same basic equipment (DeShong, et al, 1964b) modified for better energy resolution. Although the new data are of poorer statistical accuracy than those of 1963 they do extend the energy range of the measurement.

A schematic diagram of the instrument is shown in Fig. 1. A counter telescope defines a beam of vertically incident particles passing through the gap of

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a permanent magnet. Four spark chambers, having thin aluminum plates, are used to measure the deflection of the particles in the magnetic field. The fifth chamber, containing about 5 radiation lengths of high Z material is used to identify electrons by production of photon-electron showers. The modifications with respect to the previously used instrument are as follows:

1. A gas Cerenkov counter is used in the counter telescope replacing the liquid Cerenkov counter of the earlier experiment. This greatly reduces the amount of matter through which a particle must pass before entering the spark chambers and thereby reduces the amount of correction for energy loss by bremsstrahlung. This gas counter responds only to protons with energies above 17 BeV. The contribution of protons to the total number of recorded events is therefore small and the proton tracks, which furnish straight lines in the spark chamber array, are used to test for resolution and bias in the rigidity measurement.

2. An anticoincidence counter is placed under the permanent magnet to discriminate against showers produced in the steel of the magnet.

3. The fiducial system is improved for added precision in the measurement.

Data were obtained from a balloon flight launched at Ft. Churchill on July 16, 1964. They cover an interval of only 55 minutes at which time one of the cameras failed. The balloon was still rising and the residual atmosphere decreased from 9.0 g/cm^2 to 4.5 g/cm^2 during the measurement.

Because of the short time of exposure, the results of the 1964 measurements which are shown in Table 1 are statistically less significant than those obtained in 1963. The energy intervals, however, are much better defined. For comparison we have included the 1963 data in the table. The measured fraction of positrons is an upper limit for the primary electron component since no correction is made for atmospheric secondaries, which will have a positive excess.

We may draw the following conclusions from our observation:

1. The negative excess of electrons between 100 MeV and 1000 MeV which was first observed in 1963 is confirmed;

2. Within the limit of our statistical accuracy we find that the negative excess extends to at least 3 BeV, showing that also at higher energies accelerative processes are the dominant source of primary electrons. The extension of the observation to 3 BeV is important since a substantial solar contribution to the electron flux at the high energies is unlikely.

We are indebted to Mr. J. A. DeShong who designed major parts and participated in the earlier phase of the experiment. It is a pleasure to acknowledge the contributions of A. Cook, J. Upton and S. Lucero in designing, maintaining and executing the experiment. N. Metropolis and R. Dornberger provided the computer program for analysis of the events and Mrs. J. Dill was responsible for scanning and measuring.

We gratefully acknowledge the support given us by the Skyhook program, U. S. Office of Naval Research and the hospitality of the Royal Canadian Air Force, at Fort Churchill, Manitoba, Canada.

References

DeShong, J. A., R. H. Hildebrand and P. Meyer, Ratio of Electrons to Positrons in the Primary Cosmic Radiation, Phys. Rev. Letters 12, 3 (1964a).

De Shong, J. A., R. E. Daniels, R. H. Hildebrand and P. Meyer, Spark Chamber and Magnet System for Photographing Cosmic-Ray Tracks at Balloon Altitudes, Rev. Scient. Inst. 35, 1035 (1964b).

Figure Captions

Fig. 1. Schematic view of the magnet, spark chambers and counter telescope.

TABLE 1. THE FRACTION OF POSITRONS FOR VARIOUS ENERGY INTERVALS

Time	Av. Atmosp. Depth g/cm^2	Energy Interval MeV	$\frac{N^+}{N^+ + N^-}$
July-Aug. 1963	4 g/cm^2	50 - 100*	0.31 ± 0.12
		100 - 300*	0.38 ± 0.07
		300 - 1000*	0.16 ± 0.04
Aug. 1964	6/4 g/cm^2	40 - 100	0.79 ± 0.40
		100 - 300	0.43 ± 0.21
		300 - 1000	0.30 ± 0.14
		1000 - 3000	0.33 ± 0.16

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* The energy intervals in the 1963 experiment are not very accurate. Energy losses in the liquid Cerenkov counter used at that time will lead to an underestimate of the average electron energy.

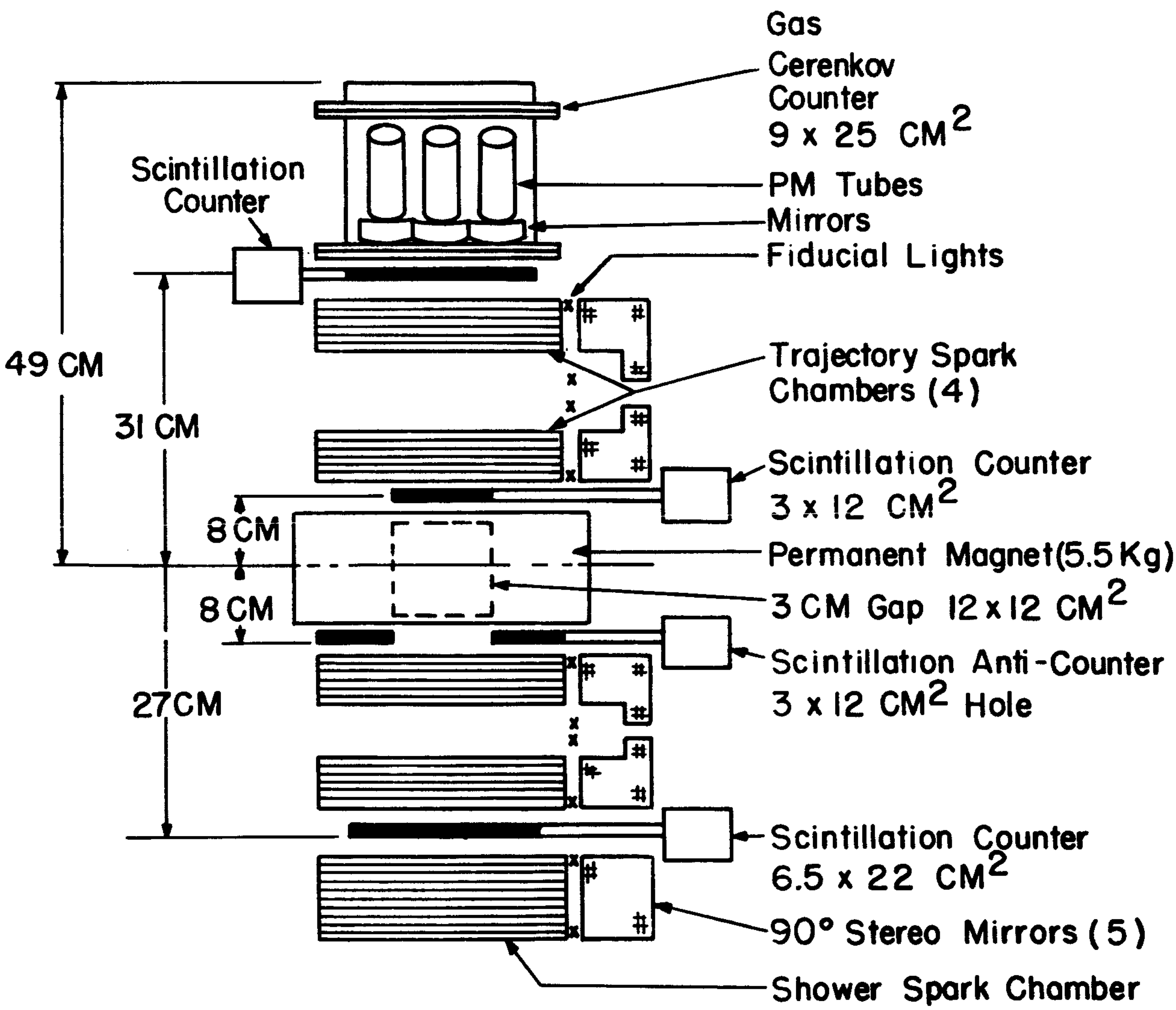
Gas
Cerenkov
Counter
9 x 25 CM2
Scintillation
Counter
PM Tubes
Mirrors
Fiducial Lights
49 CM
31 CM
Trajectory Spark
Chambers (4)
Scintillation Counter
3 x 12 CM2
8 CM
Permanent Magnet(5.5 Kg)
8 CM
3 CM Gap 12 x 12 CM2
Scintillation Anti-Counter
3 x 12 CM2 Hole
27CM
Scintillation Counter
6.5 x 22 CM2
90° Stereo Mirrors (5)
Shower Spark Chamber

Fig.1