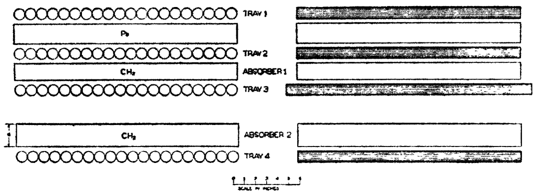

FIG. 1. Arrangement of counters.

16 g/cm², when it is partially carbon and partially polystyrene. The experiment consists of measuring the rate of occurrence of delayed coincidences as a function of the thickness of absorber 2.

The results are shown in Fig. 2. The solid curves show how 25- and 50-Mev electrons would appear in this apparatus. It can be seen that the majority of the electrons have an energy of $\sim$25 Mev, but that an appreciable number have a larger energy. For energies greater than $\sim$65 Mev, the counting rate is approximately that of the calculated background.

In computing the solid curves, the range distribution caused by scattering and geometry were taken into account. The effect of scattering was deduced from a measurement on the range in water of 16.5-Mev electrons. This was kindly communicated to me by Professor Skaggs. The energy loss of electrons has been taken to be 1.72 Mev/g/cm². This is an average value for this energy region for carbon, calculated by Halpern and Hall.[1]

The dashed curve in Fig. 2 is drawn on the basis of an electron spectrum given by

$$\{E[(\mu^2-\mu_0^2)c^4-2E\mu c^2]\}^4(\mu c^2-E)/[(\mu c^2-2E)\mu c^2]^3$$

where $\mu c^2=100$ Mev is the mass of the decaying meson, $\mu_0c^2=45$ Mev the mass of a neutral meson, and E is the energy of the electron. The formula is obtained by making a phase space calculation for the three-particle disintegration meson$^\pm\rightarrow$meson^0+electron$^\pm$+neutrino.

Apparently the spectrum of decay electrons is quite complex. In drawing conclusions from the data, it should be kept in mind that the counting rate for the higher energy electrons is only about twice background, and the statistical

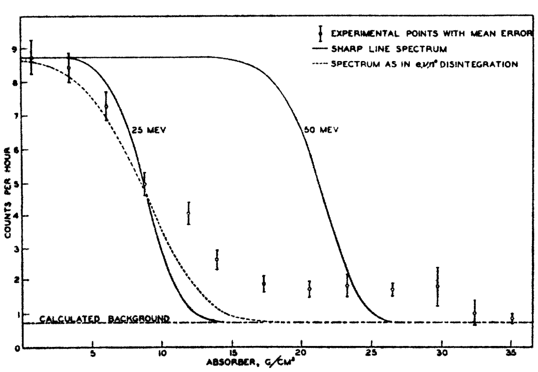

FIG. 2. Counting rate of delayed coincidences as a function of the weight of absorber 2.

errors are large. However, it seems as if the possibility that the meson decays via two competing processes should not be overlooked.

I should like to thank Professor E. Fermi and Mr. H. Ticho for much help and advice, and Mrs. N. Woods for filling the counters.

[1] O. Halpern and H. Hall, Phys. Rev. 73, 447 (1948).

Rate of Production of Helium in Meteorites by Cosmic Radiation

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THE evidences that cosmic radiation has produced helium in the metallic meteorites are: (1) The rate of production of helium by cosmic radiation in a small meteorite[1] is sufficient to produce the maximum observed helium content (4×10^{-5} cc/g) in a time less than the previously assigned "age" (7.6×10^9 yr.);[2] (2) this process gives a logical explanation to the mass-helium content diagram;[3] and (3) it completely resolves the severe difficulties introduced by the previously assigned "ages," namely, (*a*) the exceedingly great "age" of the "oldest" meteorites, (*b*) the great range in the "ages" of meteorites (from 60 million to 7600 million years), (*c*) the dividing of otherwise completely associated and similar meteorites into two or more groups on the basis of their helium contents alone,[2] (*d*) the variation of the helium content from point to point within the same meteorite,[4] and (*e*) the absence of a dependence of these "ages" on the nickel content of the meteorites and thus on their radial positions within the metallic core of their parent planet.

The 51 Bethany meteorites were all found in a limited region of Great Namaqualand, Southwest Africa. Table I gives, for five Bethany meteorites, the classification of the crystal structure, the percentage of nickel, Paneth's measurements[2] of the uranium, thorium, and helium contents, and his assigned ages. The similarity of these five masses in location, structure, and composition almost certainly establishes them as representing the same fall. However, Amalia (Krantz) has been assigned to a different fall because its helium content is so much greater than the others. These observations can be more satisfactorily accounted for by the assumption that cosmic radiation has produced the helium in Bethany, and therefore the difference in the helium contents of the different fragments arises from the difference in their radial positions within the original preatmospheric mass. The helium content of Goamus is equal to that predicted[3] at the center of a spherical preatmospheric mass of 50,000 kg. For this preatmospheric mass, Amalia (Krantz) must have been about 80 cm from the center, i.e., just on the edge of a spherical mass of 15,000 kg, the total known mass of the Bethany meteorites.

In Bethany Amalia (Krantz) two regions separated by about 7 cm have helium contents[4] that differ by 0.25×10^{-6} cc/g. If the two points were along a radial line and at a distance of 80 cm from the center of a 50,000-kg mass, the

TABLE I. Characteristics of several meteorites.

Name of Bethany meteorite	Class	Ni %	U in 10^{-8} g/g	Th in 10^{-8} g/g	He in 10^{-6} cc/g	Age in 10^6 years calculated from Individual measurements	Average activity
Goamus	Of	8	1	4	0.15	60	75
Amalia (Foote)	Of	8			0.2		110
Grôndorn	Of	8			0.2		110
Lion River	Of	8			0.2		110
Amalia (Krantz)	Of	8	1	4	3.0	1100	1500

predicted difference would be 0.90×10^{-6} cc/g. The observed difference should not be greater than the predicted difference, though it may be less if the two points do not lie along a radial line.

If these two observations, (1) the difference in the helium content of different fragments and (2) the difference from point to point within the same fragment, are accepted as indicating that cosmic radiation has produced the helium in Bethany, then two important conclusions follow: 1. The time since the solidification of the metallic core of the parent planet, and also the time since the disruption of the parent planet, are both less than 60 million years. This upper limit can be established because the U and Th contents of Bethany Goamus are sufficient to produce all of its helium in only 60 million years. 2. The rate of production of helium in meteorites by cosmic radiation is more than 70 times the rate predicted from the values of the observational quantities used in my previous paper.[1] This is true because cosmic radiation has to produce the helium in 60 million years rather than in 4 billion years. This high rate of production of helium in meteorites, as compared to the calculated rate just outside the earth's atmosphere, may arise from the effect of the sun's general magnetic field, as suggested previously,[1] or from secondary helium-producing processes that have not been considered.

[1] C. A. Bauer, Phys. Rev. **72**, 354 (1947).
[2] F. A. Paneth, Nature **149**, 235 (1942).
[3] C. A. Bauer, Phys. Rev. **74**, 225 (1948).
[4] F. A. Paneth, Roy. Astr. Soc., Occasional Notes, **No. 5**, 57 (1939).

Shape of the Positron Spectrum of N^{13}

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In a recent letter,[1] we reported the results of an investigation of the shape of the positron spectrum of Cu^{61} (3.3 h). It was shown that the momentum distribution deviated markedly at low energies from that predicted by the Fermi theory for an allowed transition. In comparison with our earlier work on Cu^{64} (12.8 h),[2] it was noted that the deviation from the theoretical straight line Fermi plot began at an energy $W=2.0$ mc² for Cu^{61}, whereas the Cu^{64} plot was a straight line down to $W=1.53$ mc². The comparison between the Cu^{64} and Cu^{61} spectra is of interest because it involves two allowed transitions in isotopes having the same nuclear charge, Z, but different maximum energies, i.e., $W_0=3.36$ mc² for Cu^{61} and 2.29 mc² for Cu^{64}.

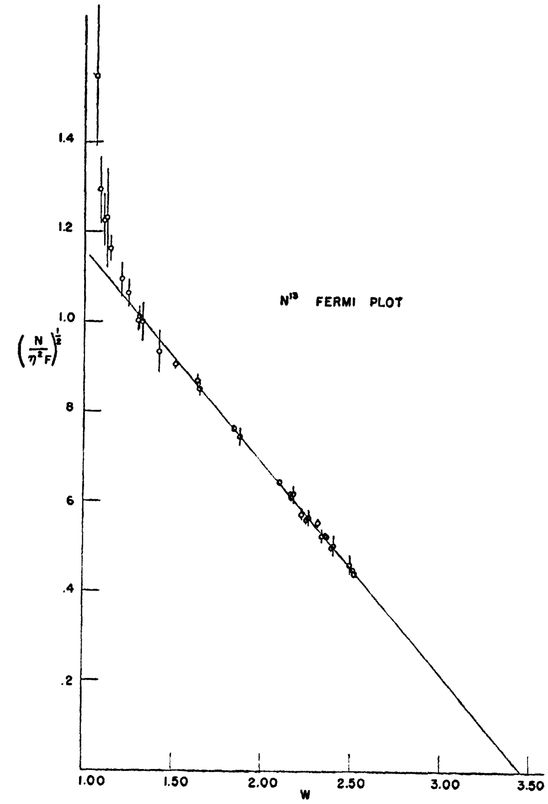

FIG. 1. Fermi plot of the positron momentum spectrum of N^{13}.

Our interest in the spectrum of N^{13} stems mainly from the fact that it is the result of an allowed transition with an energy release almost exactly the same as that in Cu^{61}, but in an isotope of much lower Z. The results of Siegbahn and Slätis[3] indicate that the N^{13} spectrum begins to deviate from theory at about the same energy as our data for Cu^{61} (i.e., 2.0 mc²). However, since their data were obtained with a relatively thick source, it was thought desirable to investigate the N^{13} distribution under more ideal conditions.

In the present experiment, the N^{13} was produced by $C^{12}(d,n)$ in the cyclotron. The sample was activated in such a form that it could be transferred directly to the spectrometer without further preparation. The source consisted of a uniform layer of 0.6-mg/cm² colloidal graphite (Aquadag) on a 0.18-mg/cm² aluminum backing. For bombardment, the sample, mounted on a skeleton aluminum ring support, was clamped against the water-cooled target plate of the cyclotron. An aluminum mask served to confine the 12-Mev deuteron bombardment to the region of the graphite desired for the spectrometer source, i.e., 0.4 cm wide by 2.5 cm long. Individual bombardments were for twenty minutes with a target current of from 100 to 130 microamperes of deuterons. The source, prepared in this way, was then transferred to the 40-cm radius of curvature, shaped field magnetic spectrometer,[4] and readings were begun within six minutes. No trouble was encountered from other activities present, since they are all negatron emitters