Letters to the Editor

PROMPT publication of brief reports of important discoveries in physics may be secured by addressing them to this department. The closing date for this department is the third of the month. Because of the late closing date for the section no proof can be shown to authors. The Board of Editors does not hold itself responsible for the opinions expressed by the correspondents. Communications should not in general exceed 600 words in length.

Some Aspects of Meek's Sparking Equation

LEON H. FISHER
Department of Physics, University of California, Berkeley, California
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IN his paper, "A Theory of Spark Discharge," Meek[1] formulated a quantitative criterion for sparking by means of the streamer mechanism. This criterion led to Meek's equation for sparking. In the above paper, Meek compares values of sparking potentials for air as calculated from his equation with data given by Whitehead.[2] Meek found his calculated values to be in good agreement with those experimentally observed for values of $p\delta$ (pressure $\times$plate distance) from 10,000 to about 100 mm$\times$cm. According to Meek, the calculated values are higher than the observed ones for $p\delta$ less than 100 mm$\times$cm, and the deviation increases steadily with decreasing $p\delta$. Below this value of $p\delta$, it is assumed that the discharge proceeds by means of the Townsend type of mechanism, the positive ion density becoming too low to insure adequate photo-ionization for streamer formation.

In connection with some recent measurements of sparking potentials, the writer has had occasion to examine in some detail the nature of the departure of the theoretical from the experimental curve at small values of $p\delta$. In an attempt to reproduce Meek's curve, the pressure was taken as 760 mm, and the gap length was varied to obtain varying values of $p\delta$. The original value of $K=1.0$ in Meek's equation has been replaced subsequently by the value $K=0.1$. Recent measurements by the author[3] show that the proper value of K is much less than 0.1. Using this small value of K, with constant pressure (760 mm), Meek's equation was used to calculate sparking potentials down to 10 mm$\times$cm. Excellent agreement (to within a few percent) was obtained down to this value of $p\delta$ with the data given by both Whitehead[2] and Schumann.[4] Changing K to 0.1 gave values which were 20 percent higher than the experimental values at $p\delta=10$ mm$\times$cm. (Changing K from 0.1 to 1.0 has very little effect.) Meek's curve (with $K=1.0$) calls for a departure of about 70 percent at $p\delta=10$ mm$\times$cm.

It is apparent that Meek's curve was not obtained by the procedure outlined here. Quite probably he used a constant gap distance (near one centimeter) with varying pressure. Using a lower value of K he would not have found so much deviation at low $p\delta$. It has been pointed out by Meek that his equation does not obey Paschen's law. It particularly fails to do so at low $p\delta$ when $p\delta$ remains constant and δ varies by a factor of one hundred.

If one examines Whitehead's summary of data at low $p\delta$, one finds variations as great as 50 percent among various observers. Therefore existing experimental data taken over a long time with poorly controlled conditions cannot be used to support Meek's claim that his equation fails at low $p\delta$ or the possibility pointed out by the writer that at high pressures no deviation occurs at all. Indeed, both conclusions may be correct for, as has been pointed out,[5] Paschen's law has never been verified over an extended pressure range. To answer the question, a set of carefully controlled experiments are needed in which $p\delta$ is varied by changing first pressure, then gap length. These experiments should be carried out in a single laboratory.

There is some basis for believing that both Meek's and the writer's contentions are true. For constant δ, the positive ion concentration decreases with decreasing $p\delta$, and the streamer mechanism probably does become inoperative at low $p\delta$. At constant pressure, the positive ion density *increases* with decreasing $p\delta$. Thus it may be that the streamer mechanism continues to be effective at high pressures and low $p\delta$.

[1] J. M. Meek, Phys. Rev. 57, 722 (1940).
[2] S. Whitehead, *Dielectric Phenomena* (D. Van Nostrand Company, Inc., New York, 1927), p. 42.
[3] L. H. Fisher, Phys. Rev. 65, 153 (1944).
[4] W. O. Schumann, *Durchbruchfeldstärke durch Gasen* (Verlagsbuchhandlung Julius Springer, Berlin, 1923), p. 25.
[5] Reference 4, p. 115.

Synthesis by Nuclear Recoil*

ALLEN F. REID
Columbia University, New York, New York
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THIS is an investigation in the use of nuclear recoils in specific synthesis to afford efficient methods of producing radioactive isotopes in high specific activity either in the synthesized compound or a derivative or decomposition form; it was primarily started in an attempt to synthesize a highly radioactive compound for medical use. The Szilard-Chalmers' technique[1] makes use of these recoils to break selectively the chemical bonds of activated atoms; in the experiments recorded here the purpose was to utilize this energy for synthesis. The choice of reactants used was a matter of convenience and ease of manipulation. The synthesis attempted was

$$I^{127}+n\rightarrow I^{128}+\gamma$$
$$C_5H_{12}+I^{128}\text{ (on recoil)}\rightarrow C_5H_{11}I^{128}+H.$$

A solution (A) of 0.103 g I_2 in 40 cc normal pentane was made up. This, along with the same amount of undissolved I_2, was irradiated with slow neutrons from the Columbia cyclotron; then the I_2 was dissolved in 40 cc normal pentane (solution (B)). The solutions were then resolved to determine distribution of the I^{128} activity. The I_2 was quantitatively removed with $0.08M$ $Na_2S_2O_3$ solution; n-amyl iodide was added as a carrier and the amyl iodide and pentane separated by distillation. Activities were measured by means of a Geiger-Mueller counter. In B, <0.5 percent of the I^{128} activity was found in the amyl iodide and pentane fractions. In A, 38±3 percent of the activity followed the n-amyl iodide, the remainder was in the elementary I_2 form. The organic I^{128} probably was distributed among all amyl iodides but no attmpt was made to resolve the amyl iodide fraction further. Removal of most of the I_2 in A from the pentane was accomplished within 15 minutes after the end of the 5-minute irradiation period, so little amyl iodide-iodine exchange was probable.

In two subsequent runs in which the slow neutron source arrangement was different and in which longer time intervals elapsed between separation of the I_2 and amyl iodide, >23 percent of the I^{128} activity of the irradiated solutions was found with the amyl iodide, as against <3 percent of the activity in the amyl iodide fractions from the controls.

The results of these experiments show that nuclear recoils may be used in specific synthesis furnishing compounds with very high specific radioactivity, though no satisfactory estimate can be made at this time of the extent of the application. Further exploration along these lines is planned.

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[1] L. Szilard and T. A. Chalmers, Nature **134**, 462 (1934).

The East-West Asymmetry of Cosmic Radiation at a Geomagnetic Latitude of 28°31′ and an Estimation of the Difference of the Exponents of the Absorption Law for the Polar and the Equatorial Regions

FRANCIS OSTER, SHENG-LIN CH'U,* AND LIEH-YANG LÜ
The Catholic University, Peiping, China
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WITH a conventional triple coincidence G-M counter arrangement, the east-west asymmetry of cosmic radiation was measured in Peiping, China, which is at a longitude 116°20′E and a latitude 39°56′N. The geomagnetic latitude of the city was calculated[1] to be 28°31′. The result of the measurement is given in Table I and shown in Fig. 1. The asymmetry is represented by $A=(I_W-I_E)/[(I_W+I_E)/2]$, which is plotted as ordinate in the graph, I_W and I_E being the counting rates for the west and the east incident rays, respectively.

TABLE I. Measurements showing east-west asymmetry at Peiping, China.

Zenith angle θ	$A=\dfrac{I_W-I_E}{\frac{I_W+I_E}{2}}$	Δr_c	$A'=A\dfrac{0.15}{\Delta r_c}+1$	$h=10\sec\theta$	$\log A'$	$\log h$
15°	0.033±0.014	0.046	1.108	10.35	0.0444	1.015
30°	0.059±0.018	0.098	1.090	11.55	0.0375	1.063
45°	0.067±0.019	0.16	1.063	14.14	0.0264	1.151
50°	0.074±0.021	0.18	1.062	15.56	0.0258	1.192
55°	0.059±0.027	0.20	1.044	17.43	0.0187	1.241
60°	0.036±0.031	0.22	1.024	20.00	0.0103	1.301

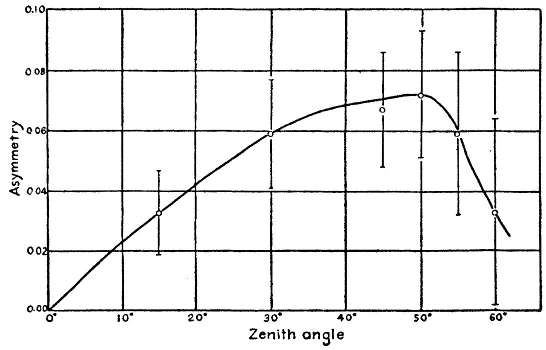

FIG. 1. East-west asymmetry against zenith angle.

It was suggested by Johnson[2] that the difference of the exponents of the absorption law $I=A/h^n$ for the polar and the equatorial regions can be more precisely determined from the analysis of the asymmetry measurements. In the present calculation the range of the threshold energies, by which the value of A was to be divided, was obtained by interpolation of Lemaitre and Vallarta's function[3] for the latitudes 0°, 20°, and 30°; thus, curves were drawn with the threshold energy against the latitude for different zenith angles both in the east and the west directions, then the ranges of the threshold energies for different zenith angles at our latitude 28°31′ were read from these curves. As there are only three points for each curve, the estimation cannot be very accurate; yet as our latitude 28°31′ is very close to 30°, for which the threshold energies were given by Lemaitre and Vallarta, the error cannot be large. Figure 2, a logarithmic plot of $A(0.15/\Delta r_c)+1$ against the atmospheric path h, shows that the points lie nearly on a straight line, the slope of which gives the value $\delta(=\Delta n)$, which was found to be 0.12.

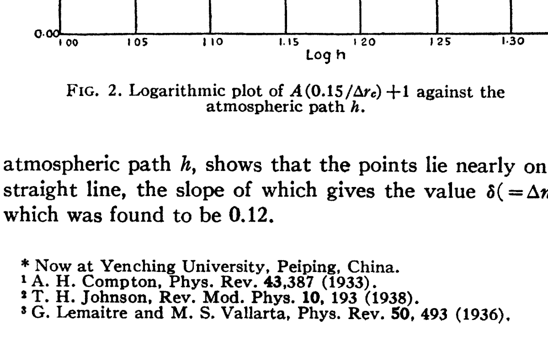

FIG. 2. Logarithmic plot of $A(0.15/\Delta r_c)+1$ against the atmospheric path h.

* Now at Yenching University, Peiping, China.
[1] A. H. Compton, Phys. Rev. **43**,387 (1933).
[2] T. H. Johnson, Rev. Mod. Phys. **10**, 193 (1938).
[3] G. Lemaitre and M. S. Vallarta, Phys. Rev. **50**, 493 (1936).