LETTERS TO THE EDITOR

Prompt publication of brief reports of important discoveries in physics may be secured by addressing them to this department. Closing dates for this department are, for the first issue of the month, the twentieth of the preceding month; for the second issue, the fifth of the month. 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.

The Specific Ionization of Cosmic-Ray Particles as Determined by Geiger-Müller Counter Efficiency

The efficiency of a Geiger-Müller counter, used in a coincidence arrangement for cosmic-ray counting, is determined, at least in part, by the primary ionization along the path of the particles.

The results here reported seem to show that the efficiency is determined to such an extent by the primary ionization that measurements of the former may serve as a satisfactory means of determining the latter.

The points plotted in Fig. 1 show measured values of

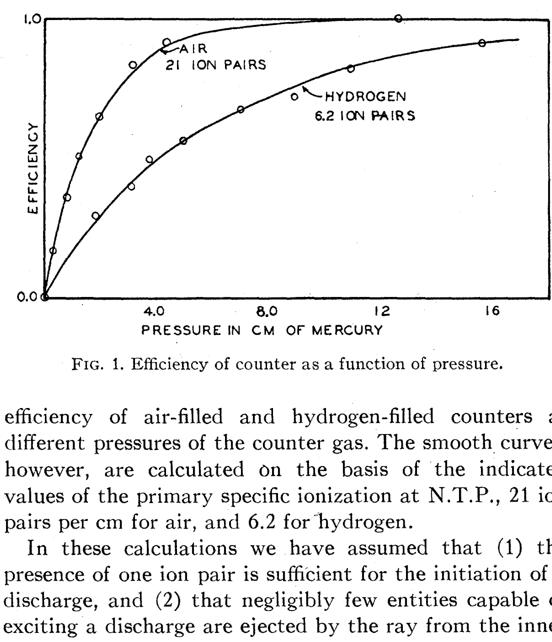

FIG. 1. Efficiency of counter as a function of pressure.

efficiency of air-filled and hydrogen-filled counters at different pressures of the counter gas. The smooth curves, however, are calculated on the basis of the indicated values of the primary specific ionization at N.T.P., 21 ion pairs per cm for air, and 6.2 for hydrogen.

In these calculations we have assumed that (1) the presence of one ion pair is sufficient for the initiation of a discharge, and (2) that negligibly few entities capable of exciting a discharge are ejected by the ray from the inner surface of the counter cylinder. The efficiency is then obtained by subtracting from unity the probability that a particle will traverse the counter without suffering an ionizing collision with a gas molecule. This probability, calculated from the Poisson law of the random sequence, involves the primary ionization and the distribution of path length within the counter.

The fact that the observed points lie satisfactorily about the calculated curves constitutes, in itself, a tentative verification of the two above-mentioned assumptions. Assumption (2) concerning the absence of wall effect has been studied in an independent experiment in which it was found that increasing the path length augments the efficiency to about the same extent as does a proportionate increase in pressure. The path length distribution problem in this auxiliary experiment is, however, so complex, that an exact calculation has not, as yet, been carried out.

One notices that the value obtained for air (21 cm^{-1}) is lower than the cloud chamber results of G. L. Locher[1] and of C. D. Anderson[2] who counted droplets in diffuse tracks and obtained 36 cm^{-1} and 31 cm^{-1}, respectively. On the other hand, our value is somewhat higher than that found by P. Kunze[3] who examined sharp tracks and found 19 droplets per cm. Two circumstances which may render the cloud chamber data uncertain are the following: (1) Diffuse tracks, by including ions which have been produced by secondaries, tend to give too high a value. (2) Sharp tracks, on account of random grouping and coalescing of droplets, tend to give too low a value. Kunze, however, applied a statistical correction to take care of random grouping. Our value for air is slightly lower than that found by E. J. Williams and Terroux[4] for a million-volt beta-particle in oxygen. For hydrogen however, our value is somewhat higher than that given by these authors (5.1 cm^{-1}) for a million-volt beta-particle.

This method should be able to detect inhomogeneity of the radiation as regards specific ionization. Interpreted as homogeneous radiation, a distribution of specific ionization would, at low pressures, give an effective ionization equal to the average, but at high pressures the effective value would be less than the average. The present results show a rather surprising degree of homogeneity.

Counters operating at low efficiency form a means of discriminating between radiations of different primary ionizations. We have in progress an experiment designed to detect, by this means, the presence of low energy protons in the radiation—entities which should exist in measurable numbers if, as has been suggested by Compton and Bethe,[5] protons form an important component of the sea level radiation.

Measurements on different gases are now in progress in the hope that the results will be of use in the theoretical problem of ionization by high energy particles.

W. E. DANFORTH
W. E. RAMSEY

The Bartol Research Foundation of the Franklin Institute,
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[1] G. L. Locher, Phys. Rev. **39**, 883 (1932); J. Frank. Inst. **217**, 39 (1934).
[2] C. D. Anderson, Phys. Rev. **44**, 406 (1933).
[3] P. Kunze, Zeits. f. Physik **83**, 1 (1933).
[4] E. J. Williams and Terroux, Proc. Roy. Soc. **A126**, 289 (1930).
[5] A. H. Compton and H. A. Bethe, Nature **134**, 734 (1934).