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 twenty-eighth of the preceding month; for the second issue, the thirteenth of the month. The Board of Editors does not hold itself responsible for the opinions expressed by the correspondents.

An Attempt to Measure the Energy of the Cosmic Electrons by Magnetic Deflection

An attempt has been made to measure the energy of the cosmic electrons with an apparatus based on Bothe and Kolhörster's[1] coincidence principle making use of Geiger-Müller tube-counters. A description of the method has previously been given.[2]

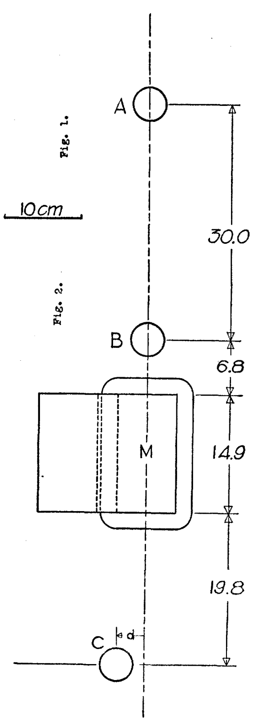

Fig. 1.

The arrangement is schematically shown in Fig. 1. A and B represent two tube-counters, viewed end-on, which serve to define a beam of the particles, M is a closed-core "magnet" which furnishes the deflecting magnetic field (produced directly in the iron), and C is a third counter which serves to analyse the beam which has passed through the magnet. An electrical vacuum tube system records on an impulse counter only triply coincident discharges of the three counters, events which are assumed to indicate the passage of an electron through the apparatus.

The principal experiment consisted in making counts of the triple coincidences for various displacements (d) of the analysing counter with the magnet unmagnetized and with it successively magnetized to a magnetic induction of 17,000 in either direction. The results are shown in the curve of Fig. 2. The values are believed to be reliable to about 8 percent (the statistical error is about 4 percent) with the exception of the points at the central position and those at 4 cm north which were studied more carefully and should not be in error by more than about 4 percent. The shape of the curve is about what is expected from the geometry of the arrangement, assuming rectilinear passage of the ionizing particle, and the count at the 10 cm displacement represents that due to chance coincidences. It is seen that within the present limits of error no deflection exists. This result is of interest because if the assumptions on which the operation of this apparatus is based are correct the energy of the particles is very high. On making what appears to be the correct assumption that the force on an electron in the iron is given by $(e/c)[v\times B]$

[1] W. Bothe and W. Kolhörster, Zeits. f. Physik **56**, 751 (1929).

[2] Phys. Rev. **35**, 1125 (1930). Experiments with the present method have been independently made by Rossi, Rend. Acc. dei Lincei **2**, 478 (1930).

where B is the magnetic induction, a deflection of 2.2 cm measured at the analyser is expected for electrons of energy 10^9 *e*-volts. It is seen from the curve that an easily observable change in count should be produced by such a deflection, particularly at the most favorable displacement of about 4 cm. Accordingly, with the reservation mentioned above, it appears that the energy of the majority of the cosmic electrons is greater than about 2×10^9 *e*-volts. The possibility that these particles may be protons or heavier nuclei should also be considered. This seems unlikely on various grounds, but even if the particles were protons we can conclude that the energy must be greater than about 10^9 *e*-volts.

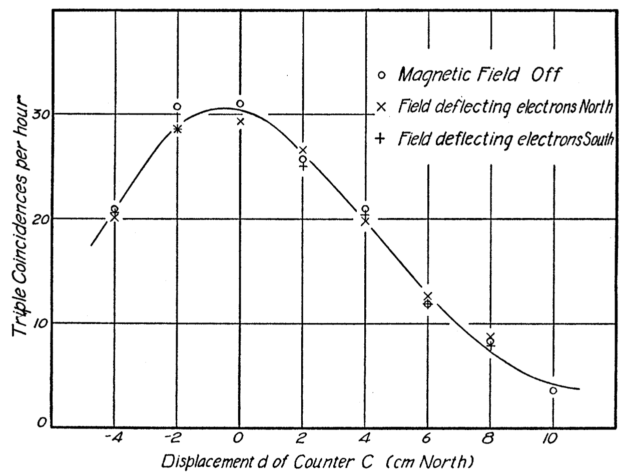

Fig. 2.

There is, however, a difficulty with the assumption of electrons of such high energies, which comes from a consideration of the process by which they are absorbed. From the usual theory of multiple scattering it is found that the path of such a particle should be nearly rectilinear until it has lost a large fraction of its energy, so that absorption must be principally due to a gradual loss of energy by the production of ions along the path. Accordingly, since the cosmic radiation (assumed electronic) is known to follow an exponential absorption law, we should expect to find at any point electrons with a definite distribution of velocities ranging from zero to some maximum. In fact, if the Thomson absorption law is still valid for these high energies, it is found, by using the known absorption coefficient for the cosmic radiation, that a considerable fraction of the electrons should have energies ranging from zero to a few hundred million *e*-volts (about 30 percent between zero and 2×10^8 *e*-volts). Were this the case, an effect of the magnetic field should have been observed. Consequently, if we wish to interpret this experiment to mean that the energy of the bulk of the electrons is as great as indicated above it is necessary to find a method of absorption for very penetrating electrons which gives considerably greater absorption than that expected on the ordinary theory. A possibility in this direction which should be investigated is a consideration of nuclear effects which are negligible when treating the absorption of electrons of low energy but which might be expected to become important when dealing with electrons of such large penetrating power.

It should be mentioned that absorption measurements have been made with this apparatus by taking counts with the magnet in position and with it withdrawn from the beam. In agreement with the result of Bothe and Kolhörster, the observed absorption is nearly the same as the value calculated for these conditions from the absorption coefficients obtained by the electroscope measurements.

It is also necessary to be sure that the coincidences are actually produced by a corpuscular radiation and not by a γ-type radiation. This question has been investigated by Bothe and Kolhörster[1] both experimentally and theoretically, with the result that they do not find it possible to ascribe the coincidence effects to a γ-type radiation unless some new phenomenon is postulated. In view of our present result it would seem desirable to reexamine this question. On the experimental side a possibility in this direction would be to look for a definite correlation between coincidences in tube-counter and tracks in a suitably disposed cloud expansion apparatus. Such an experiment appears feasible and is in progress.

In view of the foregoing considerations and also on account of certain difficulties[3] with the assumption of a corpuscular nature for the cosmic radiation, it would seem that a definite conclusion with regard to the significance of the present experiment must await further study.

A part of this work was done at the California Institute through the kindness of the members of the administration of that institution.

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[3] See R. A. Millikan and **G. H.** Cameron, Phys. Rev. **37**, 235 (1931)

Transmission of Gases from 20 to 33μ

In a letter to this section Dickinson and West[1] reported a Raman shift for liquid sulfur dioxide of 524.3 cm^{-1}. Bailey, Cassie and Angus[2] interpret this as a combination band. I have found the transmission of a four inch layer of this gas for the 20.75μ quartz reststrahlen to be only 7 percent. Such strong absorption would seem more likely to be associated with a fundamental band.

The transmissions of several gases have been determined in the spectral region 20–33μ and the results are given in Table I. These values are for a layer of gas four inches thick at atmospheric pressure and are probably correct to 2 percent.

Table I.

Gas	Reststrahlen Wave-length:	20.75μ	22.9μ	27.3μ	29.4μ	32.8μ
SO_2		7	58	100	99	96
NH_3		65	95	84	79	63
H_2S		96	98	93	89	82
N_2O		86	100	100	100	100
C_2H_2		95	100	100	98	97

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[1] Roscoe G. Dickinson and S. Stewart West, Phys. Rev. **35**, 1126 (1930).

[2] C. R. Bailey, A. B. D. Cassie and W. R. Angus, Roy. Soc. Proc. **A130**, 133 (1930).

A Preliminary Report of the Application of the Photoelectric Cell to the Reading of Minima in a Magneto-Optic Method of Analysis

It has been found that chemical compounds in solution, when traversed by polarized light and subjected to particular types of transient magnetic fields, are characterized under certain conditions by the scale readings of the minima of light intensity produced, by means of which a compound may be detected when present in a concentration as low as about 1 part in 10^{11} (Allison and Murphy, Journal the American Chemical Society **52**, 3796 (1930); Physical Review **36**, 1097 (1930)). These results have been interpreted upon the hypothesis of differential time lags in the Faraday effect. Inasmuch as the results thus far reported were obtained by visual observations only, the importance of devising some objective means of reading the minima has long been recognized. We have recently suc-