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.

Cosmic-Ray Nuclear Disintegrations

Cosmic-ray nuclear disintegrations associated with what are usually termed Hoffman's Stösse have been studied in an iron vessel 120 cm high, 90 cm in diameter, with wall thickness about 17 mm. The vessel was provided with similar independent electrodes in the top and bottom halves, and these halves could be separated by a slab of metal of any desired thickness. The purpose was to study the spurts of ionization in the two halves in the absence of the slab, and then observe it again with the slab, and so deduce from the indications in the two halves information as to the number and character of the nuclear disintegrations occurring in slabs of different materials, and the absorbability of the products of disintegration in the materials.

Each insulated system was connected to an independent FP54 Pliotron operating a short period galvanometer. Suitable means for compensation of average ionization current and of fluctuations of applied potential were employed.

In order to provide further evidence as to the reality of the indications, experiments were performed in which a Geiger-Mueller counter system, consisting of three sets of counters placed in different positions around the vessel, was used, and arranged so as to record through the amplifier only if a ray went through each simultaneously. The two galvanometers recording the spurts of ions reflected vertical lines onto the horizontal slit of the photographic recording apparatus, so that the motions of the lines drew curves on the moving paper. When the counters discharged they lighted a lamp which also illuminated the slit, producing on development a shadow whose starting edge indicated the instant at which the counter discharges took place.

Fig. 1 represents records of several of the nuclear disintegrations observed. It will be seen that in most of the examples given simultaneous spurts were observed in the top and bottom halves. The simultaneous discharge of the counters is indicated in three of the examples shown by the lower edge of the shadow S. These counter records taken with apparatus entirely dissociated from the ionization apparatus, and produced by effects outside of the vessel, demonstrate conclusively, by their correspondence with the spurts of ionization, the reality of those spurts, and relieve them of any suspicion of being caused by accidental phenomena, vibrations and so forth.

At the lower end of each trace is given the number of millions of ions corresponding to the spurt of ions observed on that curve. If one knew the average distribution of the secondary rays which participated in producing any of the above spurts, and if he should assume a number for the ionization per centimeter of path by the rays, he could calculate the number of rays involved in the spurt. The greatest distance which any ray can travel in one of the halves of the vessel is about 150 cm. The gas in the vessel

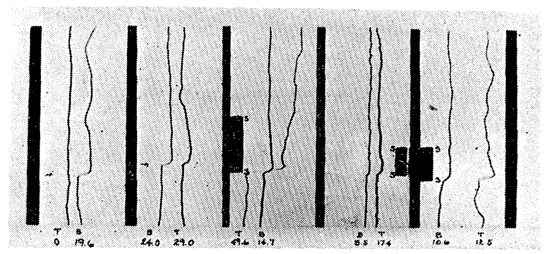

FIG. 1. Values in millions of ions at 100 lb./sq. in. of nitrogen. T, top half of chamber; B, bottom half of chamber.

was nitrogen at pressures of the order 100 lb. per square inch. Hence, if using the ion spurt corresponding to 49.6×10^6 ions recorded in Fig. 1, we divide by 100/14, the pressure in atmospheres, by 150 cm, the maximum path length, and by 50 ions/cm, which is the order of magnitude of the ions produced per centimeter of path by an electron in nitrogen at atmospheric pressure, we shall obtain the minimum number of rays which can be associated with this nuclear disintegration if these rays are assumed to be of the positive or negative electron type with energies corresponding to those usually associated with cosmic-ray phenomena. The number in question comes out as approximately 1000. It of course varies with the spurt considered. However, for all spurts examined it is large. There of course remains the somewhat unlikely possibility of the ionization being caused by a few particles of very much greater ionization per centimeter of path than that corresponding to electrons. As evidence against this, however we have the counter data.

Each of the 3 counters had an area of about 250 sq. cm.

An examination of the statistics of the problem shows that if in an appreciable fraction of ionic spurts, say 20 percent as observed, the counters also record, then the number of rays is probably not considerably less than what would correspond to an average of one ray through each counter set. Taking into account the average distances involved, we are led to the conclusion that the nuclear disintegrations observed corresponded to at least 100 secondaries, and may of course represent many more. The possibility of there being more secondaries than would correspond to the total number of electrons and protons in the disintegrated atom naturally raises interesting considerations regarding the mechanism of the processes accompanying the disintegration.

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June 1, 1933.

Scattering of Molecular Rays in Gases

Knauer[1] has recently investigated the scattering of molecular rays in gases. By the aid of high speed pumps the author has found it possible to produce a more intense beam so that scattering might be investigated with higher resolving power.

A beam is formed by three successive slits and the distribution of the scattered molecules or atoms studied by the aid of a Pirani gauge. Two slits placed before the gauge permit molecules to enter it only when they are scattered from a definite position in the beam.

Fig. 1 (curves A and B) shows the scattering curves which have been obtained for hydrogen molecules and helium atoms. The temperature of the source of the beam and scattering chamber was 20°C. The scattered intensity is expressed in arbitrary units, being simply the galvanometer deflection multiplied by sin θ to correct for the variation in the length of the beam from which scattered molecules may enter the gauge.

Massey and Mohr[2] have computed the scattered intensity for helium atoms having a relative kinetic energy corresponding to 20°C and −185°C. The results which they have obtained offer a qualitative explanation of the helium scattering curve. Curve C (Fig. 1) is reproduced from their article after being multiplied by sin 2θ and divided by sin θ to obtain the scattering per unit solid angle in a coordinate system in which one atom is initially at rest. One peak occurs at 25° and another at 40°. From a qualitative point of view three effects are immediately obvious which would tend to merge these two peaks into the one observed at 30°. The first is the finite resolving power of the apparatus, second the Maxwellian distribution of velocities in the beam and third the fact that the scattering molecules are not at rest but are moving in random directions with a Maxwellian distribution of velocities.

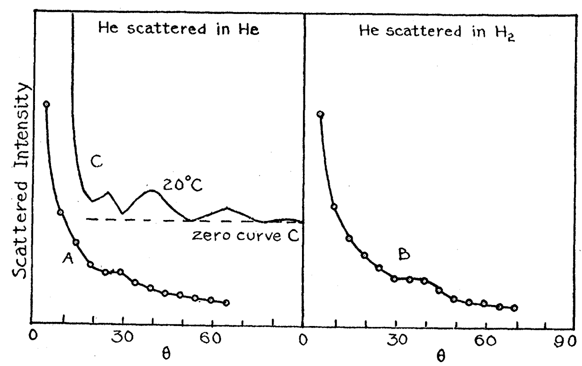

FIG. 1. Curve A, He scattered in He; curve B, H_2 scattered in H_2; curve C, results of Massey and Mohr for He scattered in He.

The intensity of the region of 65° is too small to determine definitely whether a peak exists there.

A complete report will appear in a short time.

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Massachusetts Institute of Technology,
June 3, 1933.

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[1] Knauer, Zeits. f. Physik **80**, 80 (1933).

[2] Massey and Mohr, Nature **130**, 277 (1932).

On the Production of the Positive Electron

The experimental discovery of the positive electron gives us a striking confirmation of Dirac's theory of the electron, and of his most recent attempts to give a consistent interpretation of the formalism of that theory. As is well known, and quite apart from the difficulties connected with the existence and stability of the electron itself, the theory in its original form led to very grave difficulties in all problems involving lengths of the order of the Compton wavelength, in that it predicted the occurrence of electrons of negative kinetic energy, in gross conflict with experience. Dirac has pointed out that we might obtain a consistent theory by assuming that it is only the absence of electrons of negative kinetic energy that has a physical meaning; in this way one could avoid the occurrence of the critical transitions, and yet understand the validity of many correct predictions of the theory, such as the formula for the relativistic fine structure, and the Thomson and Klein-Nishina scattering formulae: only the physical interpretation of the formulism was changed, and involved in many cases the appearance pairs of electrons and "antielectrons"

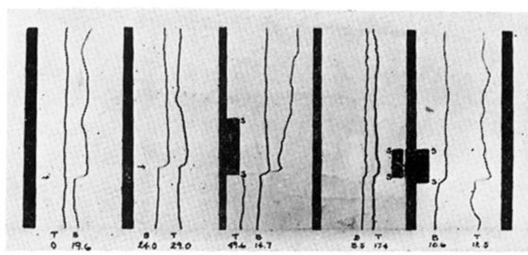

FIG. 1. Values in millions of ions at 100 lb./sq. in. of nitrogen. *T*, top half of chamber; *B*, bottom half of chamber.