Letters to the Editor

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Radioactivity induced by Bombardment with Neutrons of Different Energies

FOLLOWING the announcements of Fermi and his collaborators[1] on the radioactivity induced in many substances by bombardment with neutrons, we have undertaken some similar experiments. Using sources containing 50–100 millicuries of radon mixed with finely powdered beryllium, we have been able to confirm in general the results reported by Fermi, in addition to obtaining a few results independently similar to some which have since been, or are now being, published by him.

With the help of Dr. Oliphant, we have also been able to examine the effects induced by the neutrons produced by bombarding various substances with 200–250 kv. diplons[2]. This gives some very interesting information as to the effect of neutrons of different energy. The table given below gives the general trend of our measurements, although the figures are at present only very approximate.

Element bombarded	Period of decay	Source of neutrons			
		Be + Rn	Li + D	Be + D	D + D
Fluorine	8 secs.	100	10	<1	<½
Silicon	2½ mins.	100	50	<1	<1
Phosphorus	2½ mins.	100	30	<1	<1
Phosphorus	2½ hours	100	50	30	30
Silver	40 secs.	100	10	15	15

Relative rate of production of active atoms by neutrons from different sources (the effect from Be + Rn taken as 100 in each case).

The number of neutrons from each source was estimated using a paraffin-faced ionisation chamber and a linear amplifier of the Wynn-Williams type connected to an oscillograph. The above figures have been calculated so as to correspond to sources giving an equal number of oscillograph deflections definitely greater than the unavoidable background. This is the simplest method of estimating the relative number of neutrons, but may be subject to error when comparing neutrons of different energies.

It will be noticed that in no case was the efficiency of production (for equal numbers of neutrons) as great with the newer sources as with the original Be + Rn source, but nevertheless the behaviour of the Li + D neutrons was not very different. With the other two neutron sources, however, several of the effects do not appear to be excited at all; the case of phosphorus, where the long period is strongly excited while the short period is undetectable, even with a short exposure to the neutrons, being very striking. The neutrons from Be + Rn and Li + D are both believed to be heterogeneous with energies up to nearly fifteen million electron-volts, while the neutrons from D + D are believed to be nearly homogeneous and of energy about two million volts. It would appear from our results that the proportion of high energy neutrons from Be + D must be small, in contrast with the recent results of Livingstone, Henderson and Lawrence, and also of Kurie[3], using three million volt diplons. It is also interesting to note that the reactions which do not appear to occur with the last two kinds of neutrons are those which from general considerations, such as the hardness of the emitted β-rays, would appear to require more energy for their excitation.

We wish to thank Dr. M. L. E. Oliphant for his assistance, and for putting his apparatus at our disposal for these experiments, and Lord Rutherford for his continued interest in our work and for much helpful advice. The experiments are being continued, and fuller details will be published later.

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[1] See, for example, NATURE, **133**, 757, May 19, 1934.
[2] Oliphant, etc., *Roy. Soc. Proc.*, A, **141**, 722; 1933; and A, **144**, 692; 1934. Also Lauritsen, etc., *Phys. Rev.*, **44**, 692; 1933.
[3] *Amer. Phys. Soc. Proc.*, Berkeley Meeting, June 18, 1934, Abstract 12, and private communication to Dr. Oliphant.

Development of the Lightning Discharge

WE should like to give a brief account of some further results obtained with the Boys lightning camera, which has now been modified so as to include a means of determining the order of the component strokes of a discharge.

The material available refers to 55 lightning flashes from eleven different thunderstorms, and the total number of separate strokes photographed is 145. Of these, 65 show clearly the two-fold character which we have previously reported[1,2], namely, a downward-moving leader stroke which at the moment it strikes the ground causes the development of a faster and more intense upward-moving main stroke. If we exclude those strokes photographed under definitely bad conditions (too great a distance, obscured by rain, etc.) the fraction of the strokes showing the leader mechanism is raised from 45 (65/145) to 82 per cent (41/50). Similarly, while 62 per cent (34/55) of the separate flashes show one or more examples of leaders, the fraction is raised to 86 per cent (18/21) if we consider the better photographs only.

The results thus suggest that the leader-main stroke sequence is the most common type of development in the discharge to ground. We have not yet met with more than one or two cases which may be considered significant exceptions. The polarity of the cloud-base in the majority of these flashes is negative, and cases of the reverse polarity are too rare in South Africa for us to have much evidence as to their behaviour. In the case of flashes which do not strike the ground, we do not observe the second or main part of the stroke.

An interesting feature of this new material is that it establishes the general manner in which branches are formed. We find that the downward-moving leader blazes these branches as well as the main trunk of the discharge and that the subsequent main stroke, in its upward course, turns aside to follow the branched leader down such a branch until it catches up with it. We have now 20 cases of downwardly branched leaders, taken from 16 different lightning flashes.

The most important point, however, which emerges from a consideration of these new photographs is that there is a characteristic difference between the leader to the first stroke of a discharge