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# Liberation of Neutrons from Beryllium by X-Rays: Radioactivity Induced by Means of Electron Tubes

IT has been recently reported[1] that neutrons are liberated from beryllium by $\gamma$-rays of radium and that these are able to induce radioactivity in iodine. Following up this work, we have attempted to liberate neutrons from beryllium by means of hard X-rays, produced by high-voltage electron tubes. An electron tube, which could conveniently be operated by a high-voltage impulse generator at several million volts[2], is at present in use in the High Tension Laboratory of the A.E.G. in Berlin, and has served in the present experiment for the production of X-rays.

X-rays from a tungsten anticathode generated at a voltage above $1{\cdot}5 \times 10^6$ v. were allowed to fall on beryllium. An organic bromine compound (bromoform) was exposed to the radiation of the beryllium and this compound was then sent by air from Berlin to London. Here, at St. Bartholomew's Hospital, after an isotopic separation[3] of the radio-bromine from the ordinary bromine, a weak activity decaying with the six-hour period of radio-bromine was observed.

Afterwards, at a higher voltage, but still below $2 \times 10^6$ v., very much stronger activities were induced in bromine and were observed both in Berlin and London. Strong activities were observed in Berlin both in bromine and iodine (30 minutes half-life period) in co-operation with K. Philipp and O. Erbacher of the Kaiser Wilhelm Institute for Chemistry, the activity and its decay being easily measured by means of an electroscope. Recently, Fermi, Amaldi, Pontecorvo, Rasetti and Segrè discovered[4] that by surrounding the irradiated material with substances containing hydrogen the efficiency of activation of certain elements by neutron bombardment is greatly increased. Use was made of this effect in these experiments.

A very sharp increase of the induced activity with increasing voltage is to be expected if there is a more or less sharply defined upper limit of the wave-length at which the liberation of neutrons from beryllium begins. If there is such a critical

wave-length, and if the voltage applied to the tube only slightly exceeds the corresponding critical voltage, a small fraction only of the total X-ray energy will be present in the form of radiation of sufficiently short wave-length; this fraction will then increase sharply with the excess voltage.

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[1] Szilard and Chalmers, Nature, **134** 494, Sept. 29, 1934.
[2] Brasch and Lange, *Z. Phy.*, **70**, H. 1/2.
[3] Szilard and Chalmers, Nature, **134**, 462, Sept. 22, 1934.
[4] Fermi, Amaldi, Pontecorvo, Rasetti and Segrè, *La Ricerca Scientifica*, **2**, Nos. 7–8.

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