## The Disintegration of Beryllium by Photons and Its Possible Bearing on the Mass of $Be^9$

Szilard and Chalmers[1] found that when beryllium was bombarded with the gamma-rays of radium in equilibrium with its decay products, neutrons were liberated, and could be detected by means of the radioactivity they excited in iodine. Meitner[2] showed that these neutrons excited radioactivity in I, Au and Ag, but not in Na, Si and Al. The former reactions involve the capture of a neutron, which, as Fermi[3] has shown, is most probable when the neutrons have little energy; while the latter three reactions involve the emission of an alpha-particle or proton, and probably have a higher probability when the bombarding neutrons have greater energies. Brasch and others,[4] working with x-rays, have obtained this disintegration at voltages between 1.5 and 2 mev.

In the present experiment, beryllium was bombarded with the x-rays from the tube in the Kellogg Radiation Laboratory. The tube is self-rectifying, and was supplied with 50 cycle a.c. at 0.9 mev peak. The electron current to the target was 2 m.a. The beryllium was located directly behind the tungsten target, in a bomb which was lowered inside the electrode. The ethyl iodide used as a detector for the neutrons was also in the bomb, just above the beryllium and in a Dewar vessel to prevent the heat generated at the target from reaching the ethyl iodide in the course of the irradiation, which lasted 40 minutes. The active iodine was separated from the ethyl iodide by the method of Szilard and Chalmers.[5] 200 g of beryllium and 375 cc of ethyl iodide were employed; the inside diameter of the bomb was 6.2 cm, and its overall length 25 cm. The intensity of radiation at 1 cm behind the target is calculated to be $2.5 \times 10^4$ $r$/min., on the basis of the measured intensity at 50 cm from the target and the known filtration in both cases.

The samples of iodine separated after irradiation were tested for activity with a quartz-fiber electroscope loaned by Professor C. C. Lauritsen. There was no increase over the background on the introduction of a sample. To check the sensitivity of the method, a test run was made with 370 mg of radium placed under the bomb in the position occupied by the target of the x-ray tube in the first experiment. The activation of the iodine in this case was easily measurable, initially more than doubling the cosmic-ray background. This poor yield in the case of the radium is to be attributed to the unfavorable geometrical conditions of necessity offered by the bomb; a much larger effect can be obtained by increasing the solid angles of irradiation.

Taking into consideration the relative intensities of the two sources of radiation, it may be said that an activation produced by the x-rays of one-one-thousandth the magnitude of that produced by the gamma-rays of radium would have been detected in this experiment. This may perhaps be reconciled with the statement of Gentner[6] that 0.9 mev radiation is most effective in the disintegration of beryllium, if one presumes that the efficiency of the process falls off sharply on the low-energy side of 0.9 mev, for the number of 0.9 mev quanta in the radiation produced in an x-ray tube excited with a.c. at 0.9 mev peak is very small.

If one is to suppose that beryllium is disintegrated into two alpha-particles and a neutron by a high energy photon, and that the enormously reduced yield just below a million volts found in this experiment indicates the existence of a genuine threshold for the phenomenon, then it seems possible that the mass of $Be^9$ is too high. If we fix the threshold at 0.9 mev and take the mass of the neutron as 1.0080, then, on our assumptions, the mass of $Be^9$ must be 9.0114, a result which explains the anomaly of the stability of $Be^9$, as well as Bonner and Brubaker's[7] results on the energy of the neutrons from Be bombarded with deutons. Miss Meitner's[8] result that radioactive $B^9$ is formed in the reaction

$$ {}_3Li^6 + {}_2He^4 \rightarrow {}_5B^9 + {}_0n^1 \rightarrow {}_4Be^9 + {}_1e^+ + {}_0n^1 $$

is additional evidence for this mass of $Be^9$, as Professor Lauritsen has pointed out to us.

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Louis N. Ridenour
K. Shinohara
Don M. Yost

W. K. Kellogg Radiation Laboratory
and Gates Chemical Laboratory,
California Institute of Technology,
Pasadena, California,
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[6] Gentner, Comptes rendus **199**, 1211 (1934).

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## Evidence for a Positron-Negatron Component of the Primary Cosmic Radiation

Recent studies of the cosmic-ray shower intensities and their dependence on latitude, elevation and direction have brought forth some new results which seem to throw important light on the nature of the primary radiation. For measuring the intensity of showers, three coincidence counters were mounted with their axes horizontal and at the vertices of an upright equilateral triangle. Immediately above the upper counter was a lead plate 1.2 cm thick and slightly larger than the cross-sectional area of a single counter. The counts thus recorded were corrected for accidental coincidences and the result was taken as a measure of the intensity of the shower producing radiation ($I_s$). The same three counters were also mounted in vertical line and the counting rate in this position, corrected for accidental coincidences and sidewise showers, was taken as a measure of the total radiation incident from the