An attempt to overcome the latter effect by working near the end of the homogeneous group range, absorber more than 45 mm, met with inherent experimental difficulties.

These observations are substantiated by the observations of Cockcroft and Lewis[2] that: "the ratios of the numbers counted at the peak of the main curve at 2 cm to the numbers at the peak of the end group at 4 cm changes from 22 : 1 at 185 kv to 90 : 1 at 360 kv."

An explanation of the observed efficiency curve for the long range homogeneous group is dependent on a satisfactory explanation of the proton-boron disintegration products, for which there have been several mechanisms devised.[5]

Qualitative results for the yield of α-particles per proton calculated for a pure boron target by multiplying the observations by 34/10 at 150, 175, 200 and 225 kv are: for range greater than 18 mm, 1.68×10^{-9}, 7.06×10^{-9}, 18.4×10^{-9}, and 32.3×10^{-9}; for range greater than 40 mm, 1.79×10^{-11}, 17.4×10^{-11}, 49.7×10^{-11} and 59.7×10^{-11}.

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University of Minnesota,
Minneapolis, Minnesota,
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Photon Theory and Compton Effect

Recently Shankland[1] reported coincidence experiments on the Compton effect with Ra C γ-rays, which led him to the conclusion that the photon theory fails to explain such experiments. On the other hand Bothe[2] and Geiger had shown some years ago, that the Compton effect is in full agreement with this theory for x-rays of about 70 kv. This result has been carefully established and is to be considered as correct, although meanwhile there has been some progress in the experimental technique. The result of Shankland has been discussed theoretically by several authors.[3]

We have reexamined Shankland's result, to find out whether really the behavior of radiation changes so fundamentally if the frequency is altered by one order of magnitude. Our experiments do not confirm Shankland's results. We found the photon theory able to describe the scattering of hard γ-rays as well as of the x-rays.

The arrangement was similar to the one used by Shankland except some simplifications. As primary radiation we used the filtered γ-rays of Th C″ (20 mg RaTh), which have the advantage of being more homogeneous than the γ-rays of Ra C. The scatterer was a Cellophane foil 0.028 mm thick. The recoil electrons were counted by one thin-walled Geiger-Müller counter 1.2 cm in diameter, the scattered photons in most cases by two connected lead counters of the same size. The β and γ counters were mounted symmetrically on opposite sides of the primary beam at a distance of about 2.1 cm from its axis; only for the experiment number 3 the azimuth was not 180°, but 90° (designated by j). The foil could be moved in the direction of the primary beam. According to the photon theory coincidences were to be expected if the foil was placed in such a manner that the direction from the foil to both the recoil electron counter and the photon counters formed an angle of 30° with the primary beam.

TABLE I. *Summary of results.*

Exper. No.	Scattering and Recoil Angle	Recoil Electrons per min.	Coincidences in 14.5 Hours		
			Without Foil	With Foil	Surplus
1*	30°	40	5	25	20
2	30°	52	34	95	61
3	30°	40	30	39	9
4	21°	40	39	46	7
	30°	38		95	56
	45°	28		50	11

* Only one tube counter for scattered γ-rays.

The results of experiments are given in Table I.[4] The second column gives the angle between the primary beam and the line from the foil to each one of the counters. The third column gives the increase of β counts caused by the foil. The fourth column shows the zero effect; to obtain it the foil was removed and the counting rates of the β counter were, by means of a weak source of β-rays, adjusted to the same amount as found when the foil was present. The γ counting rates were not changed noticeably by the foil. In the fifth column the numbers of coincidences counted with the foil are shown, in column 6 the difference caused by the foil. It is seen that in the position predicted by theory the number of coincidences is far greater than the zero effect, while in every adjacent position there is only a small fraction of this effect.

These experiments show, firstly that scattered photons and recoil electrons are emitted simultaneously, and secondly that their directions are interconnected as is predicted by Compton's theory. By a more detailed discussion, which will be published elsewhere, it is seen that the observed number of coincidences is consistent with the assumption of this connection holding quantitatively.

To get a satisfactory explanation of Shankland's negative result it would be necessary to consider some more experimental data which were not contained in his paper. We believe that the inhomogeneity of the Ra C γ-rays played an important role in his experiment.

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Heidelberg, June 6, 1936.

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