Letters to the Editor

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NOTES ON POINTS IN SOME OF THIS WEEK'S LETTERS APPEAR ON P. 39.

CORRESPONDENTS ARE INVITED TO ATTACH SIMILAR SUMMARIES TO THEIR COMMUNICATIONS.

Correlation between Scattering and Recoil in the Compton Effect

As is well known, the experiments of Bothe and Geiger[1] and of Compton and Simon[2] on the correlation between scattering of individual X-ray quanta and electron recoil gave results in complete agreement with the theoretical explanation of the Compton effect, based on the conservation of energy and momentum in each scattering process. The entirely negative results of the recent attempt by Shankland[3] to find such a correlation in the scattering of γ-rays from radium was therefore most unexpected, and it seems desirable to repeat the experiments under conditions as well defined as possible and especially using the much more homogeneous γ-rays from thorium[4].

For this purpose, experiments have been carried out, using a source of 10 mgm. of RaTh filtered by 0·5 cm. lead. The γ-rays next passed through a hole of cross-section 1 — × 1·5 cm. in a lead block 30 cm. thick. The scattering angle was 30° both for the electrons and the quanta, the scatterer was a sheet of paraffin wax of 0·05 cm. thickness. A single counter was used for the detection of the scattered quanta and one for the electrons; the two counters were identical except that the electron counter had an aluminium window with thickness 0·04 mm. and diameter 2 cm. The distance from the counter to the scatterer was about 8 cm.

In a single experiment the coincidences were counted together with the kicks in each of the counters. To determine the number of chance coincidences a lead sheet of thickness 2 mm. was placed in front of the β-counter; the reduction in the number of single kicks caused by the presence of the lead plate was counterbalanced by placing a weak source of RaD close to the electron counter. The number of kicks in the γ-counter was not changed by this procedure. The coincidences found with the lead plate in position give the number of chance coincidences in the first experiment. The following results were obtained in two different series of experiments:

	Kicks per minute				Coincidences per hour		
	Without scatterer		With scatterer		Total (without lead plate)	Chance (with lead plate)	Difference
	β	γ	β	γ			
I	120	28	195	29	6·5 ± 0·6	2·3 ± 0·3	4·2
II	120	120	195	121	11·7 ± 0·9	8·6 ± 0·7	3·1

In the second experiment the number of chance coincidences was increased by exposing the γ-counter to a weak source of RaD. The experiments show that coincidences exist between the β- and the γ-counter in a number which is well beyond the experimental error.

The number of kicks in the γ-counter due to the presence of the scatterer was 1·0 per minute. This was found by replacing the scatterer by a block of paraffin wax of known weight, the proportionality between the weight of the scatterer and the number of kicks being tested by separate measurements. If for each scattered quantum recorded by the γ-counter the corresponding electron was recorded by the β-counter, the number of coincidences would thus be 1·0 per minute. This is, however, reduced considerably by a number of circumstances, such as lack of homogeneity of the primary radiation, scattering within the scatterer, etc., which are difficult to take into account accurately. A rough estimate gives for the expected number of coincidences about 8 per hour, in substantial agreement with the value actually found.

These experiments would, therefore, seem to confirm the usual theory of the Compton effect in every respect.

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[1] *Z. Phys.*, **32**, 639 (1925).
[2] *Phys. Rev.*, **26**, 289 (1925).
[3] *Phys. Rev.*, **49**, 8 (1936).
[4] Since the experiments recorded above were finished, an account of similar experiments leading to the same results has been published by Bothe and Maier-Leibnitz (*Göttingen Nachr.*, **10**, 127; 1936).

Conservation Laws in Quantum Theory

IN connexion with the new experiments on the correlation between scattering and recoil in the Compton effect by Bothe and Maier-Leibnitz, as well as those by Dr. Jacobsen recorded above, both contradicting the conclusions regarding the absence of such a correlation arrived at by Shankland, I should like to make the following brief comments upon the renewed discussion[1] on a possible failure of the laws of conservation of energy and momentum in atomic phenomena, to which Shankland's experiments have given rise.

When in an early attempt[2] at a generalisation of the classical radiation theory suited to meet the puzzling dilemma of the wave and corpuscular character of radiation, doubts were expressed regarding the validity of the conservation laws for individual quantum processes, the situation was quite different from what it is to-day. Not only have subsequent experimental discoveries made us familiar with similar paradoxes regarding the behaviour of electrons and other material particles, but above all has the establishment of rational methods of quantum mechanics and electrodynamics proved the compatibility of the existence of the quantum of action with the strict validity of the conservation laws in all such phenomena as electron diffraction and Compton effect. Moreover, the examination, initiated by Heisenberg, of the complementary limitations in quantum theory of measurements of mechanical quantities as well as of electromagnetic field components[3] has completely removed every paradox in