

This phenomenon has been described by Fr. Ahlborn and shown diagrammatically¹. I also studied this process of disintegration a few years ago, and several photographs were taken. Those photographs were not published, and the matter has been forgotten. Ahlborn's description is, however, diagrammatic and not photographic: these photographs of mine, I think, might have some scientific interest. Two of them are reproduced here (Fig. 1). (a) is one of the most beautiful examples, and represents the first disintegration stage and the beginning of the second disintegration. (b) shows a further developed stage, but not a continuation of (a).

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¹ "Dynamik des Regens", *Phys. Z.*, **32**, 139; 1931.

Scattering of Hard Gamma Rays by Lead, and the Annihilation of Positive Electrons

THE following experiment was carried out to make a further test of the hypothesis, proposed by Blackett and Occhialini, that the 'nuclear' scattering of hard γ -rays by heavy elements is due to the annihilation of positive electrons produced by the γ -rays¹. γ -rays from an emanation tube were used, the source being placed at *S* (Fig. 1). Observations were made on the ionisation produced in the chamber *I* due to the introduction of a thin lead foil (0.1 mm.) into the position *BB'*, first, with an aluminium sheet (3 mm. thick) at *AA'*, secondly without the aluminium sheet. According to the above hypothesis, the ionisation should be greater in the first case, because the positive electrons which are produced in the lead foil and escape from it in the forward direction, are stopped in the aluminium sheet. In the second case they are

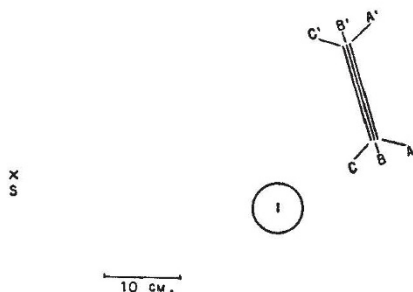


FIG. 1.

practically lost from the neighbourhood of the ionisation chamber, and therefore also their annihilation radiation. Apart from this, the only difference between the two cases is that, in the first, the lead foil absorbs some of the radiation scattered by the aluminium. This tends to make its effect smaller than in the second case, and is therefore in the opposite direction to the above positive electron effect. Quantitatively, the absorption effect is, however, quite small, being only 2 per cent of the total effect of the lead foil.

The results of several observations showed that the effect of the lead foil was greater when the aluminium sheet was present than when it was away, the difference being 25 ± 3 per cent. The result provides direct evidence for the positive electron hypothesis. Quantitatively it is difficult to say whether the fraction 25 per cent is consistent with

the supposition that all the 'nuclear' radiation from lead is due to the agency of positive electrons. Two factors detract from a 100 per cent effect. In the first place, a certain fraction of the positive electrons produced in the foil will not be able to escape from it in the forward direction, owing to insufficient range and to scattering in the foil. Secondly, the wax sheet placed at *CC'* (which absorbs in all cases the positive electrons escaping backwards from the foil) is also a source of positive electrons, and the stopping of these by the lead foil further reduces the effective number which escapes from it.

Accurate analysis is difficult, and to find, by this method, if some of the 'nuclear' radiation from lead consists of other radiation than that associated with positive electrons, observations with different thicknesses of foil and different degrees of filtering must be made. The above observations were made with 1 cm. lead filter in the path of the scattered rays. This was sufficient to absorb the Compton radiation, the angle of scattering being about 140° .

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¹ Since the present results were obtained, papers by Joliot and Thibaud (*Comptes rendus*, Dec. 18, 1933) have appeared, which also report direct evidence for the annihilation of positive electrons, a magnetic field being used to deflect positive electrons so as to be stopped close to an ionisation chamber.

Determination of Dipole Moments in Solution

SUBSTANCES the molecules of which contain a large permanent dipole give a marked decrease in the measured values of the molecular polarisation P_2 in solution as the concentration of the solution increases. This effect has been ascribed to dipole association; it appears to be much too large to be due to association in the chemical sense of the term since, for example, nitrobenzene, which from many of its physical properties would be classed as a nearly normal liquid, shows a considerable fall in P_2 in benzene over the concentration range 0.5-2 per cent.

If P_2 is plotted against the volume polarisability $(\epsilon - 1)/(\epsilon + 2)$ for solutions of benzonitrile, nitrobenzene and chlorobenzene in a number of non-polar solvents, the points for each substance all lie near a straight line through the entire range of solutions to the pure liquid (Fig. 1). The values of ∞P_2 found by Horst Müller for chlorobenzene and those recently given by Jenkins for nitrobenzene all lie close to the appropriate curve.

This regularity appears to apply only to solutions in solvents with small or zero moments. Thus solutions of benzonitrile in chlorobenzene measured by me give points which lie well below the line in Fig. 1. Highly associated liquids, for example alcohols, may also be expected to deviate from the linear law.

A crude picture of the phenomenon underlying the relationship shown in Fig. 1 may perhaps be drawn as follows. The permanent dipole of a molecule in a solution may be regarded as surrounded by an 'atmosphere' of dipoles of opposite sign produced partly by induction in the polarisable solvent molecules and partly by orientation of adjacent permanent dipoles. The measured polarisation therefore appears to be less than the true value. The correction for the opposing atmosphere of dipoles should be a