"On the Intensely Penetrating Rays of Radium." By Hon. R. J. Strutt, Fellow of Trinity College, Cambridge. Communicated by Lord Rayleigh, F.R.S. Received August 5, 1903.

Radium is known to emit three types of radiation. These are—

(1) The α rays, very easily absorbed by solids, and carrying a positive electric charge.

(2) The β rays, more penetrating than these, and negatively charged.

(3) The γ rays, intensely penetrating, and not conveying an electric charge at all.

In a paper published in the 'Phil. Trans.' for 1901, I investigated the relative ionisations of gases by the α and β rays. The present communication may be regarded as a sequel to that one, and deals with the γ rays.

The radium employed was of activity 1000 (uranium = 1), and was contained in a glass cell, over which was cemented a piece of thin aluminium. The cell was placed in a cavity in a block of lead, and over it was placed a disc of lead 1 cm. in thickness. This it was considered would suffice to suppress all but the γ rays, which are much the most penetrating.

In measuring the electrical leakage, the electroscope method was employed. The apparatus was that described in a paper published in the 'Philosophical Magazine' for June, 1903, p. 681.

The radium, covered by the thick lead, was placed under the apparatus, and the rate of leak determined when the different gases filled the testing vessel.

The conditions were, of course, arranged so as to use a saturating E.M.F. The γ rays are so penetrating that there can be no question of their being appreciably absorbed in a moderate thickness of gas.

For the methods of preparation of the gases I must refer to the former paper.*

The results were as follows; the rates of leak are given in scale divisions per hour, and are corrected to 30 inches pressure :—

* 'Phil Trans.,' A, vol. 196, 1901, p. 508.

Gas.	Rate of Leak.	Mean.
Hydrogen	10·4, 10·5, 10·4, 11·2, 10·4, 11·2, 9·86, 10·1, 10·2 .	10·5
Air	65·2, 66·6, 66·6, 60·0, 57·0, 61·5, 60·2, 63·0, 58·2, 58·3, 56·6, 56·2	62·1
Oxygen	75·0, 74·2, 71·0, 74·1	73·6
Carbon dioxide	96·0, 95·4, 94·5, 95·1, 94·1, 94·7.....	95·0
Cyanogen.....	107, 104, 106, 106	106·0
Sulphur dioxide	132, 126, 134, 135	132 0
Chloroform	297, 298, 290, 327	303·0
Methyl iodide	298, 292, 310, 291	298·0
Carbon tetrachloride..	363, 351, 344, 349	352·0

The following table gives the relative ionisations, referred to air as unity. The values of the same constants for the α and β rays formerly found are included, and also measurements of relative ionisation under Röntgen rays. These latter form part of an investigation not hitherto published.

Relative Ionisations.

Gas.	Relative density.	Relative Ionisation.			
		α rays.	β rays.	γ rays.	Röntgen rays.
Hydrogen	0·0693	0·226	0·157	0·169	0·114
Air	1·00	1·00	1·00	1·00	1·00
Oxygen	1·11	1·16	1·21	1·17	1·39
Carbon dioxide	1·53	1·54	1·57	1·53	1·60
Cyanogen	1·86	1·94	1·86	1·71	1·05
Sulphur dioxide.....	2·19	2·04	2·31	2·13	7·97
Chloroform.....	4·32	4·44	4·89	4·88	31·9
Methyl iodide.....	5·05	3·51	5·18	4·80	72·0
Carbon tetrachloride....	5·31	5·34	5·83	5·67	45·3

The determinations for the γ rays are less accurate than the former ones for the α and β rays, on account of the very much smaller rates of leak which have to be measured. I think, if this be taken into account, there is no reason to doubt that, within the limits of experimental error, the γ rays give the same values as the β rays. These values are nearly proportional to the density of the gas, except in the case of hydrogen. The law which holds in the case of Röntgen rays is totally different.

This conclusion throws some light on the nature of the γ rays. The view seems to be gaining ground that these are Röntgen rays, produced by the impact of the β rays on the radium itself.* This theory seems

* See, for instance, Madame Curie, 'Thèses présentées à la Faculté des Sciences,' 1903, p. 83.

to have much to recommend it. The β rays should, by analogy with the cathode rays in a vacuum tube, produce Röntgen rays when they strike a solid obstacle, and these Röntgen rays should be much more penetrating than the β rays themselves. The γ rays seem at first sight to be just what should be expected. But the present paper shows that in one respect, at all events, the γ rays behave quite differently to Röntgen rays, while, on the other hand, they resemble the α and β rays. There seems to be a possibility that they too are of a corpuscular nature, though uncharged with electricity. This would account for the absence of magnetic deflection

I do not think that the absence of conspicuous Röntgen radiation is very hard to understand, if we consider that the current emitted in cathode rays by a square inch of intensely active radium is only 10^{-11} ampères; the current through a focus tube is of the order 10^{-2} ampères, and probably a great part of this is carried by the cathode rays.