

# **STUDIES IN RADIOACTIVITY**

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Studies in radioactivity by W. H. Bragg

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**W. H. BRAGG**

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# STUDIES IN RADIOACTIVITY

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NO. 101  
ANNEX 101



## PREFACE

IN this book I have dealt mainly with the phenomena attending the passage of the  $\alpha$ ,  $\beta$ ,  $\gamma$  and  $X$  rays through matter. It is a subject which I have myself tried to investigate: and the book was undertaken in response to a request that I should write a short account of my experiments and of the conclusions to which they had led. My own work has been, however, so bound up with and dependent upon that of others that it could not be considered by itself with any profit. I have therefore confined the book within the limits, not of my own enquiries, but rather of the field in which the enquiries have been made. Though this is a limited portion of the domain of radioactivity, it has been difficult to consider it in any detail in the space allowed. I have tried only to give an account of the principal features of the special subject, and to draw together the things which most invite comparison. The statement is far from complete in a historical sense, and the reader who would learn more details of the work which has been done should consult the original memoirs, or books which can really claim to be treatises on radioactivity, such as those of Rutherford or Mme. Curie.

Certain general conclusions seem to me to follow from a comparative study of the three types of radiation, and I hope that I have made this appear from what I have written.

In the first place, it is interesting to observe the absence of any evidence of true secondary radiation; that is to say, of an ionising radiation which derives its energy from matter under the prompting of primary rays. That to which the name has been provisionally given draws its energy from the primary alone, and we can, up to the present, claim no power of causing the atoms to unlock and distribute any stores of energy which they may possess. This is not, of course, the first occasion on which the conclusion has been stated.

Again, it is remarkable that there should be so little evidence of the influence of molecular association upon radioactive phenomena. When an atom acts upon a passing  $\alpha$  or  $\beta$  or  $\gamma$  ray, it is unsupported by any other atom, even of those belonging to the same molecule.

It is impossible to avoid being struck by the strong family likeness which the three types of radiation,  $\alpha$ ,  $\beta$  and  $X$  or  $\gamma$ , rays, bear to each other. The  $\alpha$  rays are positively charged, the  $\beta$  rays negatively, the  $X$  and  $\gamma$  rays are uninfluenced by electric and magnetic fields. But, putting aside these differences and their immediate consequences, in their laws of penetration and of scattering, in their actions on matter and the reactions which they suffer themselves, the three forms of radiation differ in degree rather than in kind. If it is assumed that the action of each form is direct and requires no assistance from any other form, it is difficult to believe at the same time that the  $\alpha$  and  $\beta$  radiations are corpuscular, and that the  $X$  and  $\gamma$  rays are spreading pulses in the æther. The distinction in form is too great: the  $X$  and  $\gamma$  rays have corpuscular properties also.

I believe, however, that the assumption is wrong: and that the  $X$  and  $\gamma$  rays act only through the intervention of  $\beta$  rays. This is accomplished by means of a complete interchangeability between the  $X$  or  $\gamma$  ray on one hand and the moving electron on the other, a change which may be

brought about during the passage of the ray or the electron through the atom. This is one of the most striking of the general conclusions to which I have referred. It explains the great bulk of the  $X$  ray phenomena with readiness and simplicity, and, moreover, it bids fair to be useful in the still wider field of general radiation. I have tried to show that the interchange must take place with little loss of energy. Papers by R. Whiddington and C. T. R. Wilson, published so recently that I have been unable to refer to them in the book, accentuate still further the reality and importance of the conception and simplify it by showing that the transformations imply no loss of energy at all. Wilson's most recent photographs of the clouds formed on the tracks of ionising agents are far better than those which I have been able to reproduce.

The principle of interchangeability also leads at once to a corpuscular hypothesis of  $X$  and  $\gamma$  rays. The corpuscular idea correlates the main facts in a fashion which is convenient both for thought and for experiment. I think it is just to say that the æther pulse idea has been for some time unproductive. It is only by the aid of numerous and very special assumptions that it can be made to account, even to outward seeming, for the phenomena of the scattering and the absorption of  $X$  rays and the production of the secondary radiation. It seems to me better to put it aside provisionally and to take the interchangeability of  $X$  ray and electron as a new starting-point. From this, fresh opportunities of advance in knowledge open out in all directions, and after all that is the one sufficient justification for any hypothesis. To take such a step is no denial of all connection between  $X$  rays and electro-magnetic phenomena: it is but to put down one tool and to take up another better fitted for the moment to the work in hand.

I am glad to take this opportunity of acknowledging